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Influential Factors on Pro-Environmental Behaviors—A Case Study in Tokyo and Seoul

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ABSTRACT

To develop the low-carbon society, in addition to the efforts by industrial and commercial sectors, promotion of people's pro-environmental behaviors (PEBs) has become one of the key issues. Some PEBs have been investigated in previous studies, however, the targets were limited to particular behaviors (*i.e.*, recycling, water saving, electricity saving). The holistic view of understanding the characteristics of PEBs has remained insufficient. In this study, we selected 58 daily PEBs from various fields and investigated people's practice rates and attitudes in Seoul and Tokyo. The questionnaire surveys were conducted and 2393 (Seoul) and 2220 (Tokyo) valid responses were analyzed. Most PEBs had significantly different practice rates between Seoul and Tokyo. It can be concluded that the surrounding conditions, such as policy and infrastructure, have some influences on these differences. The positions of the reasons to practice or not to practice PEBs were visualized using multiple correspondence analyses. The results indicated that the monetary reason was the common factor for many PEBs, while some PEBs showed different reasons. The socio-demographic effects were not significantly different between the two regions. Commonly, women and older people showed more activities on PEBs.

Keywords: Pro-Environmental Behaviors; Practice Rate; Multiple Correspondence Analysis; Reason for Behavior

1. Introduction

The promotion of pro-environmental behaviors (PEBs) in people's daily lives is one of the key issues in developing sustainable societies. According to the national census for environmental conservation [1], more than 80% of people in South Korea express great environmental concerns. The Korean Ministry of Environment started the "Green Start Movement" in 2008 and has intensively promoted people's PEBs through campaigns, video clips, and leaflet distributions. In 2009, the Korean government established "Low Carbon Green Growth," and the "Presidential Committee on Green Growth" to achieve a 30% reduction in greenhouse gas emission by 2020. The "Carbon Cashbag" and "Carbon Footprint" programs were started in response. The "Carbon Cashbag" program offers various low-carbon products, and people who buy these products are reimbursed with shopping-points. Similar to programs in many other countries, the "Carbon Footprint" program shows the lifetime carbon dioxide emission of a product. These programs can enhance people's environmental awareness.

Even if people have a high awareness of environmental issues, there are many internal and external barriers to taking actual action [2-3]. Although people may intend to practice PEBs, various factors such as traditional values, lifestyle, and surrounding circumstances can influence their behavior. In the field of PEB studies, to understand the PEBs deeply, various cross-national studies have been conducted [4-9].

Previous studies have also paid much attention to methods for enhancing PEBs and environmental awareness. Many studies are found in the fields of recycling [10-14], electricity saving [15-19], and water saving behaviors [20-22]. However, each study mainly focuses on one particular PEB, and studies comprehensively dealing with various PEBs are rarely found. In response to the lack of the holistic understandings of PEBs, this study deals with various PEBs and discusses their characteristics through comparison of Seoul and Tokyo citizens. Seoul is the capital of the Republic of Korea, with an area of 605 km^2 and a population of 10.5 million.

Tokyo is the capital of Japan, and its central 23 wards,

with an area of 622 km^2 and a population of 8.7 million, form the target area for this study. Although these cities are geographically close (about 1150 km apart) in the Asian region, we assume that differences in citizens' behavioral patterns arise from different internal and external reasons.

This paper aims to reveal the characteristics of various PEBs through a questionnaire survey. It will particularly focus on the practice rate of each PEB, people's reasons to practice or not practice the behavior, and the effect of socio-demographics.

2. Material and Methods

2.1. Questionnaire Design

To achieve the research aims, we decided to use an online questionnaire survey. In this type of survey, people who register via a web research company are requested to fill out a questionnaire, and points are given to correspond to their answers. More general respondents can be obtained through this online method, as the respondents with higher intension tend to be willing to mail back in the case of conventional postal questionnaires. The quality of registered respondents is also controlled by the web research company. This online method is suitable for conducting a large-scale questionnaire surveys and for obtaining a quick and high response rate. The questionnaire design and analysis of the obtained raw data attribute to a researcher.

The questionnaire consisted of three parts: 1) practice rates of PEBs, 2) reasons to practice or not to practice each PEB, and 3) socio-demographics.

We selected 58 daily PEBs (**Table 1**) based on the previous selection by Aoki *et al.* [23], which was based on the behaviors recommended by the national and local governments and environmental NPOs in Japan. In addition to Aoki *et al.*'s selection, we added or subtracted several behaviors considering the circumstances of each city. For example, "B49: Carbon Cashbag" is a program that only exists in Korea, and therefore this behavior was removed from the list used in Tokyo. Hence, 56 and 52 PEBs were selected for use in Seoul and Tokyo respectively, with 50 PEBs common to both cities. Each respondent's practice rate was measured using the 4-point Likert Scale: "always," "often," "rarely," and "never." Regarding behaviors that require that the respondents have access to certain equipment, such as "B10: Personal computer," "B13: Bidet," "B55: Dishwasher," and behaviors relating to cars (B34-B38), respondents were first asked whether they had the equipment, and respondents who did own the equipment then answered the questions. In part 2, 11 reasons to practice and 13 reasons not to practice PEBs were presented to the respondent as shown in **Table 2**. Respondents who answered "always" or "often" in Part 1 were asked the reasons why they practiced the behavior, and respondents who answered "rarely" or "never" were asked the reasons why they did not practice the behavior. The respondents chose their primary and secondary reasons for practicing or not practicing the behavior from the list of reasons for each PEB.

Part 3 asked for details of socio-demographics, such as gender, age, occupation, and income.

2.2. Survey and Analysis

The surveys were conducted by EZ Survey Co. in Seoul from November 2 to 10, 2010, and by Nikkei Research Co. in Tokyo from February 1 to 13, 2011. The questionnaire was completed by men and women aged 20 - 50 in Seoul and 10 - 70 in Tokyo. The obtained sample numbers were 5546 and 3489, respectively.

When comparing the results of the two cities, the age and gender distributions should fit the distributions of the parent populations. Therefore, respondents aged 20 - 50 years were randomly extracted from the respondents to fit the distributions recorded in the 2010 National Censuses of both cities. Finally, 2393 and 2220 respondents were used for analysis in Seoul and Tokyo respectively. Data analysis was performed using SPSS 18.0 (IBM co., USA).

3. Results and Discussion

3.1. Practice Rates of PEBs

The practice rate of each PEB was defined as the percentage of answers that were "always" or "often."

A practice rate of more than 50% was observed in 42 out of the 56 PEBs in Seoul and 37 out of the 52 PEBs in Tokyo. In Seoul, the behaviors with high practice rates were "B58: Outdoor incineration" and "B24: Waste disposal by the rules," whereas low rates were observed for "B29: Composting" and "B5: Using stairs." Similarly, in Tokyo, B24 had a high practice rate and B29 had a low rate. While these trends were found in both cities, a difference in the PEB practice rate was also found. For example, "B29: Composting" had similarly low practice rates in Seoul and Tokyo when compared to other PEBs, but the practice rates found in Seoul (21.1%) and in Tokyo (7.0%) were quite different.

To check the significance of the difference between Seoul and Tokyo, the answers were coded on a scale from 4 (for "always") to 1 (for "never"), and statistical tests were conducted. According to the normality test, no behaviors showed normal distributions, and therefore the Mann-Whitney test, one of the non-parametric tests corresponding to the t-test, was adopted. **Figure 1** shows the results. In Seoul and Tokyo, 44 out of 50 PEBs showed significantly different practice scores ($p < 0.05$).

Table 1. Targeted pro-environmental behaviors.

Behavior number	Pro-environmental behavior	Short description	
B1	Avoiding overloading the refrigerator	Refrigerator (overloaded)	
B2	Reducing opening and closing the door of the refrigerator	Refrigerator (door)	
B3	Using a lower setting in the refrigerator compartment	Refrigerator (temperature)	
B4	Putting hot food into refrigerator after cooling	Refrigerator (cooling)	
B5	Using stairs instead of elevators	Elevator	
B6	Cleaning filter of air conditioner or cleaner	Filter cleaning	
B7	Turning off lights in empty rooms	Light off	
B8	Unplugging appliances not in use	Power (plug)	
B9	Turning off the TV when people are not watching	Power (TV)	
B10	Using energy saving mode or turning off when not in use	Power (monitor)	
B11	Adjusting the temperature of the air conditioner or radiator	Ideal temperature (air conditioner)	
B12	Setting a lower shower temperature	Ideal temperature (shower)	
B13	Adjusting the temperature of the bidet seat and water or closing the lid	Ideal temperature (bidet)	
B14	Doing ironing collectively	Iron	
B15	Using toothbrush cup	Water saving (teeth brush cup)	*
B16	Turning off the water when washing face	Water saving (wash face)	*
B17	Taking short showers	Water saving (shower)	
B18	Putting plastic bottles or stones into the toilet water tank	Water saving (bidet)	
B19	Washing dishes using jugged water	Water saving (dish wash)	
B20	Turning off the water when washing face or brushing teeth	Water saving (teeth brush)	+
B21	Cutting down on the frequency of washing clothes	Laundry	
B22	Avoiding throwing away waste cooking oil	Used cooking oil	
B23	Reducing detergent	Little detergent	
B24	Following garbage rules	Waste (rule)	
B25	Recycling milk packs or newspapers	Recycle (newspaper)	
B26	Giving used clothes to other people or using a recycle box	Recycle (second-hand clothes)	
B27	Using own cup	My cup	
B28	Avoiding over-volume cooking	Proper cooking	
B29	Composting kitchen garbage	Food waste (compost)	
B30	Throwing away kitchen garbage after it has dried	Food waste (dehydration)	
B31	Using receptacle instead of plastic bag	Reuse (airtight container)	
B32	Using both sides of paper	Reuse (paper)	
B33	Reducing use of disposable products	Disposable goods	
B34	Joining the one day without car program	Car (one day without car)	*
B35	Doing car checks regularly	Car (checking)	
B36	Avoiding overloading the car	Car (overloading)	
B37	Reducing idling of car	Car (idling)	
B38	Maintaining air pressure of tire	Car (tire pressure)	
B39	Using bicycle or walking	Bicycle or Walking	
B40	Using public transportation	Public transportation	
B41	Buying eco-appliances	Eco-appliance	

Continued

B42	Buying ecomark-appliances	Ecomark-appliance	+
B43	Buying recycled goods	Recycling goods	
B44	Not buying unnecessary products	Needless goods avoidance	
B45	Trying to repair things before buying replacements	Repair	
B46	Using refill goods	Refillable goods	
B47	Buying organic products	Organic goods	
B48	Choosing goods with their CO_2 emission in mind (carbon footprint)	Carbon footprint	*
B49	Buying carbon cashbag products	Carbon cashbag	*
B50	Trying to buy a hybrid car if necessary	Eco-Car	
B51	Using own bag when going shopping	My Bag	
B52	Not buying over-packaged products	Little package	
B53	Using LED lamp instead of fluorescent lamp	Using LED	
B54	Turning off air conditioner/heater in empty rooms	Temperature control off	
B55	Using dish washer	Dishwasher	
B56	Flame adjustment for cooking	Eco-cooking	
B57	Using curtain for cutting heat	Insulation	
B58	Not burning the trash in the yard	Incinerate at the outdoor	*

*Only in Seoul; +Only in Japan.

Table 2. Conduct/not conduct reasons.

Conduct reasons	Not conduct reasons
Rule	Bothersome
Habit	Time consuming
Saving	Inconvenience
Environment friendly	Not environment friendly
Friend	Cost
Moral	No consideration
Cool	Forget
Healthful	Nobody doing
Others	No recognition
Convenience	No chance
Getting points	No necessity
	No rule
	Not cool (only in Japan)

3.2. Possible Factors Causing the Practice Rate Difference

3.2.1. Influence of Surrounding Conditions

Cultural difference is one of the reasons for the difference in practice rates between the two cities.

For instance, the practice rate of "B54: Temperature control off" was significantly higher ($p < 0.000$) in Tokyo (3.48) than in Seoul (3.02). In Korea, traditional "*Ondol*" floor-heating is well-established as the system for controlling the temperature of a house. Since this is a central-heating system, people must go to a boiler room to control the room temperature. On the contrary, it is common in Japan for each room to have an individual temperature control system. Therefore, Japanese people can control the room temperature more easily than Korean people. This is reflected in the higher practice rate of B54 in Tokyo than in Seoul. Cultural difference is a fundamental factor and cannot be easily changed by external forces. However, other external factors, such as policies and infrastructure, can be controlled to enhance PEBs. The practice rate of "B26: Recycling second-hand clothes" was significantly higher ($p < 0.001$) in Seoul (3.20) than in Tokyo (2.19). In Tokyo, when people want to recycle their old clothes, they need bring their clothes to collection places like schools and department stores where local governments or apparel makers collect old clothes. On the other hand, in Seoul, the local government consigns old-clothes collection to private organizations, and collection boxes are placed beside daily curbside waste collection boxes (**Figure 2**). The higher practice rate of B26 in Seoul can be attributed to this difference.

The effect of policy can also be seen for other PEBs such as "B29: Composting" and "B51: My own bag." Seoul respondents had a significantly higher ($p < 0.000$) practice score (1.89) for composting behavior (B29) than people in Tokyo (1.29). In 1998, the Korean government put the "Basic Plan for Recycling Food Waste (1998-2002)" into force and banned the disposal of food waste

Behavior No.	Short description	Mann-Whitney U	p		Average[b]	S.D[c]
B1	Refrigerator (overloaded)	1821720.5	.000	***	S 2.45	.72
					T 2.80	.84
B2	Refrigerator (door)	2108009.0	.000	***	S 2.58	.71
					T 2.84	.81
B3	Refrigerator (temperature)	2254456.0	.000	***	S 2.36	.78
					T 2.48	.97
B4	Refrigerator (cooling)	2300291.5	.000	***	S 3.13	.82
					T 3.21	.88
B5	Using stair	2460126.5	.008	**	S 2.06	.81
					T 2.15	.91
B6	Filter cleannig	2282528.5	.000	***	S 2.45	.77
					T 2.36	.84
B7	Light off	2482578.0	.000	***	S 3.35	.69
					T 3.40	.75
B8	Power (plug)	2205625.5	.000	***	S 2.59	.89
					T 2.34	.96
B9	Power (TV)	2316680.0	.000	***	S 3.10	.85
					T 2.90	.95
B10	Power (monitor)	2584587.0	.494		S 3.18	.79
					T 3.14	.92
B11	Ideal temperature (air conditioner)	1879798.5	.000	***	S 2.85	.70
					T 3.18	.84
B12	Ideal temperature (shower)	1357503.0	.000	***	S 2.94	.64
					T 2.20	.88
B13	Ideal temperature (bidet)	612389.5	.000	***	S 2.73	.80
					T 3.17	.92
B14	Iron	1587987.0	.000	***	S 2.89	.79
					T 3.07	.95
B17	Water saving (shower)	2519834.5	.025	**	S 2.71	.77
					T 2.66	.90
B18	Water saving (bidet)	1428280.5	.000	***	S 2.13	1.00
					T 1.47	.88
B19	Water saving (dish wash)	2131505.5	.000	***	S 2.09	.84
					T 2.01	.98
B21	Laundry	2162507.5	.000	***	S 3.28	.66
					T 3.32	.76
B22	Used cooking Oil	2199698.0	.479		S 2.97	.78
					T 2.91	1.01
B23	Litter detergent	2075731.0	.000	***	S 2.81	.67
					T 2.63	.90
B24	Waste (rule)	2078980.0	.000	***	S 3.40	.67
					T 3.59	.67
B25	Recycle (newspaper)	2310619.0	.000	***	S 3.26	.77
					T 3.06	1.06
B26	Recycle (second-hand clothes)	1116555.5	.000	***	S 3.20	.74
					T 2.19	.97
B27	My cup	2204964.5	.000	***	S 2.72	.89
					T 2.55	1.14
B28	Proper cooking	1732051.0	.000	***	S 2.93	.67
					T 3.27	.77
B29	Food waste (compost)	1261224.5	.000	***	S 1.89	.83
					T 1.29	.66
B30	Food waste (dehydration)	2173609.5	.009	**	S 2.72	.82
					T 2.63	.97
B31	Reuse (airtight container)	1434087.0	.000	***	S 3.03	.70
					T 2.37	.90
B32	Reuse (paper)	2351110.5	.000	***	S 3.07	.68
					T 2.86	.96
B33	Disposable goods	2073331.0	.000	***	S 2.90	.65
					T 2.59	.83
B35	Car (checking)	473511.0	.000	***	S 2.97	.74
					T 2.53	.88
B36	Car (overloading)	2018156.5	.258		S 2.89	.73
					T 2.84	.89
B37	Car (idling)	600085.5	.000	***	S 3.06	.65
					T 3.17	.79
B38	Car (tire pressure)	647164.5	.280		S 3.01	.64
					T 2.97	.83
B39	Bicycle or Waking	694021.5	.000	***	S 3.07	.73
					T 3.36	.78
B40	Public transportation	2368392.0	.000	***	S 3.22	.76
					T 3.32	.85
B41	Eco-Appliance	1893404.5	.000	***	S 2.97	.68
					T 2.59	.89
B43	Recycling goods	2055484.0	.000	***	S 2.48	.71
					T 2.20	.79
B44	Needless goods avoidance	2574343.0	.746		S 2.94	.62
					T 2.92	.74
B45	Repair	2376463.5	.000	***	S 3.07	.59
					T 2.95	.71
B46	Refillable goods	1978887.5	.000	***	S 2.97	.65
					T 3.26	.67
B47	Organic goods	1648949.0	.000	***	S 2.51	.73
					T 2.03	.79
B50	Eco-Car	1749260.0	.373		S 2.33	.79
					T 2.33	1.01
B51	My Bag	2122037.0	.000	***	S 3.13	.79
					T 2.81	1.01
B52	Little package	2413274.0	.000	***	S 3.02	.73
					T 2.89	.87
B53	Using LED	1556756.0	.000	***	S 2.30	.81
					T 1.77	.89
B54	Temperature control off	1694261.0	.000	***	S 3.02	.79
					T 3.48	.75
B55	Dishwahser	137341.0	.000	***	S 2.45	.81
					T 2.91	1.00
B56	Eco- Cooking	1834008.5	.000	***	S 2.98	.69
					T 3.25	.84
B57	Insulation	2264993.0	.000	***	S 2.93	.72
					T 3.06	.87

[a]: ***:$p < 0.01$; **: $p < 0.05$ one-tail; [b]: S: Seoul, T: Tokyo; [c]: Standard deviation.

Figure 1. Comparison of practice rates between two cities.

Figure 2. Old cloth collection boxes in Korea.

in landfills used for other combustible waste nationwide. Based on this policy, Korean people have had to separate their food waste from other waste and dispose of it in charged waste bags. This condition creates motivation for people to separate and reduce their food waste. On the other hand, the Tokyo metropolitan government collects and treats food waste along with other combustible waste. Hence, Seoul residents have the habit of separating their food waste and some residents try to reduce the food waste themselves through composting.

The policy effect on the behavior practice rate of "B51: My own bag" seems to be large. The Korean government has charged for plastic shopping bags nationwide since 1999, while free plastic shopping bags are distributed in most regions in Tokyo. This is reflected in the significantly ($p < 0.001$) higher practice rate of B51 in Seoul (3.13) than in Tokyo (2.81). The effects of charging for shopping bags have also been discussed in previous studies. Ueta and Koizumi [24] compared the packing waste systems of Freiburg in Germany and Neyagawa in

Japan and found that the charging system in Freiburg contributed to behaviors that reduce the use of disposable plastic shopping bags. Kurisu and Bortoleto [25] compared three mega prefectures (Aichi, Osaka, Tokyo) in Japan and found that the city that implemented a charging system for shopping bags showed significantly higher practice rates of people using their own bags. Hence, the policy of implementing a charging system can have a significant effect on the PEB practice rate.

3.2.2. Influence of Personal Judgment

As discussed above, some external conditions can affect PEB practice rates. However, personal reasons can also influence people's behaviors. To understand the characteristics of PEBs based on personal reasons, we used multiple correspondence analysis (MCA). MCA is one of the statistical techniques used to reveal the optimal quantification that describes the relationships between the categorical scores of each variable as well as the relationships between the variables themselves. The reasons selected from the list shown in **Table 2** for practicing or not practicing behaviors were used as the column variables, while 50 PEBs were set as the row variables to give the input matrices for MCA.

The resulting scores were plotted as shown in **Figures 3**-**6**. Reasons and behaviors that are placed closer together are more closely connected.

Figures 3 and **4** show the reasons for practicing PEBs in Seoul and Tokyo respectively. Many PEBs were plotted close to the reason "Saving" in both Seoul and Tokyo. Monetary saving is considered one of the important factors for PEBs [3,26]. Abrahams *et al*. [26] reviewed various previous studies related to monetary intervention for household energy conservation and also showed its effectiveness. "Saving" is the main reason for practicing most PEBs in the two target cities. If we look at the positions of the 11 reasons, the related reasons of "Habit" and "Convenience" are found close to "Saving." The positions reveal that the respondents in Tokyo perceive "Convenience" and "Habit" as closely connected to "Saving," and that these three reasons are their main reasons for practicing most PEBs, while the respondents in Seoul consider these reasons distinct from "Saving." The reasons that are particularly distinct are "Rule" and "Healthy." "Rule" is closely related to external forces like laws and regulations and so is different from other reasons for practicing PEBs. The behaviors close to the reason "Rule" are "B24: Waste (rule)" and "B25: Recycle (newspaper)" in both cities. These are behaviors practiced following the waste disposal rules set by the local governments. "B30: Food waste (dehydration)" is also close to "Rule" in Seoul, because food waste disposal is regulated by the law in Korea, as mentioned in 3.2.1. On the other hand, B30 is more closely related to "Moral" rather than "Rule" in Tokyo, where no regulations about food waste disposal exist. The PEBs closely related to "Healthy" are "B5: Using stairs," "B39: Bicycle or walking," and "B47: Organic goods," all of which are related to health enhancement. In the case of "B6: Filter cleaning," Seoul respondents recognize the health advantage of this behavior, while Tokyo respondents practice this behavior as a "Habit."

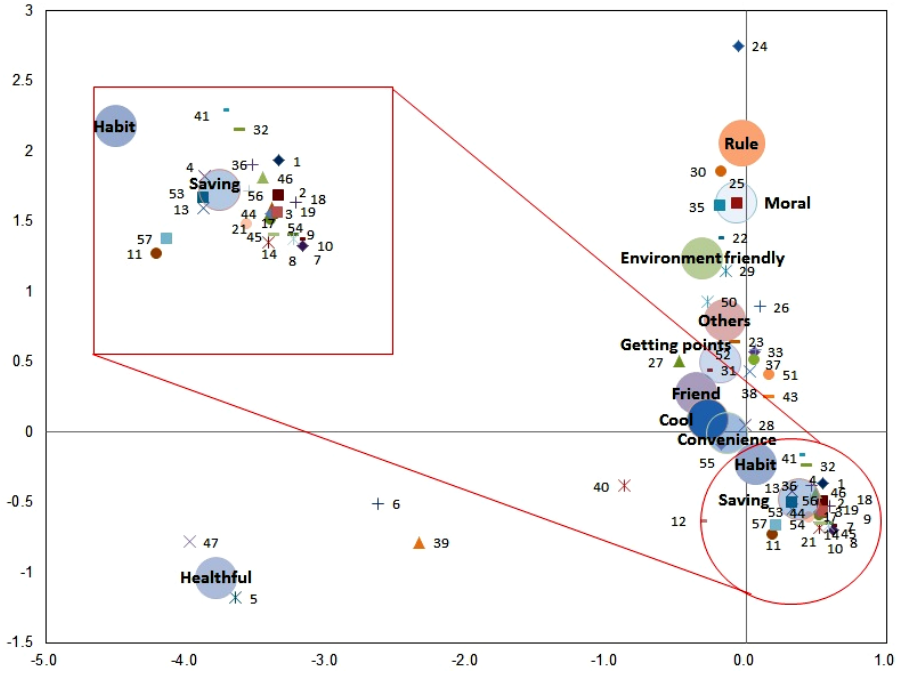

Figure 3. The matrix of practice group in Seoul (Cronbach's alpha = 0.65).

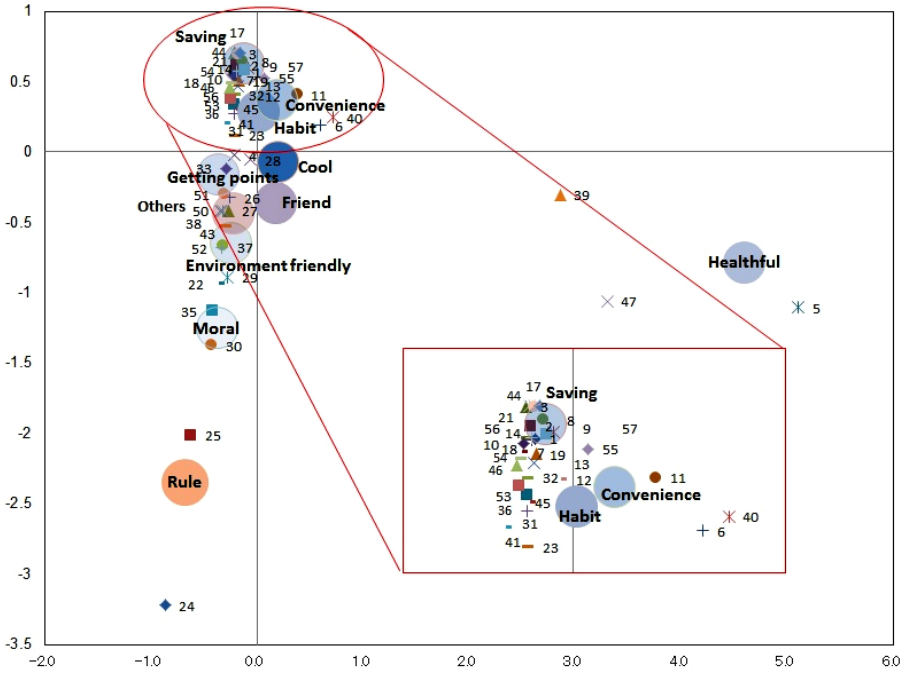

Figure 4. The matrix of practice group in Tokyo (Cronbach's alpha = 0.67).

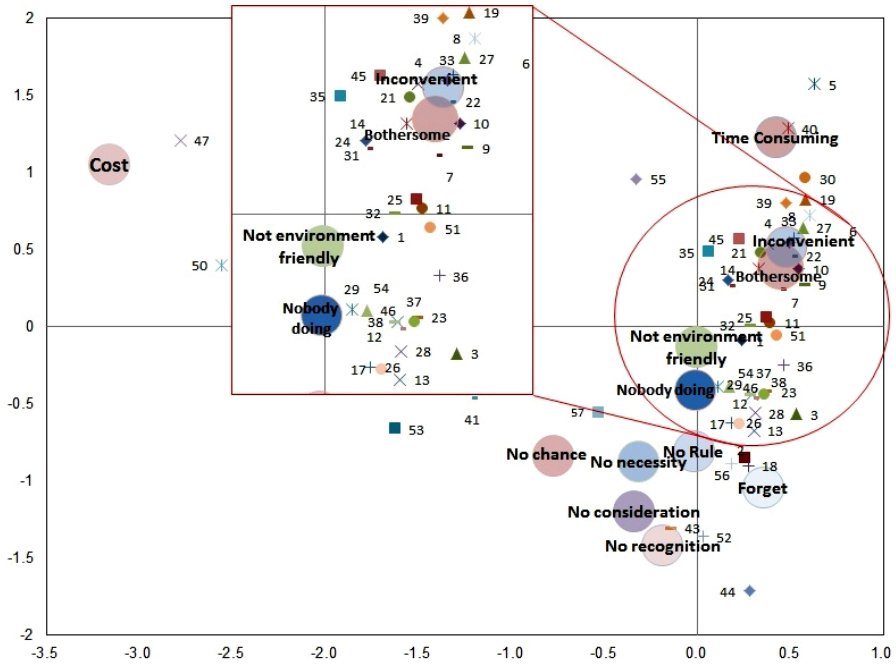

Figure 5. The matrix of non-practice group in Seoul (Cronbach's alpha = 0.58).

"Environment friendly" is relatively close to "Moral" in Seoul, while this reason is closely connected to "Following others" and "Recommendation" in Tokyo. Social norms, such as descriptive and subjective norms (*i.e.*, the influence of others), are one of the most important factors in PEBs [7,8,10,27-29]. Ando *et al.* [7,8] have pointed out that the Japanese are more influenced by others, namely by subjective norms, when practicing PEBs than people in other countries.

Figures 5 and **6** show the reasons for not practicing PEBs in Seoul and Tokyo respectively. The reason that appears most distinct from the others is "Cost." The behaviors that involve purchasing Eco-products, such as "B47: Organic goods," "B50: Eco-car," "B41: Eco-appliance," and "B53: LED," are closely related to this reason in both cities. Eco-products are generally more

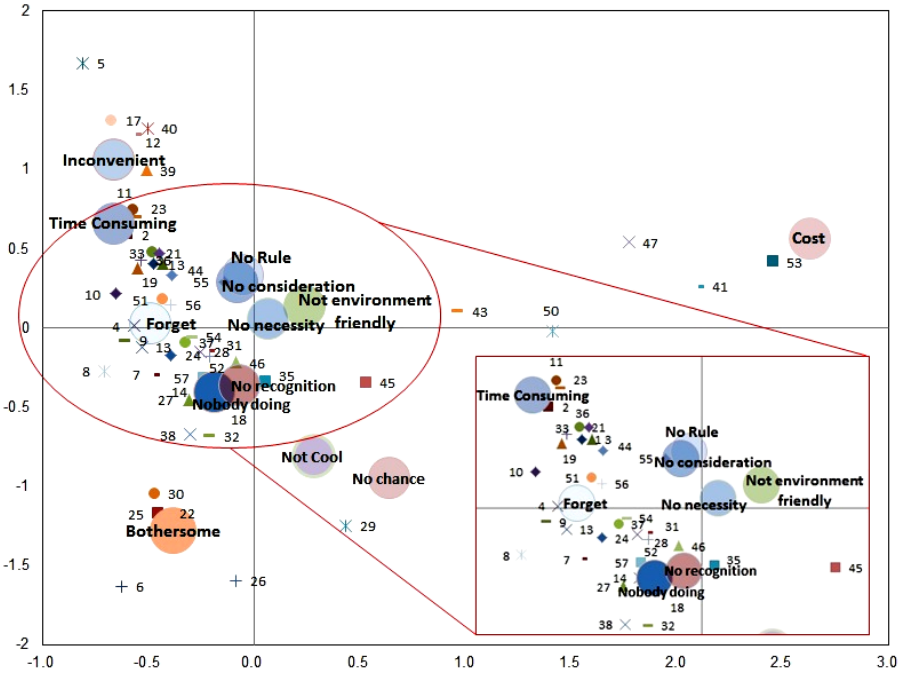

Figure 6. The matrix of non-practice group in Tokyo (Cronbach's alpha = 0.63).

expensive than regular products, and so "Cost" can be the main barrier to practicing these behaviors.

In Tokyo, the PEBs closely related to "Bothersome" are "B6: Filter cleaning," "B26: Recycle (second-hand clothes)," "B22: Used cooking oil," "B25: Recycle (newspaper)," and "B30: Food waste (dehydration)," while the PEBs close to "Inconvenience" are "B5: Elevator," "B17: Water saving (shower)," "B40: Public transportation," "B12: Ideal temperature (shower)," and "B39: Bicycle or walking". The former PEBs require additional work, while the latter PEBs cause some discomfort as the result of practicing the behaviors. There is a very well-recognized distinction between "Bothersome" and "Inconvenience" in Tokyo, while these are perceived as similar concepts in Seoul.

Unlike **Figures 3** and **4**, the PEBs are not clustered close to any particular reason, but clusters do form near multiple reasons. This indicates that the internal barriers for PEBs are more diverse than the incentives. Multiple barriers can affect PEBs. This creates difficulties in removing the barriers for the PEBs.

3.3. Effects of Demographics

One of the factors that cause practice rate difference is socio-demographics. Gender and age are potentially important factors in determining PEBs practice rates. To understand the effect of gender and age, non-parametric statistical tests such as the Mann-Whitney test and Kruskal-Wallis (KW) test were applied. We selected these non-parametric tests because the original data did not show the normal distribution. However, the parametric test corresponding to the KW test, namely one-way ANOVA (analysis of variance), which is considered to give robust results even without the normal distribution requirement, was also applied.

A post hoc (multiple comparison) test was also conducted to discover which attributes differ in practice rate. Tukey-Kramer Hochberg's GT2 was selected for the behaviors showing homogeneity of variance, while Dunnett's T3 method was adapted for the others.

Tables 3 and **4** show the result of the effects of gender and age on the practice rates in the two cities. In terms of gender, 36 and 50 PEBs show significantly different practice rates between men and women in Seoul and Tokyo respectively. The practice rate of females is statistically higher than that of males in 33 out of 36 PEBs in Seoul and 37 out of 50 PEBs in Tokyo. The higher practice rates of PEBs in women have been reported in many previous studies [5,30,31]. It is easily understood that higher practice rates for the female respondents were observed in many homemaking PEBs, such as "B14: Ironing," "B21: Laundry," "B22: Used cooking oil," "B23: Little detergent," "B24: Waste (rule)," and "B25: Recycle (newspaper)."

In terms of age, 41 PEBs in Seoul and 32 PEBs in Tokyo show significantly different practice rates. The trend is similar in the two cities. Elder respondents tend to practice PEBs more than younger people. The same trend was also observed in waste prevention behaviors [25,30]. As Whitmarsh [32] pointed out, age can be a significant variable for several PEBs. The elder respon-

Table 3. The effects of gender and age in Seoul.

Behavior Number	Gender					Age					
	Mann-Whitney		Average		High practice	HV[b]	One-Way ANOVA[c]	Kruskal Wallis		Multiple-Comparison	
	U	p[a]	Male	Female		p	p	χ^2	p	M[d]	Interpretation[e]
B1	626682	**0.000**	2.4	2.5	F	0.014	0.174	4.66	0.198		
B2	694330	0.221	2.58	2.59		0.000	**0.000**	43.23	**0.000**	T3	20s, 30s < 40s < 50s
B3	680880	0.317	2.35	2.37		0.003	**0.002**	15.52	**0.001**	T3	30s < 50s
B4	613182	**0.000**	3.05	3.22	F	0.000	**0.000**	37.7	**0.000**	T3	20s < 30s < 40s, 50s
B5	667387	0.080	2.09	2.04		0.018	**0.000**	30.65	**0.000**	T3	30s, 20s < 50s, 40s
B6	636998	**0.003**	2.4	2.49	F	**0.180**	**0.000**	98.59	**0.000**	GT2	20s < 30s < 40s, 50s
B7	642046	**0.000**	3.29	3.41	F	**0.428**	**0.001**	12.48	**0.006**	GT2	30s < 40s, 50s
B8	604111	**0.000**	2.47	2.7	F	0.000	**0.002**	13.41	**0.004**	T3	20s < 50s, 40 s
B9	707392	0.371	3.09	3.11		**0.149**	**0.019**	12.6	**0.006**	GT2	50s < 20s
B10	664337	**0.004**	3.14	3.22	F	0.000	**0.005**	8.65	**0.034**	T3	20s < 40s, 50s
B11	618941	**0.000**	2.78	2.91	F	0.000	**0.000**	30.84	**0.000**	T3	20s < 50s, 40s, 30s < 40s
B12	697620	0.115	2.95	2.92		0.000	**0.000**	67.74	**0.000**	T3	20s < 30s < 40s, 50s
B13	196145	**0.025**	2.7	2.77	F	0.017	0.143	5.16	0.160		
B14	519981	**0.000**	2.76	3.02	F	0.000	**0.000**	18.73	**0.000**	T3	20s < 40s, 50s
B17	674917	**0.008**	2.67	2.75	F	0.000	**0.000**	38.11	**0.000**	T3	20s < 30s < 40s, 50s
B18	680598	0.442	2.12	2.14		**0.582**	**0.000**	45.65	**0.000**	GT2	20s, 30s < 40s, 50s
B19	637978	**0.016**	2.13	2.06	M	0.042	**0.000**	24.79	**0.000**	T3	30s < 40s, 30s, 20s < 50s
B21	601642	**0.000**	3.2	3.35	F	0.003	0.460	3.93	0.269		
B22	574399	**0.000**	2.86	3.07	F	0.000	**0.000**	21.57	**0.000**	T3	30s < 40s, 50s, 20s < 50s
B23	642219	**0.009**	2.77	2.84	F	0.000	**0.000**	53.7	**0.000**	T3	20s < 40s, 20s, 30s, 40s < 50s
B24	629187	**0.000**	3.34	3.47	F	0.000	**0.001**	11.47	**0.009**	T3	20s < 40s, 50s
B25	650122	**0.001**	3.21	3.31	F	0.006	0.498	1.14	0.767		
B26	563394	**0.000**	3.07	3.32	F	**0.179**	**0.000**	26.73	**0.000**	GT2	20s < 40s, 50s, 30s < 50s
B27	613052	**0.000**	2.62	2.81	F	0.000	**0.000**	25.84	**0.000**	T3	20s, 30s, 40s < 50s
B28	646405	**0.002**	2.89	2.97	F	0.000	**0.003**	13.75	**0.003**	T3	20s, 30s < 50s
B29	633303	0.144	1.91	1.87		0.007	**0.000**	19.64	**0.000**	T3	30s < 20s, 50s
B30	622256	**0.002**	2.67	2.77	F	0.000	**0.000**	32.57	**0.000**	T3	20s, 30s < 40s < 50s
B31	667711	0.073	3	3.05		0.000	0.086	7.43	0.059		
B32	648318	**0.000**	3.02	3.13	F	0.001	**0.016**	10.42	**0.015**	T3	30s < 40s
B33	643500	**0.000**	2.83	2.97	F	0.000	**0.000**	43.19	**0.000**	T3	30s, 20s < 40s, 50s
B35	369833	**0.004**	2.93	3.02	F	0.000	**0.000**	17.09	**0.001**	T3	20s < 30s, 40s, 50s
B36	670495	**0.001**	2.84	2.94	F	0.000	**0.007**	11.73	**0.008**	T3	20s < 50s
B37	384090	0.165	3.05	3.08		0.029	**0.000**	18.35	**0.000**	T3	20s, 30s, 40s < 50s
B38	380448	0.128	3	3.03		0.010	**0.000**	16.72	**0.001**	T3	20s <40s, 50s
B39	365973	**0.003**	3.03	3.12	F	**0.071**	**0.135**	7.16	0.067		
B40	606689	**0.000**	3.11	3.32	F	**0.256**	**0.000**	55.14	**0.000**	GT2	40s, 30s, 50s < 20s
B41	634290	**0.000**	2.91	3.02	F	0.000	**0.006**	11.6	**0.009**	T3	20s < 50s

Continued

B43	698791	0.361	2.49	2.48		**0.073**	**0.005**	13.46	**0.004**	GT2	30s < 50s, 40s
B44	668094	**0.039**	2.92	2.96	M	0.000	**0.000**	21.89	**0.000**	T3	20s, 30s < 40s, 50s
B45	688834	0.140	3.06	3.09		**0.053**	**0.114**	6.04	0.109		
B46	614145	**0.000**	2.88	3.05	F	0.000	**0.001**	14.59	**0.002**	T3	20s < 40s, 50s
B47	674906	0.160	2.5	2.53		0.002	**0.000**	30.31	**0.000**	T3	20s, 30s, 40s < 50s
B50	618445	0.094	2.31	2.35		0.041	**0.000**	27.75	**0.000**	T3	30s < 40s, 50s
B51	584053	**0.000**	3.01	3.24	F	**0.185**	**0.000**	51.29	**0.000**	GT2	20s, 30s < 40s, 50s
B52	580953	**0.000**	2.9	3.13	F	**0.239**	**0.000**	36.7	**0.000**	GT2	20s, 30s < 40s, 50s
B53	607447	**0.000**	2.22	2.38	F	0.001	**0.010**	12.45	**0.006**	T3	
B54	648370	**0.005**	2.99	3.06	F	0.002	0.080	4.46	0.216		
B55	65191	**0.022**	2.5	2.38	M	**0.258**	**0.378**	2.08	0.556		
B56	607045	**0.000**	2.91	3.05	F	0.000	**0.000**	18.74	**0.000**	T3	20s < 40s, 50s, 30s < 50s
B57	628005	**0.000**	2.87	2.99	F	0.000	**0.000**	19.23	**0.000**	T3	20s < 40s, 50s, 30s < 50s

Note: Significant p value was indicated in ***bold***. [a]One-tail; [b]HV: Homogeneity-of Variance; [c]Be reference; [d]Post-Hoc method, GT2: Tukey-Kramer Hochberg's GT2, T3 : Dunnett's T3; [e]m < k: m is significantly better than k ($p < 0.01$) m, j < k: There is no significantly difference between m and j, but m and j are significantly better than k ($p < 0.01$).

Table 4. The effects of gender and age in Tokyo.

Behavior Number	Gender					Age					
	Mann-Whitney		Average		High practice	HV[b]	One-Way ANOVA[c]	Kruskal Wallis		Multiple-Comparison	
	U	p[a]	Male	Female		p	p	χ^2	p	M[d]	Interpretation[e]
B1	466511	**0.000**	2.7	2.9	F	**0.118**	0.572	2.58	0.461		
B2	575879	0.266	2.83	2.86		0.000	0.323	2.51	0.473		
B3	490450	**0.005**	2.42	2.53	F	0.000	0.499	2.56	0.465		
B4	439314	**0.000**	3.04	3.38	F	**0.187**	**0.000**	15.3	**0.002**	GT2	20s < 30s, 40s, 50s
B5	577393	0.111	2.17	2.12		0.004	0.542	2.79	0.424		
B6	510830	**0.005**	2.31	2.41	F	**0.094**	**0.000**	58.36	**0.000**	GT2	20s < 30s, 50s, 40s
B7	510265	**0.000**	3.29	3.52	F	0.005	**0.021**	10.49	**0.015**	T3	20s < 40s
B8	506825	**0.000**	2.21	2.47	F	0.000	**0.002**	13.95	**0.003**	T3	50s < 40s, 30s, 20s
B9	568412	**0.024**	2.86	2.94	F	0.024	**0.010**	13.66	**0.003**	T3	50s < 30s
B10	529538	**0.000**	3.05	3.23	F	**0.985**	0.195	5.08	0.166		
B11	479817	**0.000**	3.04	3.34	F	**0.058**	**0.012**	8.41	**0.038**	GT2	20s < 40s, 50s
B12	579839	0.207	2.18	2.22		**0.188**	**0.000**	31.13	**0.000**	GT2	20s < 40s, 50s, 30s < 50s
B13	188661	**0.000**	3.02	3.3	F	0.008	**0.011**	7.71	0.052		
B14	248215	**0.000**	2.82	3.25	F	0.000	**0.000**	28.59	**0.000**	T3	20s < 30s, 50s, 40s, 30s < 40s
B17	560229	**0.008**	2.62	2.71	F	0.000	**0.000**	44.49	**0.000**	T3	20s, 30s < 40s, 50s
B18	477269	**0.000**	1.52	1.42	M	0.001	**0.037**	11.05	**0.011**	T3	
B19	481233	0.104	1.97	2.05		**0.528**	**0.000**	22.19	**0.000**	GT2	30s < 40s, 50s
B21	426779	**0.000**	3.23	3.4	F	**0.079**	0.192	9.26	**0.026**	GT2	
B22	324903	**0.000**	2.64	3.13	F	0.000	**0.000**	36.24	**0.000**	T3	20s < 30s, 40s, 50s
B23	449149	**0.000**	2.54	2.72	F	0.000	**0.000**	33.03	**0.000**	T3	20s, 30s < 40s, 50s

Continued

B24	495014	**0.000**	3.5	3.68	F	0.000	**0.000**	58.39	**0.000**	T3	20s < 30s, <50s, 40s
B25	462205	**0.000**	2.93	3.19	F	0.000	**0.000**	69.87	**0.000**	T3	20s < 30s, <40s, 50s
B26	451593	**0.000**	2.02	2.36	F	**0.100**	0.465	3.88	0.275		
B27	441045	**0.000**	2.41	2.7	F	0.033	**0.000**	22.95	**0.000**	T3	20s, 30s < 40s
B28	494261	0.078	3.23	3.31		**0.244**	0.219	6.11	0.106		
B29	442434	**0.000**	1.35	1.23	M	0.000	**0.045**	7.44	0.059		
B30	384461	**0.000**	2.44	2.79	F	0.000	**0.000**	52.77	**0.000**	T3	20s <30s, 40s, 50s, 30s < 50s
B31	465825	**0.000**	2.27	2.46	F	0.005	0.264	4.2	0.241		
B32	528518	**0.000**	2.77	2.96	F	**0.105**	**0.003**	15.64	**0.001**	GT2	30s < 40s, 20s
B33	522140	**0.000**	2.49	2.7	F	0.000	**0.004**	14.53	**0.002**	T3	30s < 50s
B35	66855	0.467	2.53	2.53		**0.257**	0.871	0.95	0.814		
B36	564121	0.445	2.84	2.84		**0.082**	0.174	4.42	0.220		
B37	68624	0.364	3.16	3.2		0.026	**0.031**	6.15	0.105		
B38	62869	0.120	3	2.92		**0.063**	**0.041**	8.55	**0.036**	GT2	20s < 50s
B39	76414	**0.001**	3.3	3.43	F	**0.601**	0.086	8.86	**0.031**	GT2	
B40	568306	**0.003**	3.27	3.37	F	0.006	**0.000**	33.19	**0.000**	T3	30s < 40s, 30s, 50s < 20s
B41	494865	**0.000**	2.51	2.68	F	0.000	**0.000**	18.77	**0.000**	T3	20s < 40s, 50s, 30s < 50s
B43	529373	**0.000**	2.15	2.27	F	0.033	**0.005**	13.71	**0.003**	GT2	20s, 30s < 40s
B44	589998	0.163	2.93	2.91		0.004	0.910	0.84	0.841		
B45	588463	0.162	2.92	2.97		0.025	0.056	6.04	0.110		
B46	497921	**0.000**	3.15	3.37	F	0.000	0.617	3.89	0.274		
B47	500835	**0.000**	1.95	2.1	F	**0.298**	**0.000**	33.48	**0.000**	GT2	20s < 40s, 50s, 30s < 50s
B50	288283	0.089	2.29	2.37		0.017	0.085	7.6	0.055		
B51	428616	**0.000**	2.57	3.05	F	0.018	**0.000**	32.87	**0.000**	T3	20s < 30s, 50s, 40s, 30s < 40s
B52	483229	**0.000**	2.75	3.04	F	0.000	**0.000**	34.77	**0.000**	T3	20s < 50s, 40s, 30s < 40s
B53	511397	**0.023**	1.73	1.8	F	**0.952**	**0.042**	11	**0.012**	GT2	20s < 50s
B54	486947	**0.000**	3.34	3.62	F	0.000	0.137	2.91	0.406		
B55	31423	0.296	2.89	2.93		0.003	**0.000**	22.4	**0.000**	T3	50s < 30s, 40s
B56	375951	**0.000**	3.04	3.45	F	0.001	**0.002**	11.65	**0.009**	T3	20s < 40s, 30s
B57	501362	**0.000**	2.94	3.18	F	0.000	**0.003**	9.72	**0.021**	T3	20s < 30s, 40s

Note: Significant *p* value was indicated in bold. [a]One-tail; [b]HV: Homogeneity-of variance; [c]Be reference; [d]Post-Hoc method, GT2: Tukey-Kramer Hochberg's GT2, T3: Dunnett's T3; [e]m < k: m is significantly better than k ($p < 0.01$) m, j < k: There is no significantly difference between m and j, but m and j are significantly better than k ($p < 0.01$).

dents show higher practice rates in saving energy related to the use of lights, whereas the younger people show relatively higher scores for mobility. Our results also show that younger respondents have higher practice rates for "B40: Public transportation" than elder people in both cities.

The previous cross-country studies like Hunter *et al*. [33] and Aoyagi-Usui *et al*. [5] imply that the influences of gender and age on behaviors can be different in different countries, but insignificant differences in socio-demographics were observed between Seoul and Tokyo in our study. Comparison within the Asian region appears to yield quite similar trends in basic variables like socio-demographics for the PEBs.

4. Conclusion

We selected various PEBs and discussed the practice rates and influential factors using Seoul and Tokyo as the case study areas. Some external forces like policy and

infrastructure influence the practice rate differences in some PEBs. Relationships between the PEBs and internal incentives and barriers are visualized using MCA. The positions of the reasons to practice or not to practice the PEBs provide us with implications about the common and different perceptions of reasons for practicing/not practicing PEBs in the two cities. Monetary saving is considered to be the most common influential factor for many PEBs. Health is a different type of incentive from other factors and can be an effective factor for some PEBs relating to health improvement. The reasons for some PEBs are quite different for the two cities, indicating that different reasons can increase or suppress these PEBs. Unlike the results of the MCA, the socio-demographic effects on the practice rates show little difference between the two cities. Our study can contribute to the holistic understanding of various PEBs and can be used to consider effective measures to enhance people's PEBs by promoting incentives or removing the barriers for each PEB.

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