Public acceptance model for siting a repository of radioactive contaminated waste

The disposal of designated radioactive contaminated waste resulting from the Fukushima nuclear accident is a primary issue in Japan. However, residents often strongly oppose siting a repository of designated waste; therefore, a possible site remains undecided. The NIMBY (Not In My Back Yard) aspect, whereby people refuse to build a repository in their hometown, has led to strong opposition. This study examined a public acceptance model for the siting investigation of a repository of designated waste. The model proposes that the antecedents of the three types of fairness, namely, procedural, distributive, and interpersonal fairness, determine public acceptance in addition to affecting evaluation of designated waste. The study investigated the differences of influences of the three types of fairness between residents in possible siting areas and in a non-siting area to compare the cognitive process toward the NIMBY issue. The respondents included 1016 residents in possible siting areas (Miyagi, Tochigi, Gunma, Ibaraki, and Chiba Prefectures), and 1006 residents in a non-siting area (the Tokyo metropolitan area). All respondents completed a web-based questionnaire. The results revealed that the influence of procedural fairness on public acceptance in the non-siting area was stronger than it was in the possible siting areas. Conversely, the influence of distributive fairness was stronger in the possible siting areas than it was in the non-siting area. Furthermore, affect evaluation through antecedents of fairness was more influential for public acceptance in the possible sites than it was in the non-siting area. Therefore, the findings suggest that the strong opposition due to the NIMBY aspect was caused by the differences between the process of fairness and the concept of fairness that people emphasize.

Keywords: Designated waste; Distributive fairness; Interpersonal fairness; Procedural fairness; Public acceptance

1. Introduction

Waste contaminated by radioactive particles, encountered by Japan after the Fukushima nuclear accident in 2011, is a risk. The emissions of radioactive materials in this incident discharged into the environment in neighboring areas and the decontamination of these areas resulted in contaminated of waste due to radioactive. While contaminated wastes with low radioactivity concentration can be processed safely and can be disposed of just as ordinary waste, the Ministry of Environment stipulates that radioactive wastes exceeding 8000 Bq/kg should be disposed of as designated waste. Currently, designated waste has been temporarily stored by garbage incineration, water purification, and sewage treatment facilities, as well as on farms. Because of the ever-present risk of designated waste leaking due to natural disasters such as typhoons and landslides, a repository of the safe disposal thereof is an urgent matter. The Ministry of Environment plans to collect designated waste and locate a repository to prevent leakage of radioactive waste in prefectures where the waste is generated in large amounts. In Miyagi, Tochigi, Gunma, Ibaraki, and Chiba Prefectures where repositories are required, siting procedures to select a suitable area within each prefecture have been conducted. However, possible sites have, as yet, not been decided because of the strong opposition from local residents. In fact, three municipalities in the Miyagi Prefecture that were proposed as possible sites by the Ministry of Environment have been requested to withdraw their plans (Yomiuri Shinbun 2015, December 15).

Two aspects prevent the acceptance of such a repository. First, people tend to have stronger aversive reactions to a repository of radioactive waste such as high-level radioactive waste when compared with other undesirable facilities such as prisons and nuclear power plants (Easterling 2001). Second, repositories are characterized by the NIMBY attitude (Not In My Back Yard; Burningham, Barnett, and Thrush 2006; Luloff,

Albrecht, and Bourke 1998). Especially, siting a NIMBY facility concentrates the risk and cost on siting areas while diffusing the benefits outside of the siting areas. Thus, even if they agree that a repository to dispose of harmful waste is necessary, they refuse to build one in their hometown, that is, their backyard. In particular, NIMBY facilities often induce a conflict between siting and non-siting areas. While residents in siting areas suffer damage to their private interests, such as a devaluation of property, those in non-siting areas are able to experience public interests, such as safety, without their private interests being damaged. Consequently, residents in siting areas experience repulsion to inequity and are likely to oppose the facility strongly.

Social psychology discusses the multidimensional aspect of the judgment of fairness to accept technology or risky facilities. Besley (2010, 2012) suggested that distributive, procedural, and interpersonal fairness play a role in perceptions of decision-making of public acceptance. First, distributive fairness is concerned with the fairness of outcomes, such as risk–benefit evaluation. Research on justice has revealed that a desirable, i.e., equitable, result plays an important role in the acceptance of a decision (Deutsch 1975). Second, procedural fairness involves fairness in a decision-making procedure, such as the opportunity of voice. Research on justice has shown that procedural fairness is more important than distributive fairness (Lind and Tyler 1988; Törnblom and Vermunt 1999). Third, interpersonal fairness occurs when people recognize that risk communicators are trustworthy and respectful of people's views and/or values. According to Bies (2005), interactional fairness represents a third component of fairness along with distributive and procedural justice. Previous studies have demonstrated internalized moral values as related to the judgment of fairness (Skitka 2002; Skitka and Mullen 2002). In issues related to energy technology, protected value, which is not tradable against other values, has consistent effects on the acceptance of

various energy technologies (Fiske and Tetlock 1997; Siegrist and Visschers 2013; Visschers and Siegrist 2014). In conjunction with the risk communication of the risks and benefits of technology, acceptance of technology may become difficult if the procedure is contrary to people's values.

2. Public acceptance model of repository of radioactive waste

The public acceptance model is a comprehensive model that includes the three aspects of fairness to examine the psychological process involved in the public acceptance of siting a repository of high-level radioactive waste (HLW; Ohtomo et al. 2014; Osawa et al. 2016, : see Figure 1). In relation to distributive fairness, the model assumes risk perception and social and personal benefit. According to Luloff, Albrecht, and Bourke (1998), the siting of a repository can introduce inequity of risk and benefit between the siting areas and other areas. Risk perception has been considered to be an important factor that has an impact on the advantages and disadvantages involved in siting a repository of radioactive waste (Slovic, Flynn, and Layman 1991). Furthermore, social benefit was found to have an effect on the acceptance of siting the facility in Japan (Ohtomo et al. 2014) whereas, in France, personal benefit was found to have an effect on acceptance (Osawa et al. 2016). The effect of benefits may vary according to the cultural context involved in the issue of radioactive waste. Previous studies have noted that benefits have little effect on the acceptance of a repository of HLW built in the neighborhood (Flynn et al. 1992; Tanaka 2004).

The public acceptance model postulates that procedural fairness affects the acceptance of siting a repository. Research on justice has revealed that people are more likely to accept decisions, even when the outcomes are undesirable, when they perceive the decision-making procedure to be fair (Lind and Tyler 1988; Nonami et al. 2015; van den Bos 1999). Besley (2010, 2012) found that the effect of procedural fairness was the

strongest among various fairness judgment factors in the acceptance of nuclear plants. Furthermore, in a study of repositories for low- and-intermediate-level waste, the fairness of procedures, such as those pertaining to public involvement, were of major concern in the acceptance of decisions (Krütli et al. 2010).

With reference to interpersonal fairness, the public acceptance model proposes trust, stigma, and intergenerational subjective norms. Previous studies have found trust to be an important determinant of the public acceptance of technology (Earle 2010; Poortinga and Pidgeon 2006; Slovic 1999). In a study on the renewal of a nuclear reactor, trust had a consistent effect on the perception of risks and benefits before and after the Fukushima nuclear power plant accident (Visschers and Siegrist 2013). A previous study on repositories for HLW indicated that trust affected risk perception and stigma (Flynn et al. 1992). Issues regarding radioactive waste are often exposed to strong opposition from quarters espousing ethical views (Seidl, Krütli, et al. 2013). Furthermore, ethical acceptability such as unfairness among generations is discussed because the storage of radioactive waste is long-term across future generations (Mackerron and Berkhout 2009; Taebi 2017). Therefore, the stigma of perceptions as a "town polluted by radioactivity" due to acceptance of the repository and intergenerational subjective norms that are responsible for influences across generations are significant barriers to accept the facility. Previous studies of the public acceptance model have revealed that stigma and intergenerational subjective norms decreased people's acceptance of a repository (Ohtomo et al. 2014; Osawa et al. 2016).

Finally, affect is considered to be a factor that biases various cognitions. Loewenstein et al. (2001) noted that affect has an important role in risk decision-making. Previous studies have found affect evaluation to be related to the preference for a nuclear plant (Keller, Visschers, and Siegrist 2012; Siegrist, Keller, and Cousin 2006).

Furthermore, Besley (2012) suggested that the judgment of fairness in relation to the acceptance of a nuclear policy depends on affect evaluation. With regard to HLW, people who had negative emotions tended to be opposed to siting a repository, considering negative evaluations in various judgments or their perception of the process as being unfair (Slovic, Flynn, and Layman 1991). Thus, the public acceptance model postulates that affect evaluation influences the judgment of fairness as a bias factor.

3. The purpose of study

This study was aimed at examining the public acceptance model for siting a repository of designated waste that resulted from the Fukushima nuclear accident. In particular, the differences of the effect of fairness between the possible siting areas and non-siting areas, as well as the NIMBY aspect, in designated waste were revealed.

When compared with nuclear power plants, repositories for radioactive waste have many disadvantages, such as radioactive contamination and stigma, and few benefits (Easterling 2001). Compensation is considered to be a means of solving such distributive unfairness. However, previous studies have shown that the introduction of monetary compensation tends to motivate personal benefit but does not encourage the acceptance of siting a repository (Frey, Oberholzer-Gee, and Eichenberger 1996; Seidl, Moser, et al. 2013). Linnerooth-Bayer and Fitzgerald (1996) revealed that both general citizens and residents in the possible host area did not support outright monetary compensation. Krütli et al. (2010) indicated that the safety and risk of radioactive waste repositories were of great interest to residents in possible host areas. There may be a difference in risk perception although there is no difference in the evaluation of benefits between the siting and non-siting repository areas.

In relation to the acceptance of technology, some studies have emphasized the importance of procedural fairness on public acceptance (Besley 2010, 2012; Krütli et al.

2012b), whereas other studies have shown the limited impact of procedural fairness (Earle and Siegrist 2008; Visschers and Siegrist 2012). Skitka (2002) suggested that personal values such as moral mandates determine whether procedural fairness has an influence on acceptance. Procedural fairness postulates that people care more about the manner in which decisions are made than they do about the nature of decisions that are made (Törnblom and Vermunt 2016; Törnblom and Vermunt 1999). Consequently, procedural fairness plays a greater role when individuals place less value rather than greater value on issues. Similarly, when individuals are affected by possible repositories, the matter becomes one of high importance. Therefore, procedural fairness is likely to be stronger in areas that are unaffected by repositories.

Furthermore, a strong affect reaction to the repository is more likely to arise in residents in siting areas rather than non-siting areas. Affect involves intuitive decision-making, such as that in the case of decisions entailing risks (Slovic 2007). In this study, it was assumed that affect biases the judgment of various fairness factors. Previous studies of risk decision-making have shown that affect evaluation influences antecedents of public acceptance (Dohle, Keller, and Siegrist 2012; Midden and Huijts 2009; Rodriguez-Sanchez et al. 2018). In particular, when affect experience was salient owing to risky events, such as natural disasters, affect evaluation was more likely to have an effect on risk judgment(Västfjäll, Peters, and Slovic 2008; Västfjäll, Peters, and Slovic 2014). In this study, the influences of the affect evaluation of residents in possible siting areas, where affect evaluation is likely to be salient, and that of residents in non-siting area, where affect evaluation is less likely to be salient, were compared.

4. Methods

Participants

A web-based questionnaire was distributed by INTAGE Inc., a web survey company. Respondents were recruited among pooled samples in the company, who lived in possible siting areas (Miyagi, Tochigi, Gunma, Ibaraki, and Chiba Prefectures), and in a non-siting area (the Tokyo metropolitan area). About two hundred respondents were recruited from each of the five possible siting areas, ensuring an equal number of men and women. Also, about a thousand respondents were recruited from the Tokyo metropolitan area, again with due attention to gender balance. The total sample consisted of 1,016 respondents from the siting areas and 1,006 from non-siting areas. All the respondents completed the web-based questionnaire. No significant differences were found between respondents in the possible siting areas and in the non-siting area for age (possible siting areas: $M = 45.98$, $SD = 11.85$ vs. non-siting area: $M = 46.12$, $SD = 11.70$; $F(1, 2010) = .07$, $p = .795$) and gender (possible siting areas: male = 50%, female = 50%, non-siting area: male = 50%, female = 50%; $\chi^2(1) = .002$, $p = .966$).

Procedure

The respondents were briefly explained using content from the Ministry of the Environment's website,[1] regarding designated waste. Subsequently, affect evaluation of designated waste, risk perception, and trust toward relevant organizations were assessed. Thereafter, a hypothetical scenario in which the possibility of their city being chosen as a possible siting area was described (Appendix). Stigma, intergenerational subjective norms, procedural fairness, social benefits, personal benefits, and public acceptance of a repository of designated waste were measured.

Measurements

With the exception of affect evaluation, all items were rated on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree).

Affect evaluation: Participants were asked to rate their feelings, using Semantic Differential adjectives, regarding designated waste of on a 5-point scale (good–bad, dislike–like, favorable–unfavorable, unpleasant–pleasant, necessary–unnecessary, dangerous–safe, harmless–harmful, unstable–stable, insecure–secure, problematic–unproblematic). A high score implied that the respondent had a positive feeling toward designated waste (possible siting areas: α =.91, non-siting area: α =.91).

Risk perception: The respondents were required to assess the following items: If an accident or an unexpected situation comes to pass at a repository of designated waste, environmental damage would occur soon; Repository of designated waste is unfamiliar to me; I have enough knowledge regarding repositories of designated waste; Scientific understanding of repositories of designated waste is advancing; If radioactive materials leak from a repository of designated waste, many people would be harmed; If radioactive materials leak from a repository of designated waste, risk managers can minimize damage; Repositories of designated waste are dangerous to future generations, including children and grandchildren; and Repositories of designated waste are risky facilities. Higher scores indicated a higher risk perception (possible siting areas: α =.81, non-siting area: α =.81).

Trust: The respondents were required to assess their trust toward three organizations by using the following items: The review committee has the ability to choose a proper area for the repository of designated waste; The review committee will make decisions that involve considering residents' safety; The government has the ability to handle the project of siting a repository of designated waste; The government will

consider residents' safety when making decisions; The local government has the ability to judge the acceptance of a repository of designated waste; and The local government will consider residents' safety when making a decision. Higher scores implied greater trust (possible siting areas: α =.88, non-siting area: α =.89).

Stigma: The respondents were required to assess the following two items: The city where I live and I will be avoided by people in other places; and Our city and I will be labeled negatively by other people. Higher scores implied stronger stigma (possible siting areas: α =.79, non-siting area: α =.85).

Intergenerational subjective norms: The respondents were required to assess the following items: I will feel sorry for my ancestors if our city accepts a repository of designated waste; My ancestors would not expect me to accept a repository of designated waste; I will feel sorry for my future children and grandchildren if our city accepts a repository of designated waste; My children and grandchildren would not expect me to accept a repository of designated waste; My family would not expect me to accept a repository of designated waste; and Inhabitants in my city do not expect me to accept a repository of designated waste; Higher scores implied a stronger perception of normative pressure (possible siting areas: α =.90, non-siting area: α =.90).

Procedural fairness: The following two items were assessed: The process of selecting a possible area for a repository of designated waste by the government was fair; The procedure that the government followed to select a possible area for a repository of designated waste was fair. Higher scores implied a fair procedure (possible siting areas: α =.86, non-siting area: α =.86).

Benefit: Social benefit was measured by using two items: Accepting a repository will benefit the whole of our prefecture; and Accepting a repository will contribute to the whole of our prefecture (possible siting areas: α =.84, non-siting area: α =.84). Personal

benefit was also measured by using two items: Accepting a repository will result in more employment in our city; and Accepting a repository will result in financial benefits for our city (possible siting areas: α =.76, non-siting area: α =.77).

Public acceptance: This was measured by using two items: I agree that this city should accept a siting investigation for a possible repository area; and I can be convinced our city should accept a siting investigation for a possible repository area. Higher scores implied higher acceptance (possible siting areas: α =.90, non-siting area: α =.88).

5. Results

Descriptive statistics of the variables of the public acceptance model in the possible siting areas and non-siting area are presented in Table 1. The mean values of trust ($F(1, 2020) = 8.04$, p =.005, η_p^2 =.004); social benefit ($F(1, 2020) = 13.94$, p <.001, η_p^2 =.007); and personal benefit ($F(1, 2020) = 22.09$, p <.001, η_p^2 =.011) were statistically higher in the non-siting area than they were in the possible siting areas.

To examine the causal relationships among the variables and the differences between the possible siting areas and non-siting area, multi-group analysis with latent variables of the model was conducted. The correlations of the latent variables are presented in Table 2. To determine the difference path coefficients for the possible siting areas and non-siting area, chi-square difference tests from the fully constrained model to the unconstrained model were conducted to determine whether the additional path release resulted in a statistically better model fit (Table 3). Based on the results of the chi-square difference tests and AIC (Akaike Information Criterion)[2], the model without the constrained paths of procedural fairness → public acceptance, risk perception → public acceptance, social benefit → public acceptance, affect evaluation → social benefit, risk perception → stigma, fit the data better (Figure 1).

Although the model demonstrated that the effect of procedural fairness on public acceptance in the non-siting area was stronger than it was on the possible siting areas, the effects of risk perception and social benefit on acceptance in the non-siting area were weaker than they were in the possible siting areas. The effects of risk perception on stigma and affect evaluation on social benefit in the possible siting areas were stronger than they were in the non-siting area. However, the effect of personal benefit on public acceptance was not significant in either the possible siting areas or the non-siting area.

Furthermore, the difference of the indirect effect of affect evaluation on public acceptance mediated by other variables such as affect evaluation → risk perception → public acceptance between the possible siting areas and non-siting area was examined. The 95% confidence intervals of the indirect effect were estimated with a bias-corrected bootstrap method based on 10,000 resamples. For the possible siting areas, the indirect effect of affect evaluation on public acceptance was B =.40 (95%LCL =.325, 95%UCL =.470, p <.001). For the non-siting area, the indirect effect was B=.26 (95%LCL =.201, 95%UCL =.318, p <.001). Consequently, affect evaluation in the possible siting areas was more influential for public acceptance than it was in the non-siting area.

6. Discussion

Our results revealed that with the exception of trust, as well as personal and social benefits, there were no significant differences among the variables in the public acceptance model for siting a repository of designated waste between residents in the possible siting areas and non-siting area. For trust and personal and social benefits, individuals in the non-siting area gave slightly higher rating than those in the possible siting areas on trust and on personal and social benefit. Thus, we can conclude that the residents in the non-siting area had somewhat greater trust in the organizations authorized to site a repository. Furthermore, they perceived greater personal and social benefits.

Seidl, Moser, et al. (2013) found that people in a non-affected community of a deep geological repository had a more positive reaction than did those in the affected community.

Furthermore, we identified significant differences in the process of public acceptance for the siting investigation of a repository between the residents of the possible siting areas and non-siting area. First, procedural fairness in the non-siting area had a stronger effect on public acceptance than it did in the possible siting areas. When an issue is highly important to people, they tend to rely on distributive fairness and disregard procedural fairness when making a judgment (Earle and Siegrist 2008; Skitka 2002). When compared with the residents in the non-siting area, those in the possible siting areas had placed greater importance accorded to siting a repository of designated waste, consequently weakening the effect of procedural fairness on their acceptance.

Second, the process of distributive fairness, risk perception, and social benefit in the possible siting areas had a more influential effect on acceptance than it did in the non-siting area. The influences of risk–benefit evaluation had a greater effect on acceptance. Furthermore, risk perception in the possible siting areas had a greater influence on stigma than it did in the non-siting area. In a study by Visschers and Siegrist (2013), the effects of risk perception before and after the Fukushima nuclear accident were compared, and the results showed that the influence of risk perception became stronger after the accident. If people, such as residents in the possible siting areas are concerned about the issue, risk perception may be a more influential factor. However, the effect of personal benefit on acceptance did not vary between residents in the possible siting areas and those in the non-siting area. After moral considerations, monetary compensation reduced the public's willingness to accept a repository (Frey, Oberholzer-Gee, and Eichenberger 1996). According to Linnerooth-Bayer and Fitzgerald (1996), outright compensation is a

distraction from the motivation to accept a repository as a social duty or responsibility and can undermine public acceptance. Previous studies have found that benefits related to personal interests were not an important determinant of the acceptance of a repository in the neighborhood (Flynn et al. 1992; Tanaka 2004). Thus, social benefits such as a desire to contribute to the community may be more important than personal benefits for people affected by the repository.

Third, no significant differences in the process of interpersonal fairness between residents in the possible siting areas and non-siting area were found. A study on the public acceptance model of HLW by Ohtomo et al. (2014) revealed that the influences of stigma and intergenerational subjective norms were stable before and after the Fukushima nuclear accident. Aspects of interpersonal fairness are perhaps not affected by changes in social concerns in respect of nuclear accidents or the differences between the possible siting areas and the non-siting area in relation to NIMBY because the aspects are mainly concerned with people. However, these aspects were not important factors in the acceptance of a repository of HLW in France (Osawa et al. 2016). The results, however, are perhaps linked to the characteristics of Japanese cultural contexts. The influences of fairness may differ according to cultural contexts such as collectivism vs. individualism. In this regard, further research is needed.

Therefore, in accepting a repository of designated waste, this study showed that the residents in the possible siting areas who suffered potential damage to their private interests were likely to rely on distributive fairness, whereas residents in the non-siting area were likely to rely on procedural fairness. Furthermore, the influence of interpersonal fairness was not likely to vary among the residents in both the areas. The NIMBY issue in the acceptance of a repository of designated waste may be evoked by the different perceptions of fairness between residents in the possible siting areas and the non-siting

area. As noted previously, residents in the non-siting area were able to accept decisions because of procedural fairness, while those in possible siting areas based their viewpoint on distributive fairness. However, procedural fairness was one of the most important determinants of public acceptance for residents in both areas. This finding differs from those of studies that revealed that procedural fairness had little influence on public acceptance (Earle and Siegrist 2006; Visschers and Siegrist 2012). On the contrary, the findings of the present study are consistent with studies that found procedural fairness to be a main determinant of public acceptance (Besley 2010, 2012). However, without procedural fairness, it would be impossible to legitimize the acceptance of the risk of a repository of harmful waste. Some studies have assumed that procedural fairness is a prerequisite for acceptance (Krütli et al. 2012a; Törnblom and Vermunt 2016). Our results revealed that personal benefits had no effect on acceptance. It is difficult to compensate for stigma and intergenerational subjective norms, which result from siting a repository of designated waste. Consequently, procedural fairness perhaps plays an important role in accepting an undesirable decision.

Furthermore, affect evaluation was relatively negative in the residents of both areas. Previous studies have demonstrated that affect evaluation influenced the risk decision involved in nuclear power (Keller, Visschers, and Siegrist 2012; Siegrist, Keller, and Cousin 2006). In particular, the more salient the affect experience the greater the impact of affect evaluation on the risk decision (Västfjäll, Peters, and Slovic 2008; Västfjäll, Peters, and Slovic 2014). Consistent with the typical NIMBY pattern, in contrast to the residents in the non-siting area, siting a repository was an important issue for residents in the possible siting areas. Consequently, affect evaluation was more likely to be salient. Previous studies have demonstrated that affect evaluation influenced the risk acceptance indirectly through risk perception and benefit evaluation (Dohle, Keller, and

Siegrist 2012; Midden and Huijts 2009; Rodriguez-Sanchez et al. 2018). The findings of this study suggest that the affect evaluation of residents in the possible siting areas became salient as a real risk issue and that the affect evaluation influenced public acceptance through antecedents such as social benefits. Because residents in the possible siting areas reacted emotionally to a repository of designated waste, they were relatively influenced by the process of distributive fairness (i.e., risk perception and social benefit), which is an obstacle to the public acceptance of siting a repository.

This study has several limitations. Although we tested a causal model, our analysis was based on a cross-sectional dataset. Therefore, we cannot fully generalize conclusions about causal relationships. Further systematic studies such as experiments are recommended for the purpose of validating more evidence in relation to how affect evaluation and variables of fairness influence public acceptance. Furthermore, the study implemented a survey with a hypothetical scenario because the possible siting areas for a repository have yet to be chosen. In the domain of justice research, the validity of studies with hypothetical scenarios has been confirmed (Nonami et al. 2015; van den Bos 1999). Our sample in the possible siting areas was recruited from all areas within the prefectures. However, it is possible that our sample may differ from that constituted by residents of an area chosen to be a site for a repository in the future. When the siting area is actually chosen, a survey study targeting the area will be needed to generalize our conclusions to the reality. Although it is not at a serious level, trust, in relation to radioactive wastes, toward governments and organizations showed a drop after the Fukushima nuclear accidents. Recovering trust is also an important issue in the promotion of siting a repository. Moreover, interpersonal fairness represents a third component of fairness. However, the component is highly related to such issues, and we suggested that the issue

of radioactive wastes was a concern regarding stigma and future generations as an interpersonal fairness. Further research is needed to examine these concepts.

Despite these limitations, this study may promote public acceptance of a repository of designated waste. Procedural fairness, distributive fairness, and interpersonal fairness were employed to determine the public acceptance of a siting investigation for a repository. Procedural fairness was the main determinant of acceptance for residents in the non-siting area. On the contrary, distributive fairness was the main determinant of acceptance for those in possible siting areas and for individuals with greater likelihood of affect evaluation being salient. Our study suggests the importance of changing approaches to promote acceptance according to the fairness that people emphasize.

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Note:

1. The web site was retrieved from http://shiteihaiki.e.,nv.go.jp/initiatives_other/.
2. The Akaike Information Criterion (AIC) was used to select between competing models. A lower AIC value indicates better fitting model (Schermelleh-Engel, Moosbrugger, and Müller 2003).

Appendix

Hypothetical scenario

In A prefecture in which you live, all the municipal chiefs' meetings discussed how to choose a repository site for designated waste. The government explained that they would review the possible site based on safety and security in the process of site-selection and announce the result. The procedure of deciding on a municipality to have a repository is as follows:

1. The government should explain to all city and town mayors the necessity of siting a repository in the prefecture.
2. Regarding the site-selection of a repository, the government should incorporate the requests and opinions of the city and town mayors.
3. Regarding the criteria and procedure for site-selection, the government should refer to the opinions of council experts.
4. According to the request from city and town mayors, the government should select a possible site by scientific and technical standards that are based on safety and security, and council experts should review the result.

5. The government should present the possible sites adjudged as appropriate area to city and town mayors.

6. The city and town mayors of possible sites should decide whether to accept a siting investigation for a repository.

Because of site-selection, the city where you live was chosen as one of the possible sites.

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Table 1. Means and standard deviations in the possible siting areas and non-siting area

	Affect evaluation	Risk perception	Trust	Personal benefit	Social benefit	Stigma	Intergeneration al subjective norm	Procedual fairness	Acceptance
Possible siting areas(n=1016)	1.97	1.97	2.56	3.84	2.56	3.46	3.05	2.77	2.75
	(.73)	(.63)	(1.23)	(.95)	(.93)	(.92)	(.88)	(.86)	(1.02)
Non-siting area(n=1006)	2.01	2.01	2.66	3.99	2.71	3.43	3.04	2.81	2.82
	(.74)	(.63)	(1.26)	(.88)	(.91)	(.91)	(.83)	(.83)	(.92)
F(1, 2020)	1.10	.18	8.04**	22.09**	13.94**	.55	.09	1.11	2.85
η_p^2	.001	.000	.004	.01	.01	.000	.000	.001	.001

** p <.01.

Table 2. Correlations among latent variables in the possible siting areas and non-siting area

	1	2	3	4	5	6	7	8	9
1 Affect evaluation	-	-.78 **	.49 **	.30 **	.50 **	-.42 **	-.35 **	.29 **	.46 **
2 Risk perception	-.74 **	-	-.57 **	-.36 **	-.61 **	.57 **	.52 **	-.32 **	-.56 **
3 Trust	.37 **	-.49 **	-	.38 **	.56 **	-.36 **	-.26 **	.66 **	.55 **
4 Personal benefit	.17 **	-.25 **	.39 **	-	.80 **	-.18 **	-.26 **	.32 **	.50 **
5 Social benefit	.42 **	-.53 **	.55 **	.73 **	-	-.43 **	-.47 **	.43 **	.70 **
6 Stigma	-.39 **	.50 **	-.23 **	.01	-.23 **	-	.61 **	-.25 **	-.43 **
7 Intergenerational subjective norm	-.31 **	.44 **	-.23 **	-.09 *	-.29 **	.54 **	-	-.27 **	-.55 **
8 Procedual fairness	.26 **	-.40 **	.68 **	.43 **	.51 **	-.19 **	-.17 **	-	.52 **
9 Acceptance	.39 **	-.52 **	.58 **	.42 **	.64 **	-.36 **	-.43 **	.68 **	-

Note * p <.05, ** p <.01. Correlations in the possible siting areas are above the diagonal and correlations in the non-siting area are below the diagonal.

Table 3. Model fit indexes of unconstrained and constrained models

Model	χ^2	*df*	*p*	$\Delta\chi^2$	Δdf	Δp	AIC	GFI	CFI	RMSEA
Unonstrained model	972.65	214	<.01	-	-	-	1156.65	.95	.96	.04
Full constrained model	1011.66	228	<.01	39.02	14.00	< .01	1167.66	.94	.96	.04
Free of PF to Acc path constraint	1005.47	227	<.01	6.19	1.00	<.05	1163.47	.94	.96	.04
plus Free of Risk to Acc path constraint	998.58	226	<.01	6.89	1.00	<.01	1158.58	.94	.96	.04
plus Free of SB to Acc path constraint	991.36	225	<.01	7.22	1.00	<.01	1153.36	.95	.96	.04
plus Free of Aff to SB path constraint	987.17	224	<.01	4.18	1.00	<.05	1151.17	.95	.96	.04
plus Free of Risk to Stigma constraint	982.64	223	<.02	4.53	1.00	<.05	1148.64	.95	.96	.04

Note: PF = procedural fairness, Acc = acceptance, Risk = risk perception, SB = social benefit, Aff = Affect evaluation

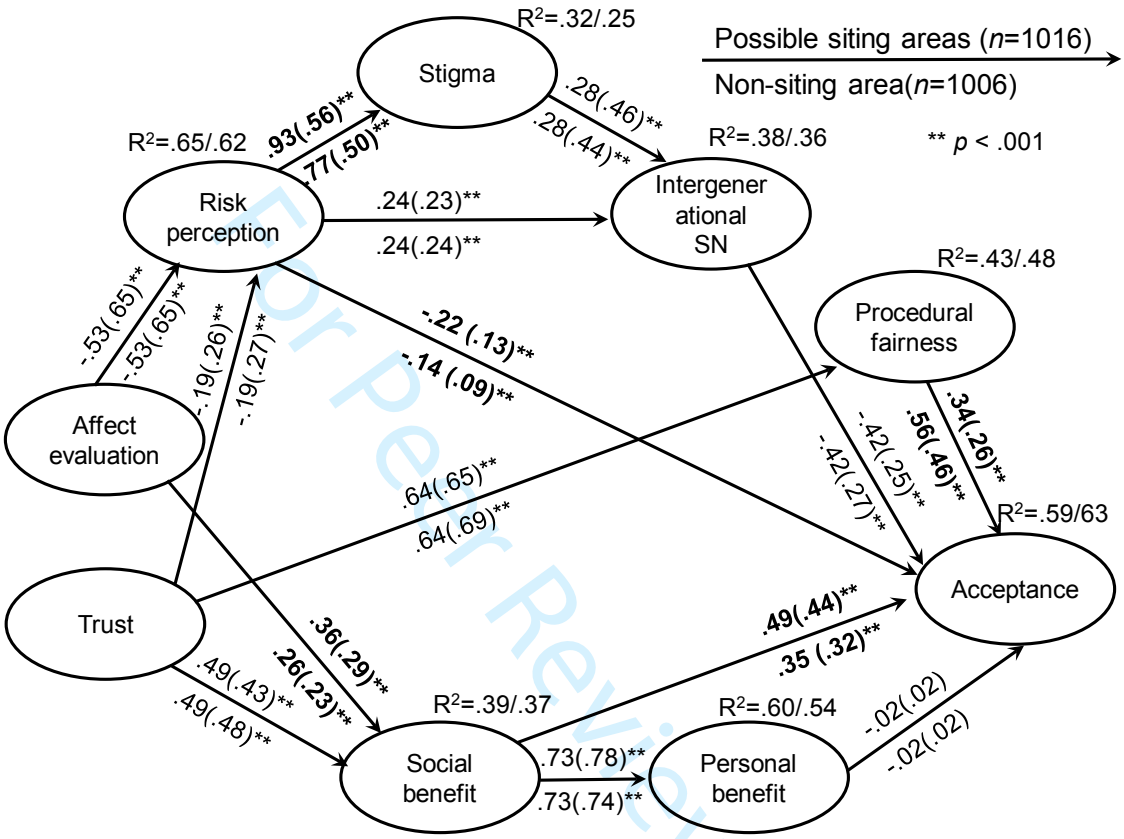

Figure 1. Multi-group model in the possible siting areas and the non-siting area

Note: Path coefficients outside the parentheses indicate an un-standardized solution.

Path coefficients in parentheses indicate a standardized solution.