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APPLYING NPS ASSESSMENT TO RESIDENTS' EVALUATION OF EARTHQUAKE-RESISTANT CITY IN JAPAN.

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Abstract: *20％ of all earthquakes of over Mw 6 on the earth happen in Japan. Building a city that is resistant to earthquakes is an important issue. This study examines how much residents in the areas that have experienced or expected a huge earthquake evaluate their earthquake-resistant city, with the "Net Promoter Score (NPS)", which is a brand assessment method of marketing research. In the study, we hypothesize that residents' evaluation of NPS is associated with their experiences and cognitive and behavioral factors. We conducted a web survey for residents in Hyogo prefecture, which experienced the Great Hanshin-Awaji Earthquake, Miyagi prefecture, which experienced the Great East Japan Earthquake, and Tokyo, which is expected to experience a metropolitan earthquake. A total of 300 respondents in each area were recruited, and valid samples were n = 219 in Hyogo, n = 239 in Miyagi, and n = 230 in Tokyo. As a result, the NPS in Tokyo was rated lower than the NPS in Hyogo and Miyagi prefectures. The number of disaster-prevention behaviors that the residents took in Tokyo were lower than in Hyogo and Miyagi prefectures. Moreover, the associations of the insecurity about quake resistance of houses and the number of disaster-prevention behaviors with NPS were commonly found in the three areas. The more insecurity about quake resistance of houses, the less NPS residents rated. And, the more number of disaster-prevention behaviors, the more NPS residents rated. In conclusion, residents in the areas that have experienced a large earthquake have more positive evaluations of earthquake-resistant cities than residents in the area that expected it to occur. The experiences of long-term recovery from a past large earthquake can be related to these results. Our results suggested that mitigating residents' concerns about the safety of their houses and increasing their involvement in disaster-prevention are important to continue developing earthquake-resistant cities.*

1. Introduction

Natural disasters of various kinds are becoming more severe (UN Office for Disaster Risk Reduction, 2020), and building cities that are resistant to multihazard disasters is an important issue. Globally, 20% of all earthquakes over six moment magnitude (Mw) happen in Japan (Cabinet Office, 2010), making it a high-risk region for disasters. The Great East Japan Earthquake in 2011 exposed the limitations of existing civil engineering disaster prevention and mitigation plans (Mochizuki and Komendantova, 2017). Recently, there has been increasing interest in the creation of resilient communities that are able to adapt to and recover from disasters (Cutter et al., 2008;Cutter et al., 2010). However, the involvement and support of residents are important to the success of such communities. This study examines the attitudes of residents toward local government efforts to build disaster-preventive cities.

In the domain of market research, the Net Promoter Score (NPS®) assessment method has been developed to evaluate consumer loyalty to brands of products and services (Reichheld, 2003)(Figure 1). The NPS asks participants to respond to the question, "How likely is it that you would recommend [brand] to a friend or colleague"? with a rating on a scale of 0–10, with 0 being least likely and 10 most likely. Participants

who provide ratings of 9–10 are classed as “promoters,” those who rate 7–8 as “passives,” and 0–6 as “detractors.” The NPS enables prediction of the market growth of products and services based on consumers’ brand loyalty (Reichheld, 2003). The present study applies the NPS to the assessment of residents’ commitment to their city’s conversion into a disaster-preventive city. To the best of our knowledge, no previous research has evaluated residents’ attitudes toward the building of disaster-preventive cities using NPS. Direct evaluation of residents’ support for disaster-prevention policies can be difficult, but the NPS provides a potential means of achieving this.

In this study, we also examine the factors affecting the NPS ratings of residents regarding disaster-preventive city creation. Among the factors evaluated, we included residents’ recognition of hazard maps. Most local governments in Japan have introduced hazard maps as a means of communicating disaster risks to residents (Ikeda et al., 2005). However, previous studies indicate that recognition of hazard maps is seldom related to residents’ risk decisions or evacuation choices (Ohtomo et al., 2020b;Siegrist and Gutscher, 2006). Thus, we examine the relationship between the recognition of hazard maps and support for disaster-preventive city policies. Within the next 30 years, there is a 70% chance of an Mw 7 earthquake in the metropolitan area of Tokyo(The headquaters for eathquake research prommotion, 2023). Residents’ expectations of earthquake probability may also be related to their degree of support for disaster-preventive city building. Research on the relationships between previous experience of an earthquake and disaster-prevention behavior or evacuation behavior has produced inconsistent results (Meyer and Kunreuther, 2017). Oishi et al. (2015) found that housing damage by an earthquake causes a long-term decline in residents’ subjective well-being. However, a study of disaster recovery found no relationship between damage by an earthquake and recovery cognition after the earthquake (Terumoto et al., 2022). This study examines how past experiences of victims of earthquakes affect their support for their disaster-preventive city. It also investigates the effects of insecurity about the quake resistance of one’s house and concern about anxiety issues in the event of a large earthquake. A previous study indicated that residents’ anxiety and fear of disasters correlates with disaster mitigation behaviors (Siegrist and Gutscher, 2008). We predicted that residents with higher insecurity about the quake resistance of their house or greater anxiety in the event of a large earthquake would have less favorable attitudes toward disaster-preventive city policies due to concerns about the security of their homes. In general, taking an action tends to lead to attitude changes consistent with the action (Sherman, 1980). According to Ohtomo et al. (2017), residents’ behavioral choices during an earthquake affect their subsequent evaluation of similarity and trust in the local government. Thus, we predicted that the more disaster-prevention behaviors a resident engaged in, the higher their support for a disaster-preventive city would be. Previous studies have found both gender and economic status to be related to disaster risk perceptions (Ohtomo et al., 2020a;Slovic, 1999). We examine the effects of demographic factors on the NPS indicative of attitudes toward disaster-

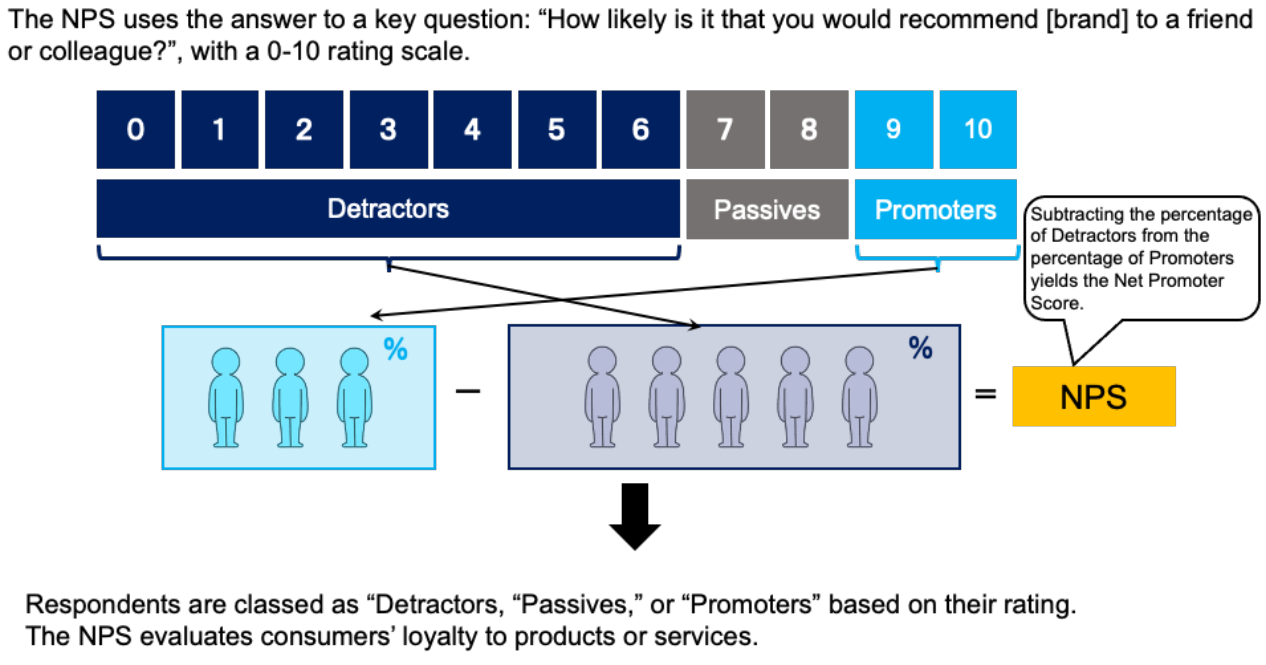

Figure 1. Marketing assessment of Net Promoter Score (NPS)

preventive cities.

In the study, we compare the NPS ratings of residents in three representative disaster-prevention cities: the Hyogo prefecture, which experienced the Great Hanshin-Awaji Earthquake in 1995, the Miyagi prefecture, which experienced the Great East Japan Earthquake in 2011, and Tokyo, which is expected to experience a metropolitan earthquake within 30 years. It has been suggested that recovery from a major disaster does not constitute a return to the pre-disaster state but involves "creative recovery" (Kimura, 2015) or the establishment of a “new normal” (Tierney and Oliver-Smith, 2012). In areas affected by disasters, residents’ attachment to the city may be strengthened through the recovery process. Differences in disaster-prevention education have been identified in cities that have experienced major earthquakes (Sato et al., 2021). Thus, by comparing three regions, we identify the effects of contextual differences, such as the experience of a major earthquake and recovery from it in the last 30 years and the expectation of a large earthquake in the near future on the NPS ratings of residents of disaster-prevention cities.

2. Method

1.1. Participants

Participants were recruited from pooled samples registered with the iBRIDGE Corporation, an internet survey company in Japan. The survey targeted a total of 900 residents, with 300 each from the Hyogo prefecture, the Miyagi prefecture, and Tokyo. The 300 residents from each region were divided into 10 groups according to gender (male and female) and age range (20, 30, 40, 50, over 60s), with each group comprising 30 participants. Participants were provided with information about the study at the top of the survey web page and expressed their informed consent through enrollment in the study. Each participant then completed our online survey and was subsequently presented with a debriefing in which we thanked the participants for their cooperation and further explained the purpose of the survey. The study was conducted in accordance with the Declaration of Helsinki and its subsequent revisions and the ethics regulations of Kanto Gakuin University. The questionnaire, data files, and analyses output are available online at https://osf.io/ztbgu/?view_only=9f59962fab0f4103ae0dfa78be699e73.

1.2. Measurements

Net promoter Score

Based on Reichheld (2003), we asked participants “How likely is it that you would recommend living in Hyogo(Miyagi/Tokyo) to a friend or colleague from the perspective of city development to prevent earthquake disasters?”, using a 0-10 scale.

Anxiety issues in the event of a large earthquake

Participants were asked about their anxieties in the event of a large earthquake. They were provided with a list of eight items about which they might be concerned and told to select all that were applicable. These were “Own personal safety,” “Family safety” “Being unable to live at home,” “Loss of means of communication and inability to contact others,” “Transportation systems down so unable to return home,” “Inability to secure electricity, gas, and water,” “Inability to secure water and food,” and ”Other.” We counted the number of items selected by each participant.

Insecurity about quake resistance of house

Participants were asked to rate their insecurity about the quake resistance of their home on a 5-point Likert scale, ranging from 1 (not at all) to 5 (very insecure).

Recognition of hazard map

The question regarding the awareness of hazard map was: Have you ever seen the hazard map (earthquake) of your residential area before the disaster? The respondents could choose from the following options: 1) I have seen the hazard map (earthquake) and remembered the contents; 2) I have seen the hazard map (earthquake) but did not remember the contents; 3) I knew the hazard map (earthquake) but I had never seen it; 4) I know the word hazard map but was unaware that there was one in this area; and 5) I did not know the word hazard map. For the analysis, the items were made into binary dummy variables; where “I know the word

hazard map but I did not know there was one in this area" and "I did not know the word hazard map" were set as 0, and where other items were set as 1.

Expectation of the earthquake

The question regarding the expectation of the earthquake was: Do you think a major earthquake will occur in your area that will cause great damage? The respondents could choose from the following options: 1) The earthquake is likely to occur within a few years; 2) The earthquake is likely to occur within the next 10 years; 3) The earthquake is likely to occur within the next 30 years; and 4) Probably the earthquake will not occur. For the analysis, the items were made into binary dummy variables; where "Probably the earthquake will not occur" was set as 0, and where other items were set as 1.

Disaster-prevention behaviors

Based on Kimura et al. (2017) we asked participants about their disaster-prevention behaviors. From a list of 32 items, they were asked to select all behaviors in which they had engaged, e.g., "I have readied food, drinking water, and daily goods," "I have prepared emergency clothes and blankets," "I have agreed on a mode of communication with my family," "I have decided on a nearby place for evacuation such as a school or park," "I have secured the furniture and refrigerator to prevent them from tipping over." We counted the number of prevention behaviors that each participant selected.

Demographics

The data on the registered samples include age, gender, yearly income, marital status, presence or absence of offspring(s), and ownership of residence. We also recorded participants' past experience of victims of earthquakes by themselves or their relatives.

3. Results

After the exclusion of participants with missing data, we were left with valid responses from 219 Hyogo residents, 239 Miyagi residents, and 230 Tokyo residents. Table 1 summarizes the characteristics of the participants from each region. There were no significant differences in gender, age, marital status, recognition of hazard maps, and number of anxiety issues between the three areas. Conversely, average income of the Tokyo residents was significantly higher than the average incomes of residents of both the Hyogo and Miyagi prefectures. The proportion of residence ownership was highest in the Hyogo prefecture, followed by the Miyagi prefecture, and then Tokyo. Residents of the Hyogo and Miyagi prefectures were significantly more likely to have children than Tokyo residents. The expectation of an earthquake was significantly higher in Miyagi than in the Hyogo prefecture and Tokyo. The rate of victims of past earthquakes was highest in the Miyagi prefecture, followed by the Hyogo prefecture, and then Tokyo. Residents of the Miyagi prefecture were more insecure about the quake resistance of their houses than residents of Tokyo (marginally significant). Residents of the Miyagi prefecture engaged in the highest mean number of disaster-prevention behaviors, followed by those in the Hyogo prefecture, and then Tokyo. The NPS responses of the three regional groups are shown in Figure 1. Compared to the Hyogo and Miyagi prefectures, Tokyo had a significantly higher proportion of detractors (χ^2 (4) = 11.754, p = .019). Thus, the ratings of the NPS of the Tokyo group was lower than those of the Hyogo and Miyagi groups.

We conducted regression analyses to determine the factors that affect NPS ratings of attitudes toward earthquake-resistant cities. In the models, we used the raw NPS ratings from each region as the dependent variable and sociodemographic characteristics, hazard map recognition, expectations of an earthquake, the past experience of victims of earthquakes, the number anxiety issues, insecurity about quake resistance of house, and the numbers of disaster-prevention behaviors as the independent variables. Table 2 shows the results of our analyses. In the Hyogo group, higher income was associated with higher NPS ratings. Additionally, NPS ratings were lower among those who owned their residence. Residents who recognized the hazard map gave higher NPS ratings than those who did not. Insecurity about the quake resistance of one's house was related to lower NPS ratings. The number of disaster-prevention behaviors was positively correlated with NPS ratings. In the Miyagi group, females gave significantly higher NPS ratings than males. Higher income was associated with higher NPS (marginally significant). Insecurity about the quake resistance of one's house was related to lower NPS ratings. The number of disaster-

Table 1 Characteristics of the participants in the three areas.

		Hyogo(n = 219)	Miyagi(n = 239)	Tokyo(n = 230)
Gender				
	Male	47%	49%	51%
	Female	53%	51%	49%
		χ^2 (2) = .68, p = .71		
Age				
	Mean	47.99	45.33	47.63
	(SD)	(15.56)	(14.76)	(15.02)
		F (2, 685) = 2.13, p = .12		
Marital status				
	Married	55%	51%	45%
	Unmarried	45%	49%	55%
		χ^2 (2) = 4.20, p = .12		
Income				
	Median segment	4~5 million yen	4~5 million yen	5-6 million yen
		F (2, 685) = 11.25, p < .001		
Ownership of residence				
	Owner	73%	65%	51%
	Other	27%	35%	49%
		χ^2 (2) = 23.33, p < .001		
Children				
	Yes	45%	48%	34%
	No	55%	52%	66%
		χ^2 (2) = 9.35, p < .01		
Recognition of hazard map				
	Recognition	72%	72%	72%
	Non-recognition	28%	28%	28%
		χ^2 (2) = .01, p = .99		
Expectation of the earthquake				
	Expectation	85%	98%	89%
	Non-expectation	15%	2%	11%
		χ^2 (2) =224.68, p < .001		
Past experience of victims of earthquakes				
	Yes	62%	91%	21%
	Non	38%	9%	79%
		χ^2 (2) = 23.30, p < .001		
Number of anxiety issues				
	Mean	4.30	4.44	4.33
	(SD)	(2.06)	(2.09)	(2.24)
		F (2, 685) = .28, p = .76		
Insecurity about quake resistance of house				
	Mean	3.22	3.35	3.12
	(SD)	(1.11)	(1.18)	(1.11)
		F (2, 685) = 2.51, p = .08		
Number of disaster-prevention behaviors				
	Mean	4.17	6.02	3.81
	(SD)	(5.36)	(5.30)	(3.97)
		F (2, 685) = 13.57, p < .001		

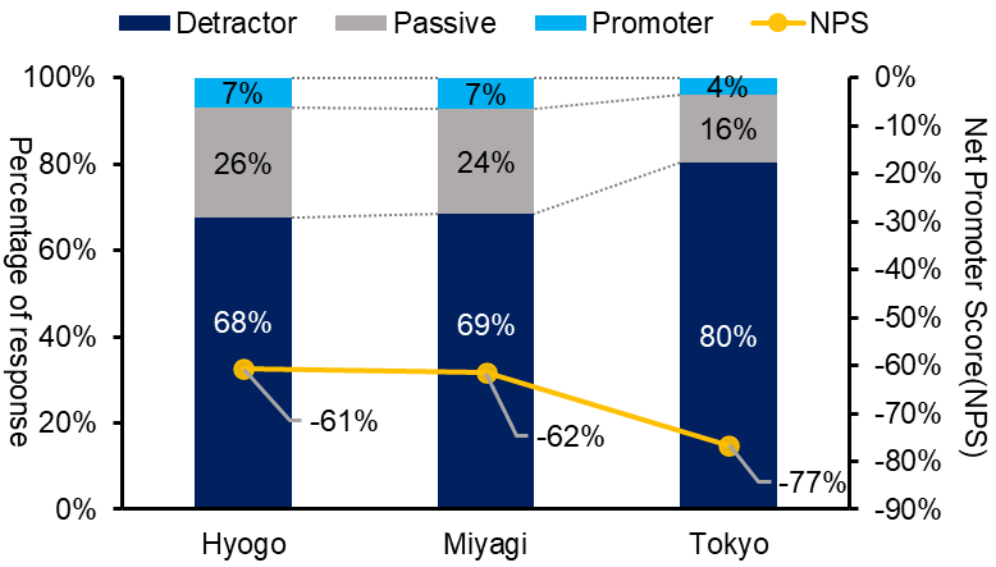

Figure 2. Comparison of NPS between the three areas.

Table 2 Results of regression analysis for predicting NPS ratings in the three areas.

	Hyogo			Miyagi			Tokyo		
	Parcial regression coefficient	Lower 95% Confidence interval	Upper 95% Confidence interval	Parcial regression coefficient	Lower 95% Confidence interval	Upper 95% Confidence interval	Parcial regression coefficient	Lower 95% Confidence interval	Upper 95% Confidence interval
Intercept	5.701 ***	4.068	7.334	7.042 ***	4.117	9.967	4.554 ***	2.919	6.188
Age	-.009	-.031	.012	-.008	-.032	.016	.001	-.022	.024
Gender(Male)	.321	-.239	.880	-.746 *	-1.340	-.153	.555 †	-.012	1.121
Marital status(Married)	-.105	-.889	.680	-.099	-.907	.708	-.438	-1.264	.388
Income	.139 **	.038	.239	.107 †	-.004	.218	-.001	-.099	.097
Ownership of residence(Owner)	-.905 **	-1.583	-.228	-.162	-.827	.504	.050	-.558	.658
Children(yes)	.223	-.520	.965	-.232	-1.036	.572	.514	-.301	1.329
Recognition of hazard maps(Recognition)	.732 *	.053	1.410	-.261	-.968	.446	.374	-.294	1.042
Expectation of an earthquake (Expectation)	.530	-.271	1.330	.182	-2.405	2.769	1.114 *	.137	2.092
Past experience of victims of earthquakes(Yes)	-.234	-.819	.351	.440	-.594	1.475	-.386	-1.071	.299
Number of anxiety issues	-.013	-.154	.127	-.123	-.274	.028	-.117 †	-.256	.021
Insecurity about quake resistance of house	-.296 *	-.550	-.043	-.378 **	-.625	-.131	-.335 *	-.595	-.075
Number of disaster prevention behaviors	.076 **	.021	.131	.060 †	-.003	.124	.085 *	.004	.165
R^2	.190			.124			.116		
F	3.796 ***			2.493 **			2.266 *		

† p < .10, * p <.05, ** p <.01, *** p < .001

prevention behaviors were positively correlated with NPS ratings. In the Tokyo group, male respondents gave significantly higher NPS ratings than females. Residents who had higher expectations of an earthquake gave higher NPS ratings. A greater number of anxiety issues (marginally significant) and higher insecurity about the quake resistance of one's house were related to lower NPS ratings. The number of disaster-prevention behaviors was positively correlated with NPS ratings.

4. Discussions

This study found that the NPS ratings of the Hyogo and Miyagi prefectures, which have both experienced a major earthquake in the last 30 years, were higher than those for Tokyo, which has not experienced a major earthquake in the last 100 years. Recovery from disaster is not a return to the pre-disaster state but a translation into “a new normal” through the recovery process (Kimura, 2007;Trumbo et al., 2016). Residents in the areas affected by a major earthquake may become more attached to their city through their involvement in city reconstruction during the recovery process. In our assessment of the factors affecting the NPS ratings, we found that the past experience of victims of earthquakes did not have a direct effect on NPS in any of the three areas. Previous studies on the relationships between the experiences of disaster victims and disaster risk perceptions or disaster-prevention behaviors have produced inconsistent results (Meyer and Kunreuther, 2017). A study of recovery perceptions after the Great East Japan Earthquake found the experience of victims of the earthquake to have no effect on recovery perceptions 5 years after the disaster(Terumoto et al., 2022). However, while the experiences of victims of past disasters may not be associated with attitudes toward disaster-prevention cities, the experience of recovery from past disasters may be related to an increase in attachment or favorability to the city. In each of the three areas, the higher the insecurity about the quake resistance of one’s house, the lower the NPS. Previous studies have shown housing conditions to be an important factor in recovery perceptions after a disaster (Terumoto et al., 2021;Terumoto et al., 2022). Insecurity about the quake resistance of houses can reduce NPS ratings because it reduces the residents’ sense of security in their housing. Furthermore, the more disaster-prevention behaviors residents took, the higher their NPS ratings. Individuals who engage in disaster-prevention behaviors appear to develop a psychological commitment (Sherman, 1980) to disaster prevention that leads them to support their city’s disaster prevention policies. Ohtomo et al (2017) found that residents’ behavior choices regarding disasters are related to their evaluation of the government and local government responsible for risk management.

Significant relationships were found between NPS ratings and gender in the Miyagi and Tokyo groups, and between NPS ratings and income in the Hyogo group. Previous studies have shown that demographic characteristics contribute to risk perception and attitudes (Ohtomo et al., 2020a;Slovic, 1999). An association has been found between family income and perceptions of post-disaster recovery (Terumoto et al., 2022). Thus, demographic factors can affect the average NPS ratings regarding disaster-prevention policies among residents of a given region. We found differences in the relationships between NPS ratings and demographic variables between the three regions. A further detailed study is needed to examine the effects of the sociodemographic characteristics of a region’s residents on their attitudes toward disaster-prevention cities. We found NPS ratings to be significantly correlated with both the expectation of an earthquake and the number of anxiety issues relating to possible earthquakes in Tokyo. A previous study indicated that people who have a concrete negative image of a disaster are more likely to engage in mitigation behaviors (Siegrist and Gutscher, 2008). Fear of impending earthquakes can increase support for disaster-prevention policies in areas with no experience of a major earthquake. Moreover, we found a positive association between hazard map recognition and NPS ratings in the Hyogo prefecture. A previous study has identified a weak relationship between the recognition of hazard maps and disaster mitigation behavior (Ohtomo et al., 2020b). In the present study, recognition of the regional hazard map was only found to affect the NPS ratings of residents of the Hyogo prefecture. This may be related to regional differences in disaster-prevention education (Sato et al., 2021). Hyogo prefecture has focused on disaster-prevention education for many years since the Great Hanshin-Awaji Earthquake in 1995, resulting in popularity of disaster literacy among residents.

This study utilized the NPS marketing brand assessment method to examine the factors that affect residents’ support for disaster-prevention city. A resilient society is required to adapt to such unprecedented disasters as the Great East Japan Earthquake. To realize such a society, residents’ support for disaster-prevention policies is important. The NPS assessment in this study reflects residents’ loyalty to their city and is expected to provide a new method of evaluating disaster-prevention policies, the value of which can be difficult to assess directly. Further studies are needed to develop this method of assessing residents’ attitudes toward multi-hazard policies concerned with not only earthquakes but also meteorological disasters.

5. Conclusion

This study measured residents' support for disaster-preventive city-building in three representative cities: Hyogo prefecture, Miyagi prefecture, and Tokyo with the NPS assessment. The results indicated insecurity about the quake resistance of one's house and a number of disaster-prevention behaviors were associated with the NPS in three cities. Thus, the reassurance activity of daily living may lead to an increase in support for disaster-preventive city-building. Moreover, there were differences in factors related to NPS between the three cities. Recovery from a past major earthquake, an expectation of a future earthquake, and demographic factors differentiated residents' support for disaster-preventive city-building. Assessment of the characteristics of residents and regions is important for the development of disaster-preventive city-building.

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