


## RESEARCH ARTICLE

## Charging plastic bags: Perceptions from Japan

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## Abstract

Mandatory charges for plastic bags at all stores was implemented in Japan in July 2020 to encourage interest in environmental issues and raise awareness of environmental risks. We conducted a survey on mandatory plastic bag charging, dealing with environmental risk perception, pro-environmental habits, attempts to reduce plastic bags, and sense of community. In this study, we assumed that factors distinguished by the behavior change after charging, that is, reduced use of plastic shopping bags or no change from before, and the relationship with other typical environmental behaviors and perceptions would suggest its long-term success. Data were collected from two groups: Group 1 consisted of those who had reduced their use of plastic bags after the implementation of the mandate, and Group 2 were those who had not changed their behavior because of the mandate. First, we extracted factors to distinguish Group 1 from Group 2 using binary regression analysis. Second, we illustrated the relationship between the attempt to reduce plastic bags and other typical environmental behaviors and perceptions by conducting structural equation modeling (SEM). The results showed that age, place of residence, observing others' behavior, attempts to use eco-friendly bags, and energy-saving behavior were significant influential factors in reducing plastic bags. Moreover, SEM showed that it was not significantly related to pro-environmental habits but would significantly influence environmental risk perception and recycling behavior. Therefore, it is suggested that mandatory charging can raise interest in environmental issues to foster further environmental behavior, while a detailed outreach strategy considering influential factors such as age, place of residence, individual pro-environmental habits, and so on would be necessary to successfully implement this strategy.

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## 1. Introduction

Convenience and cost effectiveness have made access to plastic products easier and subsequently led to an increase in plastic waste. The proliferation of plastic usage, in combination with its poor end-of-life waste management, has resulted in widespread and persistent plastic pollution. Around 6,300 million tonnes of plastics waste are thought to have been generated between 1950 and 2015, of which only 9% were recycled, and 12% incinerated, leaving nearly 80% to accumulate in landfills or the natural environment [1]. These environments include places where humans do not reside such as the deep seas, ocean basins, remote islands, as well as the polar regions. In addition, nearly, 5 to 13 million tons of plastic are introduced into our

environment every year [2]. The increasing use of plastics is responsible for significant greenhouse gas emissions and plastic pollution in the natural environment [3].

Plastic bags are one of the most widely used plastic products in Japan [4]. They are easily accessible and a part of everyday life, which make plastic bags ideal for raising awareness about individual behaviors that lead to environmental pollution. Worldwide, countries are implementing complete or partial bans and charges on plastic shopping bags, in an effort to reduce plastic waste [5,6]. Some countries have implemented levies on the use of plastic bags [7–10]. These campaigns have reduced the use of plastic bags, particularly after a charge was levied on their usage [5,11,12].

In Japan, mandatory charge on plastic bags in all retail shops was introduced in July 2020. Each bag carries a charge of about US\$ 0.05. The aim behind this was to get people to think about the necessity for plastic bags, to give them an opportunity to review their lifestyles, and to motivate them to act in favor of the environment [13]. According to a survey conducted by the Ministry of Environment, Japan, this strategy is effectively reducing the use of plastic shopping bags. About, 72 percent of the respondents of this survey declined the offers to purchase plastic bags at stores, and about 94 percent carried their own shopping bags with them during the first week following the announcement to charge plastic bags. The number of people declining to purchase plastic bags more than doubled, from March, after the rule to charge them was implemented on July 1 [14].

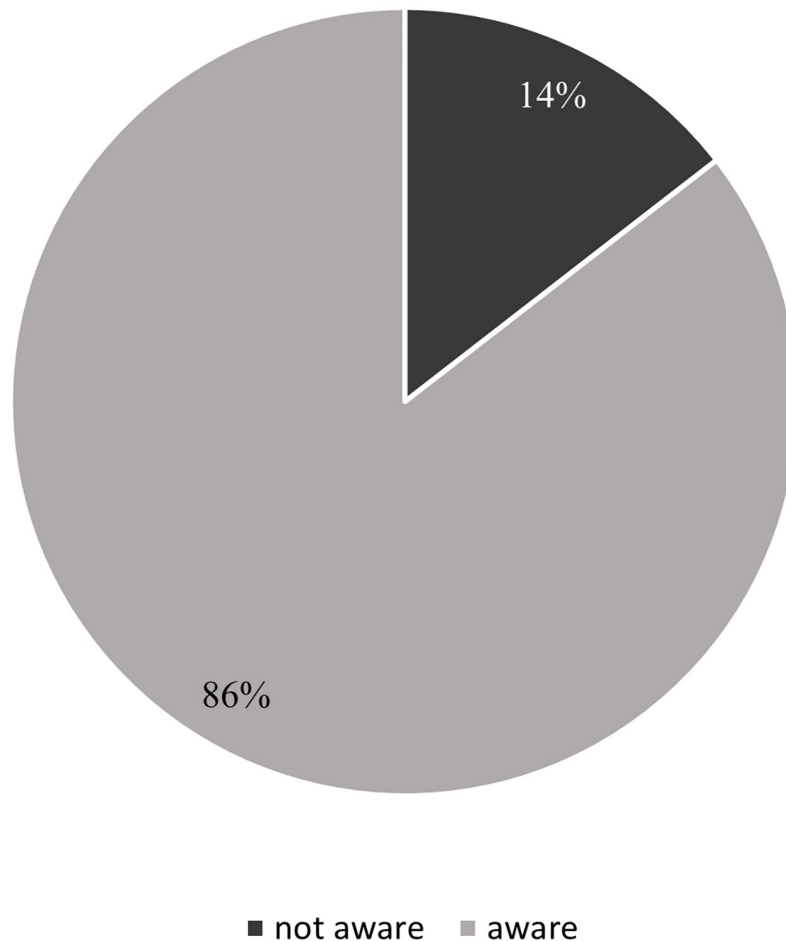
We assume that there are influential factors, other than government mandates, such as people's perceptions and typical environmental behaviors that can influence the success of a policy in the long term. The focus of our study is to investigate these influential factors and to explore the relationship between perceptions about environmental risk and pro-environmental behaviors that would promote reduced use of plastic bags. In our study, we applied a binary logistic model to investigate influential factors to mitigate plastic bags and constructed a structural model that illustrates the relationship of attempt to reduce plastic bags with pro-environmental behaviors and environmental risk perception.

## 2. Results

According to the questionnaire survey, 86% of respondents knew about the mandatory charge applied to plastic bags (Fig 1). The ratio of the individuals who used eco-friendly bags at least once a week before charging was approximately 10% in Group 1 and 18% in Group 2 (Fig 2). Those in Group 2 were relatively more numerous than those in Group 1. This also explains why Group 1 had a relatively higher percentage of people who changed their behavior after the mandate, than Group 2. The number of the individuals who had been relatively frequently using eco-friendly bags instead of plastic bags ranged from 10% to 20%. This is consistent with the results of previous studies [15,16]. This suggests that 20% of people were already using eco-friendly bags and 80% of people had the potential to reduce plastic bag usage. Mandatory charging provides people with a chance to eliminate plastic bag usage in their everyday life.

Factors related to plastic bag reducing behavior were selected by backward elimination and included age, place of residence, observation of others' behavior, attempt to use eco-friendly bags, and energy-saving behavior. Parameters were of significance at 0.05 (Table 1). The GOF test results showed that the  $p$  value was above 0.05 ( $\chi^2 = 3.67$  for 8 degrees of freedom).

Each parameter represents the influence of the factors that reduce plastic shopping bag usage. For age, the parameter was negative, suggesting that a relatively young population may have actively responded to the government campaign and reduced the use of plastic shopping bags. The parameter for place of residence was negative, suggesting that respondents in rural environments participate more actively than those in urban and suburban areas. To observe

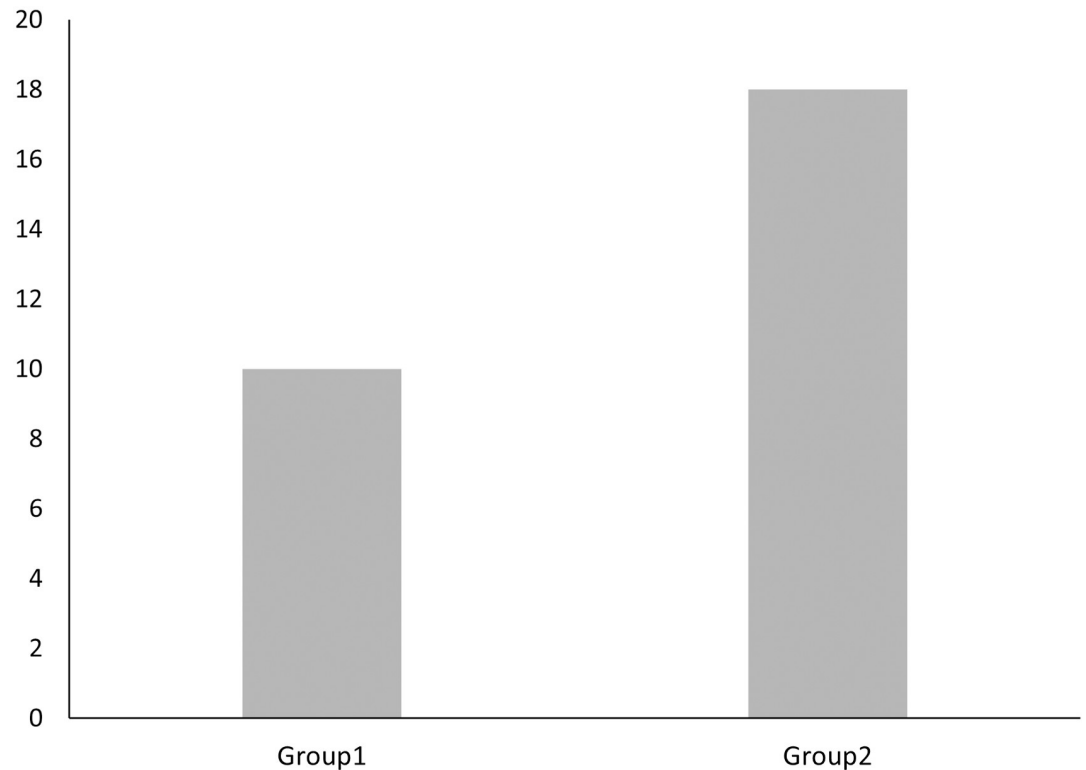


**Fig 1. Awareness of mandatory charges for plastic bags.**

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others' behavior, it was suggested that respondents who observe others' behavior learn from them. The results also indicate that the higher usage frequency of eco-friendly bags, reduces the use of plastic shopping bags. For energy-saving behavior, it was suggested that respondents who attempted to save electricity or water were actively involved in reducing the usage of plastic shopping bags. The odds ratio of variables illustrates that observing others' behavior was the strongest positive factor to reduce plastic bag use, followed by energy-saving behavior and attempts to use eco-friendly bags. The age and place of residence were negative.

The results for the structural model confirmed an acceptable fit ( $\chi^2 = 45.806$ ,  $df = 29$ ,  $p = 0.025$ , GFI = 0.919, CFI = 0.906, RMSEA = 0.077). A structural model with standardized coefficients is shown in Fig 3. A significant relationship between environmental risk perception and recycling behavior was shown with a structural path estimate of 0.79 ( $p < 0.01$ ). The sense of community affected pro-environmental habits with a path estimate of 0.82 ( $p < 0.05$ ). Attempts to reduce plastic shopping bags had a positive significant influence on environmental risk perception with a path estimate of 0.54 ( $p < 0.05$ ). However, no significant influence of environmental risk perception (coefficient = 0.17,  $p > 0.1$ ) and reuse behavior (coefficient = 0.62,  $p > 0.1$ ) on pro-environmental habit was shown. In turn, pro-environmental habit had no significant influence on attempts to reduce plastic shopping bag usage (coefficient = 0.16,  $p > 0.1$ ) (Table 2).



**Fig 2. Percentage of individuals who have used an eco-friendly bag instead of a plastic bag at least once a week before the introduction of mandatory charging of those in Group 1 and Group 2, respectively (Group 1 were respondents who answered that they turned to reduce plastic bags with charging; Group 2 were those who answered that they acted same as before charging was imposed).**

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### 3. Discussion

In Japan, the introduction of a charge for plastic bags is expected to raise awareness of environmental risks and motivate people to reduce their use of plastic bags. Over 80% of the survey respondents were aware about the implementation of the mandatory charge on plastic bags. Many of them were positive about the effectiveness of mandatory charging in reducing plastic waste and protecting the environment. Respondents also understood the general environmental risks humans would face if plastic pollution remained unchecked. Mandatory charging could effectively invoke individuals' interest in environmental issues, especially those related to plastic waste problems, environmental risks, and necessitate pro-environmental behavior in everyday life.

**Table 1. Binary logistic regression.**

	$\beta_n$	Odds ratio	95% confidence interval for odds ratio	
(Intercept)	-2.623	0.073	0.009–0.559	*
Age	-0.023	0.977	0.956–0.999	*
Place of residence	-0.406	0.667	0.454–0.979	*
Observing others' behavior	0.566	1.760	1.257–2.465	***
Attempt to use eco-friendly bags	0.263	1.301	1.019–1.662	*
Energy saving behavior	0.397	1.487	1.110–1.993	**

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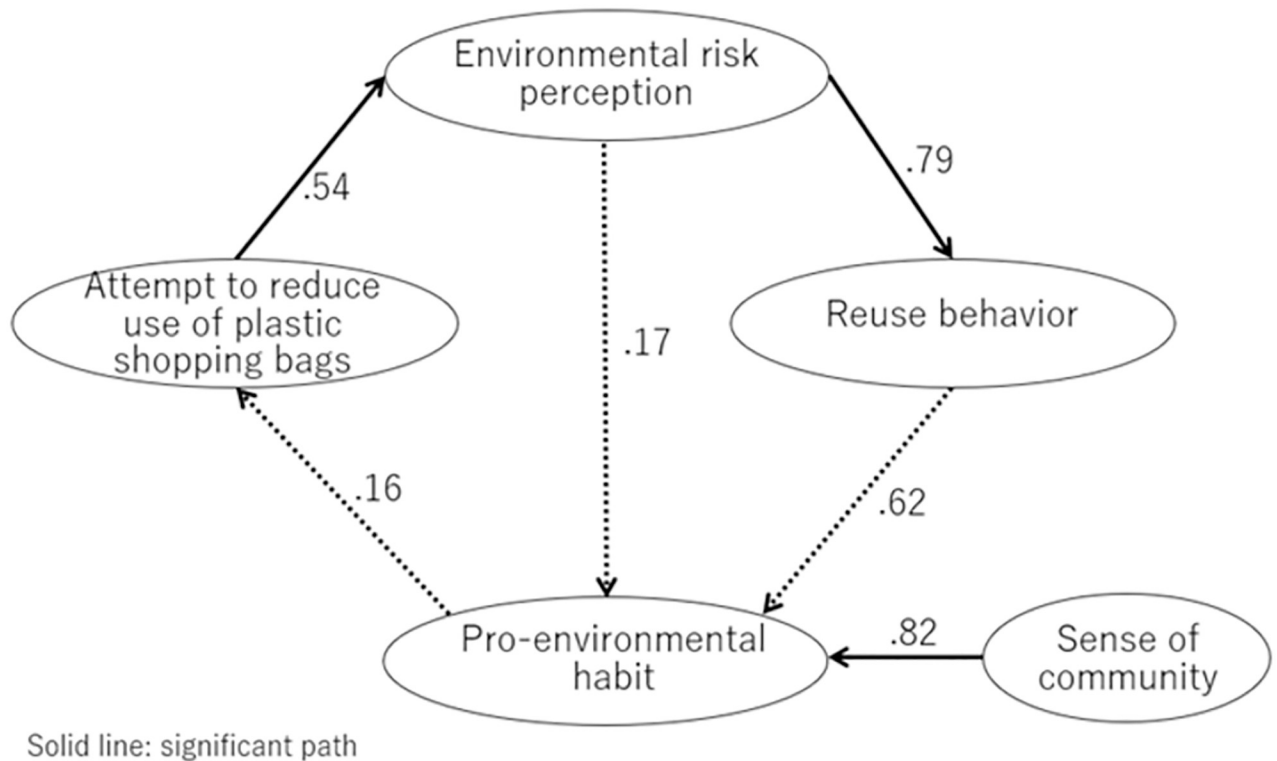


Fig 3. Structural model of the mandatory charging.

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Effective implementation of the mandate at individual level requires motivation, attitudes, and habits. These are highly dependent on individuals’ perceptions and behaviors. Factors influencing the reduction of plastic shopping bag usage, along with mandatory charging were related to age, place of residence, observing others’ behavior, attempts to use eco-friendly bags, and energy-saving behavior (Table 1). Younger people and those living in rural communities, as well as those influenced by others’ behavior were more likely to positively respond to any campaigns targeted at reducing plastic wastage. Similarly, people who used eco-friendly bags, and saved energy, were actively involved in reducing plastic waste.

Interestingly, according to a national survey, the increase in the weekly plastic bag refusal rate was greater for people in their 20s than for those in their 60s or older [14]. Considering that our results reinforce this, mandatory charging, we believe, would increase awareness

Table 2. SEM results (standardized parameter estimates for the structural model).

path			standardized parameter estimates
Pro-environmental habit	<---	Sense of community	0.822 <sup>***a</sup>
Reuse behavior	<---	Environmental risk perception	0.792 <sup>***</sup>
Pro-environmental habit	<---	Environmental risk perception	0.168
Pro-environmental habit	<---	Reuse behavior	0.622
Attempt to reduce plastic shopping bag	<---	Pro-environmental habit	0.157
Environmental risk perception	<---	Attempt to reduce plastic shopping bag	0.538 <sup>**</sup>

<sup>a</sup> \*, \*\*, \*\*\* significant at 10%, 5% and 1%.

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about the need to reduce plastic usage among the younger people. Previous reports have stated that younger people are more likely to engage in eco-friendly behaviors than older people, especially when it comes to adopting alternative means toward sustainability such as ridesharing and organic foods [17–19]. In the same context, they would find reusable eco-friendly bags a better alternative to plastic bags. Furthermore, they have the potential to drive societies toward sustainable lifestyles to achieve sustainable development goals (SDGs) more actively than older people [20]. To encourage everyday environmental consciousness among the younger people, regular communication and campaigns would be effective and sustainable over time.

The place of residence, which has strong ties with one's socio-physical environment, can lead individuals to adopt more pro-environmental lifestyles [21–24]. Our comparison revealed that people living in rural areas participate more actively in reducing plastic bag usage. Rural residents are known to have a higher place identity and attachment [25,26]. Moreover, place-attached individuals are more likely to protect their community, engage in civic activities that are beneficial to the local environment, and appreciate as well as protect the natural resources present in their daily life settings [27]. This is also shown in the relationship between sense of community and pro-environmental habits in Fig 3. Respondents who were more interested in community development and were satisfied with their community were protective about their environment.

One of our learnings from this study is that alongside enforced environmental behavior policies, a commitment to more local action can support and encourage individuals to transition to a more sustainable lifestyle. We also believe that more robust monitoring and evaluation of local authority sustainability programs are required [28]. At present, sustainable community design, involves tackling unsustainability and reducing carbon emissions by local authorities. Increased participation from individuals can increase the pace of these processes. Furthermore, since observing others' behavior, is often induced due to adaptive psychological biases, copying the behavior of others [29], or informally enforced social norms, getting individuals to participate in community sustainable activities could increase such observations and interactions, which in turn could change their environmental behavior [30].

The SEM showed that environmental risk perception and pro-environmental habits did not significantly influence attempts to reduce plastic shopping bag usage (Fig 3). In this survey, we assume that charging is not only something that fosters environmental conscience but is rather a compulsory initiative to promote environmental behavior. The actions of those who reduced their use of plastic bags after the introduction of the plastic bag charge were not likely to be voluntary within the scope of their awareness of environmental risks and their daily environmental behavior. Rather, they were, more likely, actions taken to comply with regulations. Reducing the amount of plastic used is an environment conservation action; however, in the case of pay-as-you-go, it involves governmental enforcement. As this survey was conducted in the early stages of implementation, it is possible that this trend might have been more pronounced. It illustrates individuals' change and influence factors just after the implementation of administrative measures to enhance environmental awareness and behaviors. In turn, environmental risk perception positively influenced recycling behavior. As people participate in government campaigns, they are likely to gain knowledge, and this could influence and kindle their interest in environmental issues. Therefore, mandatory charging is an effective strategy for raising environmental awareness.

To sustain the reduction in the use of plastic shopping bags, it is necessary to foster self-motivation toward environmental acts. It is deemed that well-organized and long-term environmental education could reduce this and become part of everyday life activities. Environmental education is a strong motivator for building climate literacy and encouraging pro-

environmental behavior. The importance of environmental education is well-recognized in Japan. However, its implementation alongside school curriculum has been challenging for educators [31,32]. Subsequently, it is mainly being led by volunteer club activities or through information disclosures, such as newsletters, symposiums, and events. Although active environmental education was introduced with the revisions in 2011, lectures here are still shorter than in other OECD countries and are positioned as supplementary work at school [33–35]. In Singapore, it was reported that transformative education for climate change programs focusing on knowledge, skills, and values, encourages the adoption of pro-environmental behavior [36]. Similar programs are required in Japan, to strengthen its environmental education and improve self-motivated environmental behavior towards environmental protection and sustainable development.

## 4. Conclusion

We explored the factors that influence the reduction of plastic bag usage, along with mandatory plastic bag charge policy. We were able to study the relationship between environmental risk perception, pro-environmental habits, recycling behavior, and sense of local community and plastic bag usage. We found that individuals who reduced the use of plastic bags were relatively more numerous among younger people, those living in rural areas, observing others, attempting to use eco-friendly bags, and saving energy. Attempting to reduce plastic bag usage could significantly influence environmental risk perception and reuse behavior. However, this was not related to pro-environmental habits or environmental risk perception. Therefore, mandatory charging could be effective in raising interest in environmental issues to foster further environmental behavior. Toward long-term success, a precise outreach strategy concerning the influential factors and environmental education is necessary.

## 5. Materials and methods

### 5.1 Process

The questionnaire for this study was developed based on previous research on recycling behaviors [37,38]. The questionnaire used in these studies was modified to include questions related to plastic shopping bags. We then conducted a pre-questionnaire with a sample size of 50 people in order to verify whether the respondents understood the question as intended, or if there were any survey items that were difficult to answer, and if the expressions of the options were appropriate, and so on. Based on the feedback obtained from this pre-questionnaire, a final questionnaire was developed. The questionnaire included questions about individuals' attempts to reduce usage of plastic shopping bags, recycling behavior, pro-environmental habits, environmental risk perception, along with sense of community and the influence of observing others' behavior. A 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) was used for gathering responses [39]. The survey was conducted in Japanese, online, between 11<sup>th</sup> to 14<sup>th</sup>, December 2020. Data were collected anonymously.

### 5.2 Participants

The survey questionnaire was distributed to 218 people, among which 200 questionnaires were valid. Incomplete responses were excluded. The age of the respondents varied from 10 to 60 years.

The responses received were grouped into two. Respondents who answered that there was a reduction in their plastic bag usage after a charge was implemented were referred to as Group 1 (100 respondents). Similarly, Group 2 (100 respondents) referred to people who answered

that they act the same (no behavioral or lifestyle change) change, even after the mandate to charge plastic bags was implemented.

Based on the regulations of the Ethics Committee of Tokyo University of Science, this study did not require an ethics review. It contained no questions that could cause psychological trauma. However, all necessary precautions were taken to maintain the anonymity of all the participants.

### 5.3 Data and variables for analysis

Table 3 provides an overview of the survey questionnaire used to gather data for this study.

A Binary logistic regression analysis was conducted for the dependent variables of behavior change: 1 for reduced plastic shopping bag use and 0 for no change. Additionally, age and place of residence were considered. For residence, the binary value for the urban area was 1, suburban was 2, and rural was 3. The independent variables were selected through the backward elimination model of the Akaike information criterion (AIC). The model fitness was checked by using the Hosmer and Lemeshow goodness-of-fit (GOF) test. All statistical analysis was conducted using the R software package [40].

**Table 3. Questionnaire survey and variables.**

Adoption of the mandatory charging		
Have you reduced the use of plastic bags after the mandatory charging?		
Yes (Group1)	No change (Group2)	
Age/ Sex/ Place of residence		
Attempt to reduce plastic shopping bags	Q1	How often did you use eco-friendly bags before the mandatory charging?
	Q2	I know when the mandatory charging started.
	Q3	It's good to bring my own bag to shop.
	Q4	Sometimes I forget to bring my bag and buy a plastic shopping bag.
	Q5	I know that it is necessary to reduce plastic bags for the environment.
	Q6	I know that eco-friendly bags can reduce plastic wastes
	Q7	I don't think that continuing to use plastic bags by myself will help improve environmental problems.
Observing others' behavior	Q8	I notice people who bring their own bags at supermarkets.
	Q9	When you buy a plastic bag at the supermarket, are you aware of the eyes around you?
Recycling behavior	Q10	I reuse shopping bags for garbage bags and shopping.
	Q11	I feel reluctant to throw away what can be reused.
Pro-environmental habit	Q12	I save electricity / water.
	Q13	I use eco-friendly products such as eco-friendly chopsticks, reusable tumblers, etc.
	Q14	I separate the garbage.
Environmental risk perception	Q15	I think that extreme weather change such as a super-large typhoon will affect our daily lives in the future.
	Q16	I think that changing one's lifestyle can contribute to the improvement of environmental problems.
	Q17	I think it is important for each person to behave pro-environmentally.
Sense of community	Q18	As of December 2020, I am a member of the neighborhood association and residents' association.
	Q19	I am interested in town / community development.
	Q20	I am satisfied with the living environment, public transportation, educational environment, and cultural facilities of the city I am currently living in.

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Group 1 was chosen for structural equation modeling (SEM) to build a model that can illustrate the relationship between attempts to reduce plastic shopping bags with pro-environmental habits, environmental risk perception, recycling behavior, and sense of community, as described in Table 3. SEM is a statistical technique that incorporates both confirmatory factor analysis and path analysis. A factor-analysis-like part is called a measurement model, where the observed variables are indicators of the latent variable. A path-analysis-like part is called a structural equation model, in which causal relation or correlation among latent or observed variables are statistically estimated. The statistical significance of factor loadings, causal (i.e., regression), or correlation coefficients estimated by SEM can be tested. Furthermore, several indices concerning the goodness of fit of the postulated measurement and structural equation models are provided. It is customary to support any SEM model if the goodness of fit index (GFI) exceeds 0.90. The SEM results are usually presented using path diagrams [41]. We used SPSS Amos 27 to build the structural equation model.

## Dryad DOI

Doi: [10.5061/dryad.qv9s4mwfp](https://doi.org/10.5061/dryad.qv9s4mwfp) [42].

## Author Contributions

**Conceptualization:** Yuna Seo.

**Data curation:** Fumiko Kudo.

**Investigation:** Fumiko Kudo.

**Methodology:** Yuna Seo.

**Supervision:** Yuna Seo.

**Validation:** Yuna Seo.

**Visualization:** Yuna Seo.

**Writing – original draft:** Yuna Seo.

**Writing – review & editing:** Yuna Seo.

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