THE IMPROVEMENT IN CITIZEN AWARENESS OF LOW-FREQUENCY HAZARDS AFTER A DISASTER RISK REDUCTION TOWN WALK – A CASE STUDY IN THE TEJTURI BAZAR AREA OF DHAKA CITY

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Abstract

It is necessary to prevent the damage caused by low-frequency hazards and larger than the scale of the hazard. It is, therefore, important to take effective measures by raising awareness of disaster management in the public and private sectors. One of the important measures to reduce the damage caused by earthquakes is seismic retrofitting, and one of the measures to raise the disaster risk reduction awareness of building owners is the "disaster risk reduction town walk." This is an activity in which local people receive information on earthquakes, walk around the town to understand the dangers in it, and think about improvement measures, which they expect to be eventually realized.

The purpose of this study is to clarify how residents' awareness of disaster risk reduction and the cost-bearing consciousness of building seismic retrofitting have been improved by disaster risk reduction town walking. Accordingly, the following two research questions are set. First will disaster risk reduction town walk change people's awareness of earthquakes and seismic retrofits? The cost of implementing a disaster risk reduction town walk is not high, so if such an event causes a change in people's consciousness, it would be valuable to implement it actively. The second question is, what kind of people are particularly affected by disaster risk reduction town walks? By clarifying this point, it will be possible to implement it more efficiently and effectively by narrowing down the places where it will be conducted and the participants that will be called.

The target area of this study is Tejturi Bazar area in Dhaka city, Bangladesh. The target disaster risk reduction town walk was the Town-Watching Program (TWP) conducted by SEEDS Asia. TWP consists of three parts: 1) walking around the area, 2) making a map by each group of each of the locations found, and adding explanation and pictures to the map, 3) presentation of what they found in front of all the participants.

As conclusions, firstly, it became clear that people's consciousness about earthquakes, seismic retrofitting, and the cost burden to them was changed by the disaster risk reduction town walk. A particularly clear effect was seen for better seismic retrofitting, and the effect can be evaluated as being significantly higher than the cost of a single TWP. Secondly, the impact on the WTP for seismic retrofitting was particularly affected by having less education, by being younger, by whether they are residents of newer or older homes, and by not being worried about earthquakes. It is therefore important to encourage people in these groups to participate in the TWP from the viewpoint of improving the TWP's efficiency.

Keywords: low-frequency hazard; seismic retrofit; willingness to pay; disaster risk reduction town walk; Dhaka city

1. Introduction

1.1 The importance of "disaster risk reduction town walks" for low-frequency disaster

We live with various hazards such as earthquakes, floods, and tsunamis. For citizens to live a safe and secure life, it is important to take appropriate measures against these hazards. Various measures, both structural and non-structural, are being undertaken for hazards that occur frequently in the region, as both public and private sectors maintain a high awareness of disaster risk reduction. Therefore, even if a disaster of a certain scale occurs, the damage can be controlled. On the other hand, in both public and private sectors, the awareness of disaster risk reduction is not necessarily high with regard to low-frequency hazards, and sufficient disaster risk reduction measures are not being taken. Therefore, when such a hazard occurs, the damage is larger than the scale of the hazard, which may result in a large-scale disaster.

To prevent such a situation, it is important to raise awareness of disaster management in the public and private sectors, and to prevent the spread of damage by taking effective measures.

One of the important measures to reduce the damage caused by earthquakes is seismic retrofitting. Although it is costly, in countries where earthquakes occur frequently, such as Japan, the government provides subsidies, and each building owner bears to spend a certain amount of money to carry out the retrofitting work. This has been effective as a measure against earthquake disasters. However, if earthquakes are a low-frequency hazard, governments rarely provide subsidies for seismic retrofits, and owners rarely invest in them, either. This is especially true when the public and private sectors have no economic margins, as is the case in developing countries.

Therefore, to prepare for such low-frequency hazards, it is necessary for both the public and private sectors to properly understand the risks, raise disaster risk reduction awareness, and take appropriate measures accordingly. In particular, the owner of the building is primarily responsible for it, so it is important to improve the owner's awareness of disaster risk reduction and to encourage them to do seismic retrofitting of the building.

One of the measures to raise the disaster risk reduction awareness of building owners is the "disaster risk reduction town walk." This is an activity in which local people receive information on earthquakes, walk around the town to understand the dangers in it, and think about improvement measures, which they expect to be eventually realized. The town walk itself does not require a large budget, so if it can attract a larger investment from the private sector, a safer town can be created with a small administrative budget.

1.2 Previous studies

Faupel et. al. (1992) [1] examined the impact of participation in disaster education programs generally, the impact of hurricane experience as a type of education, and the impact of participation in earthquake-specific education programs to determine whether there is any transference of knowledge across agent types. They found that participating in a disaster education program is strongly related to preparedness measures, while participation in earthquake-specific education programs is not a significant predictor of either planning or response when controlling for other variables.

Rahman et al. (2018) [2] applied the concept of „Participatory Vulnerability Reduction" to the community of Dhaka city, which had been identified in a research as one of the most vulnerable areas of the city for earthquake. PVR consists of the following three steps: assessment of earthquake vulnerability, assessment of community capacity and development of the strategy to overcome the vulnerability. They finally found that the participatory methods can be successfully applied to draw more in-depth findings in participation of local community who possess the best knowledge about themselves.

Newport et al. (2003) [3] described how the Society for National Integration through Rural Development in India was involved in local communities when developing disaster mitigation measures. They showed how the participation of the community in resource identification, capabilities, coping mechanisms, and vulnerability assessments would be more effective in the planning of a sensible and practical system, and more suitable for the needs of the community.

Yoshida et al. (2009) [4] carried out the town walking program for disaster risk reduction and illustrated the effects of collective watching and participatory mapping on the engagement of school children and communities in risk reduction activities. Though the program itself is similar to the program carried out in this study, the target area as well as the effect measurement target is different from the present study.

Saito et al. (2017) [5] clarified that the outcomes for disaster management activities in the local community include improved risk perception, disaster management activities, and disaster awareness for residents. They also identified the issues in planning and continuing community disaster management activities after deciding to make a disaster management plan.

In addition, Nakagawa (2015) [6] identified the effectiveness of the experience-based disaster education program utilizing ICT in the practical activity of "Ishinomaki Tour -Remember 3.33-," a kind of town walking program for disaster prevention, developed after the 2011 Great East Japan Earthquake.

However, no study has yet clarified the effectiveness of a disaster risk reduction town walk in developing countries in improving the residents' awareness of disaster risk reduction and their willingness to retrofit buildings.

1.3 Objectives of this study

The purpose of this study is to clarify how residents' awareness of disaster risk reduction and the cost-bearing consciousness of building seismic retrofitting have been improved by disaster risk reduction town walking.

Accordingly, the following two research questions are set. First, will disaster risk reduction town walk change people's awareness of earthquakes and seismic retrofits? As mentioned above, the cost of implementing a disaster risk reduction town walk is not high, so if such an event causes a change in people's consciousness, it would be valuable to implement it actively. The second question is, what kind of people are particularly affected by disaster risk reduction town walks? By clarifying this point, it will be possible to narrow down the places where town walks are carried out and the number of participants who can be invited, which means that a more efficient and effective project implementation and a more significant achievement of the objectives will be possible. This is the basic information necessary for effectively promoting countermeasures against low-frequency earthquake hazards.

1.4 Target and methods used in the study

The study was conducted in the Tejturi Bazar area in Dhaka, Bangladesh. The target residents were 14 building owners and residents in the area. The number of people surveyed was not necessarily sufficient. However, given the low awareness of low-frequency risks in developing countries, it is inevitable that the number of participants will be limited at first. In fact, when developing countries are used as a field, it is important to search for the truth by stacking multiple (albeit somewhat incomplete) data rather than by aiming for perfect data from the beginning.

The target disaster risk reduction town walk was the Town-Watching Program (TWP) conducted by SEEDS Asia.

The survey method was a hearing survey followed by a questionnaire survey. The survey was conducted in July 2018.

Regarding willingness to pay (WTP), we used a multiple-choice system rather than a questionnaire design that repeats alternatives, which is considered a better method. This is because the survey time was limited and it was necessary to use a simple survey method in consideration of the ability of the respondents, so that changes in responses before and after the TWP could be grasped accurately.

2. Contents of Town-Watching Program

The Town-Watching Program was developed based on UNISDR's Town-Watching Handbook (Shaw and Takeuchi, 2009) [7] and modified to suit the situation in Dhaka city [8].

As regards learning systems, town-watching falls in the experiential learning category, which needs to be complimented by lectures (using text books, videos and other related information sources), and presentations (using different workshop tools). The objectives of town-watching are to increase children's and adults' awareness of disaster risk reduction and preparedness.

The TWP mainly consists of three parts. The first part is walking around the area. Each group walks around the predetermined area, finds the designated locations, takes notes, and takes photographs. The second part involves making a map by each group of each of the locations found, and add explanation and pictures to the map. The last part is the presentation. Each group makes a presentation of what they found in front of all the participants, and the other groups ask questions of the group making a presentation. If there are no questions, the chair asks questions. The chair makes comments and provides a summary.

3. Basic information about the participants and their buildings

3.1 Attributes of the participants

Regarding the age of participants (Fig. 1), middle-aged people in their 30s and 40s made up the majority, eight people (57%). Five young people were under the age of 30 (36%). There was only one person aged 50s or older.

In terms of occupation (Fig. 2), five people said "business" (36%), while three people each said "private job" or "student."

Regarding educational background (Fig. 3), five (36%) graduated from college, and three (21%) completed master's degrees, more than half in total. Considering that the university enrollment rate in Bangladesh is 18% (UNESCO, 2017) [7], this is a very high value. Four people had a secondary education (29%).

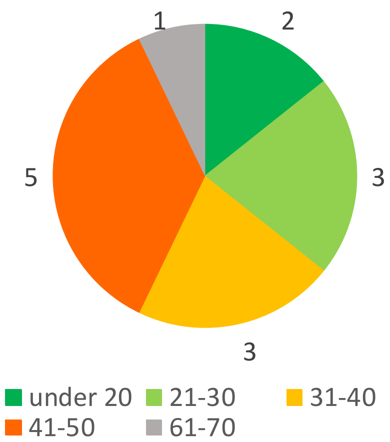

Fig.1 Age of the participants

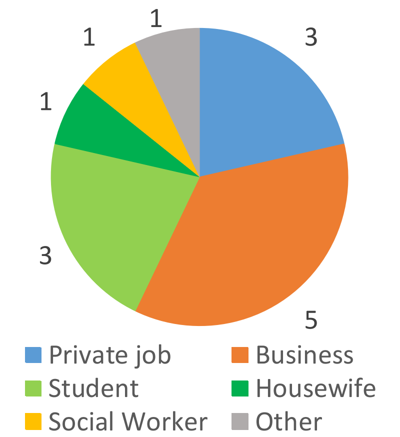

Fig. 2 Occupation of the participants

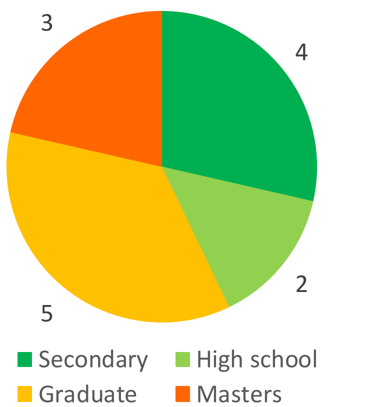

Fig. 3 Educational background of the participants

Regarding income (Fig. 4), they responded subjectively on a three-point scale. Six people (43%, the highest percentage) said "no answer," while five respondents said their income was "high" (36%).

For the number of family members (Fig. 5), 13 respondents (93%) answered "4" or "5."

As for real estate rights (Fig. 6), ten were owners and four were renters.

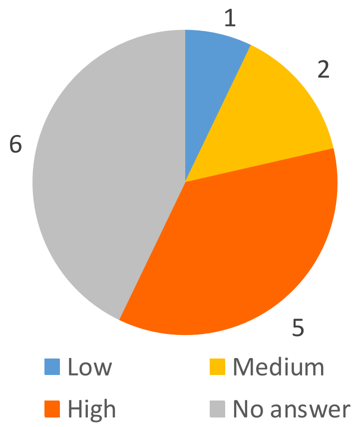

Fig.4 Income of the participants

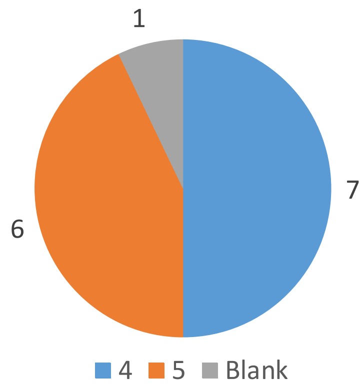

Fig.5 Number of family members of the participants

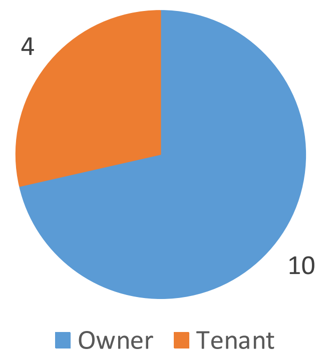

Fig.6 Real estate right of the participants

3.2 Attributes of owned/rented buildings

Regarding the age of the buildings (Fig. 7), responses varied with five (36%) reporting "fewer than 10 years," and two each saying "10-20 years," "20-30 years," "30-40 years," and "40-50 years."

As for the structure, all of them live in reinforced concrete buildings. All (Fig. 8) had between five and nine floors, indicating that all were medium-rise buildings. Regarding rebuilding (Fig. 9), 11 people (79%) answered that they did not consider rebuilding, and three people (21%) said they would rebuild "within 10 years."

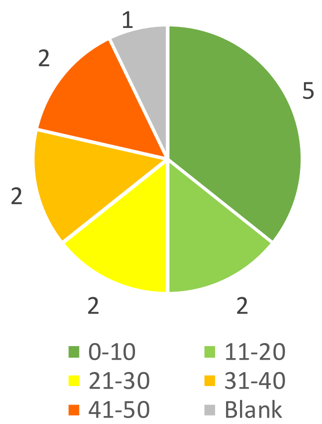

Fig.7 Building age (year)

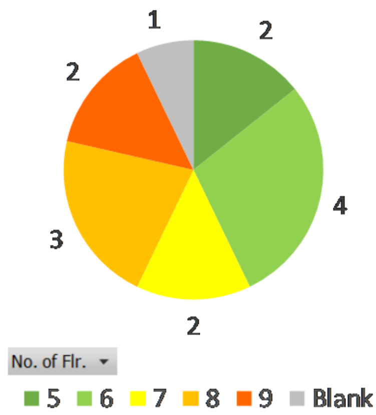

Fig.8 Number of floors of the building

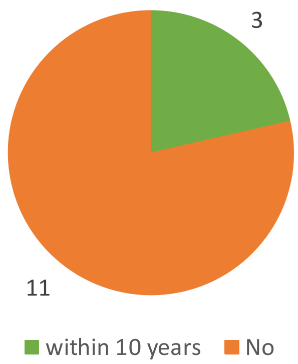

Fig.9 Plan of rebuilding

4. Changes in the awareness of disasters

4.1 Changes in the awareness of earthquakes

Before the TWP, 10 (71%) said that they were "very worried" about an earthquake, while four (29%) were "little worried" and no one was "not worried" (Fig. 10). This suggests that they had a certain perception of the danger of earthquake hazard in the first place. In contrast, after the TWP, one (7%) still answered "little worried," but the rest (93%) answered "very worried." This suggests that the implementation of the TWP increased the awareness of earthquake hazards.

Analyzing their responses according to the age of the building in which they reside (Fig. 11), the proportion of respondents who answered “little worried” is relatively high when the building is no more than 20 years old, while most of the respondents who reside buildings more than 20 years old answered “very worried.” It was found that the residents of older buildings had relatively less fear of earthquake, though their awareness changed due to the TWP.

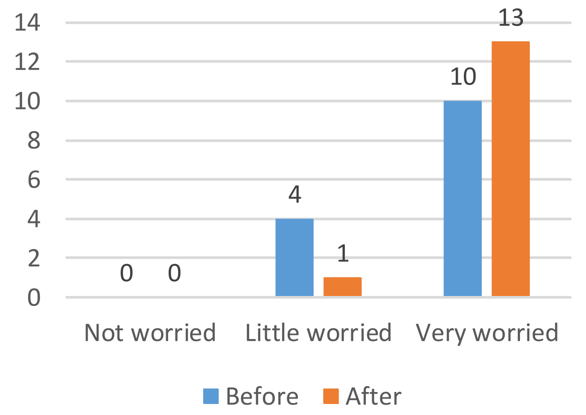

Fig.10 Worried about earthquake

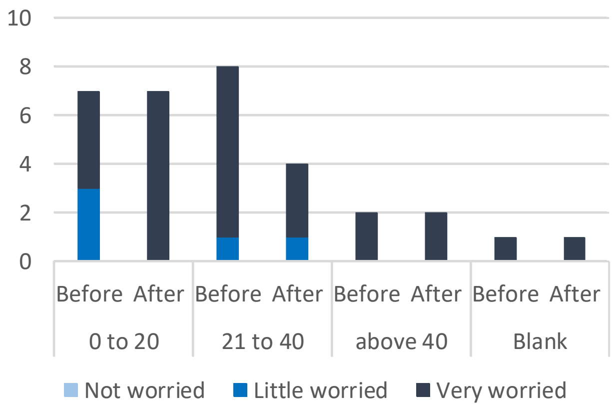

Fig.11 Worried about earthquake by own building age

4.2 Changes in awareness about the building

Before the TWP, the majority, 9 (64%) were “little worried,” while two were “not worried” (14%), and only three were “very worried” (21%) (Fig.12). However, the TWP reduced the number of “not worried” to 0, while the number of “very worried” increased significantly to 11 (79%). The TWP, therefore, changed the awareness of residents who consider their buildings safe.

A cross-analysis of this with earthquake awareness (Fig. 13) reveals that only one person answered “very worried” about both the earthquake and his own building. The remaining nine people answered “very worried” about the earthquake and “not worried” or “little worried” about their buildings. This shows that many citizens consider their own buildings to be safe even if they have anxiety about earthquakes in general.

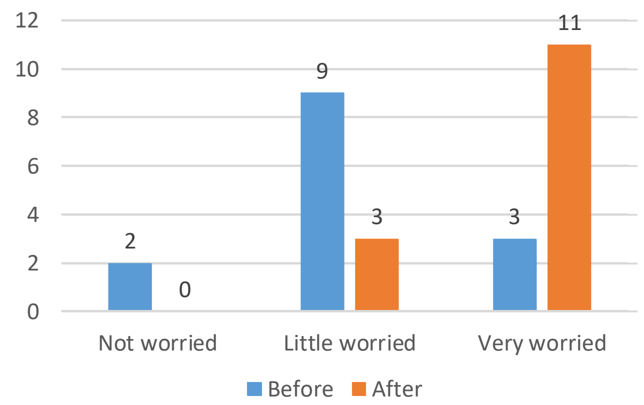

Fig.12 Worried about own building

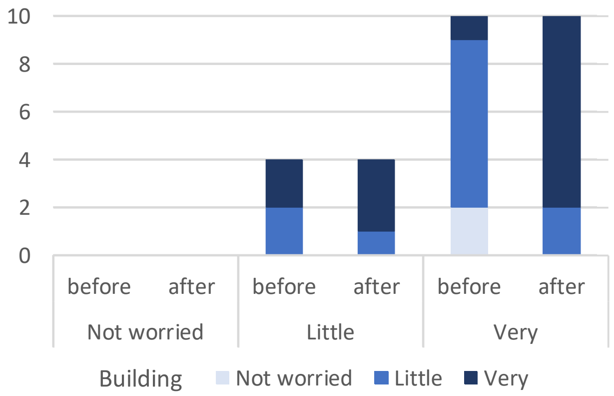

Fig.13 Worried about own building and earthquake

Looking at this by building age (Fig.14), six out of seven residents (86%) living in a building less than 20 years old answered either “not worried” or “little worried,” while two people living in a building more than 40 years old both answered "little worried." It can be said that there is no clear correlation between the age of the building and the residents' concerns about their own building.

In terms of educational background (Fig. 15), those who answered "not worried" initially were all secondary school graduates, while those who answered "very worried" were all college graduates. The higher the educational background, the higher the awareness of earthquakes. In addition, all four secondary graduates became "very worried" after the TWP, suggesting that such community programs are likely to be effective with those with a low educational background.

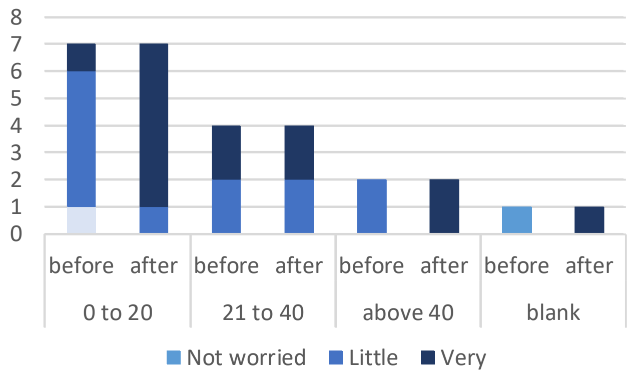

Fig.14 Worried about earthquake by own building age

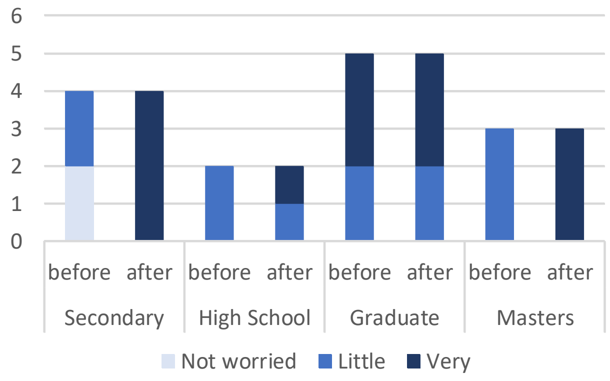

Fig.15 Worried about earthquake by education

4.3 Changes in WTP for seismic retrofits

Regarding seismic retrofitting, questions were asked about four cases: the possibility of building collapse being 80%, 60%, 40%, and 20% due to seismic retrofitting. There were seven options: willing to pay 200 Bangladeshi Taka (TK)/sq. ft. or less, 200-400 TK/sq. ft., 400-600 TK/sq. ft., 600-800 TK/sq. ft., 1,000-1,200 TK/sq. ft., and 1,200 TK/sq. ft. or more. In calculating the average, the median of each range was taken. In addition, we calculated "1,200 TK/sq. ft. or more" as 1,400 TK/sq. ft. Therefore, the average value may be lower than the actual value.

First, looking at the WTP by collapse probability (Table 1), it can be seen that WTP increases as the collapse probability decreases, both before and after the TWP. It can also be seen that the TWP increases due to the TWP regardless of the probability of collapse. This is characteristic of the rate of increase in WTP. Once the probability of collapse reaches as high as 80%, it increases by only 8%, and there is almost no effect of TWP. On the other hand, if the collapse probability can be reduced to 40% or less, the increase rate was more than 70%, which illustrates that the TWP has a large effect on increasing the WTP. In particular, when the probability of collapse could be reduced to 20%, the modal class after TWP was 1,200 TK/sq. ft. or more (six persons). The t-test shows that the population mean is different, with a significance level of 1%, when the probability of collapse is 20% and 40%. If safety can be ensured by seismic retrofitting, it can be said that the willingness to pay a certain amount has been fostered to a considerable degree by the TWP.

Table 1 WTP for seismic retrofit by collapse probability before and after TWP

Collapse Risk (n=13)	Avg. WTP before TWP (TK/sq. ft.)	Avg. WTP after TWP (TK/sq. ft.)	Difference	t-test * : P<0.05 ** : P<0.01
80%	192	208	16 (+8%)	
60%	330	423	93 (+28%)	
40%	346	615	269 (+78%)	**

20%	577	992	415 (+72%)	**

Regarding the measures to reduce the probability of collapse to 20%, looking at changes by age (Fig. 16), those who were under 30 years old showed relatively high values from the beginning, such as the two people indicated their WTP more than 1,200 TK/sq. ft.; the number increased further after the TWP, and all of them selected 800 TK/sq. ft. or more. On the other hand, all those aged 30-50 selected 800 TK/sq. ft. or less from the beginning, and four out of eight people still chose 800 TK/sq. ft., even after the TWP. Middle-aged people were more reluctant to retrofit after the TWP compared to younger people.

Table 2 WTP for seismic retrofit by age before and after TWP (20% collapse risk)

Age	Avg. WTP before TWP (TK/sq. ft.)	Avg. WTP after TWP (TK/sq. ft.)	Difference	t-test *：P<0.05 **：P<0.01
Under 30 (n=5)	780	1,200	420 (+54%)	
30-50 (n= 8)	450	850	400 (+89%)	**
Over 50 (n=1)	1,400	1,400	0 (0%)	

Next, looking at this in relation to educational background (Table 3), in the case of junior and senior high school graduates, 3 out of 4 people had a willingness to pay less than 400 TK/sq. ft. before the TWP, and the average amount was 533 TK/sq. ft., which was 21% lower than 675 TK/sq. ft. of college graduate or higher. However, after the TWP, the average has risen to 1,000 TK/sq. ft., which is 4% higher than 963 TK/sq. ft. for college graduate or higher. The amount (rate) of increase was 288 TK/sq. ft. (43%) for college graduate or higher, while that for junior high and high school graduates was 467 TK/sq. ft. which accounts for nearly double. For these junior high school graduates, the WTP after TWP is significantly higher (significance level 5%) than before TWP. It can be seen that though lower educated people were more skeptical about earthquake countermeasures compared to higher educated people, their awareness has increase drastically after the TWP.

Table 3 WTP for seismic retrofit by educational background before and after TWP (20% collapse risk)

Educational background	Avg. WTP before TWP (TK/sq. ft.)	Avg. WTP after TWP (TK/sq. ft.)	Difference	t-test *：P<0.05 **：P<0.01
Middle and high school graduates (n=6)	533	1,000	467 (+88%)	*
College graduates or higher (n=8)	675	963	288 (+43%)	

Next, looking at the relationship with the building age (Table 4), it can be seen that the residents living in the 21-40 years old buildings had the highest WTP both before and after the TWP. Comparing the growth before and after the TWP, the residents of the building 40 years or older, which showed the lowest WTP before the TWP, was 800 TK/sq. ft. after the TWP, which accounts for quadruple. In addition, the WTP of residents of buildings with relatively young age has also increased by 51%, a very high growth rate. Thus, it can be seen that the TWP is particularly effective for residents of relatively new and old buildings who had low WTP. However, the sample size of residents living in buildings older than 40 is two, which is not reliable enough. This point needs to be examined by increasing the number of samples in the future.

Table 4 WTP for seismic retrofit by building age before and after TWP (20% collapse risk)

Building age	Avg. WTP before TWP (TK/sq. ft.)	Avg. WTP after TWP (TK/sq. ft.)	Difference	t-test *：P<0.05 **：P<0.01
0-20 (n=7)	643	957	314 (+49%)	
21-40 (n=4)	900	1,100	200 (+22%)	
40- (n=2)	200	800	600 (+300%)	-

Regarding the relevance to the worry about the earthquake before the TWP (Table 5), those who previously answered “little worried” had a low WTP, as low as 500 TK/sq. ft.. However, it increased more than twice by 575 TK/sq. ft. (115%) after the TWP to 1,075 TK/sq. ft.. On the other hand, the residents who answered “very worried” had a higher WTP of 660 TK/sq. ft. than that of “little worried” before TWP. However, after the TWP, it increased by only 280 TK/sq. ft. (42%) to 940 TK/sq. ft., which is lower than those who answered “little worried.” The TWP therefore has a particularly large effect on people who are not worried about earthquakes.

Table 5 WTP for seismic retrofit by worries about earthquakes before and after TWP (20% collapse risk)

Worry about earthquakes before TWP	Avg. WTP before TWP (TK/sq. ft.)	Avg. WTP after TWP (TK/sq. ft.)	Difference	t-test *：P<0.05 **：P<0.01
Little worried (4)	500	1,075	575 (+115%)	
Very worried (10)	660	940	280 (+42%)	

5. Discussions and conclusions

In this study, which aimed at clarifying how cost-consciousness regarding building seismic retrofitting improved after the disaster risk reduction town walk, we set the following two points as research questions: 1) how people’s awareness of earthquakes and seismic retrofitting are changed by the disaster risk reduction town walk, and 2) what kind of attributes in people are particularly affected by it. The following summarizes the conclusions made in this study.

As for the first point, it became clear that people’s consciousness about earthquakes, seismic retrofitting, and the cost burden to them was changed by the disaster risk reduction town walk. A particularly clear effect was seen for better seismic retrofitting, with an improvement to 20% and 40% collapse probability. Examining the benefit/cost ratio, this TWP has had the effect of increasing the expense of seismic retrofitting of 269 TK/sq. ft. (for a 40% collapse risk) to 415 TK/ sq. ft. (for a 20% collapse risk) for 14 participants. Assuming that the housing area per owner is 1,000 sq. ft., the TWP had the effect of improving 3.8-5.8 million TK/TWP. This can be evaluated as being significantly higher than the cost of a single TWP, even if we take it into consideration that the results of the questionnaire can be overstated. It is expected that the effect will be further enhanced if the number of participants increases.

Regarding the second point, the impact on the WTP for seismic retrofitting was particularly affected by having less education, by being younger, by whether they are residents of newer or older homes, and by not being worried about earthquakes. It is therefore important to encourage people in these groups to participate in the TWP from the viewpoint of improving the TWP’s efficiency.

Two points, however, remain unanswered by this study. The first point ifs the accuracy of the results. It can be presumed that those who participated in this TWP have higher disaster risk reduction awareness than ordinary people. In addition, the questionnaire regarding the WTP uses a hypothetical scenario, and the result may be significantly higher than an actual scenario. Due to the characteristics of the participants and the survey method, there may be errors in the results. This point, therefore, needs to be corrected in the future for greater accuracy. The second point, related to the first point mentioned above, is how to increase the number of the people surveyed. This time we had a very limited sample size of 14 people, and that number needs to be increased for the results to be generalized.

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