

Effect of Life Cycle Thinking-based Information on Environmental Attitudes and Behaviors in Bangkok, Thailand

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Abstract

The concept of life cycle thinking (LCT) is essential for sustainable consumption and product development. A thorough evaluation of its impacts on people's environmental consciousness and behavior is still lacking, however, as is people's understanding of the LCT concept. The present study aims to evaluate the effect of LCT on people's attitudes and behaviors, using an information-provision strategy, and to compare the effects of LCT-based information with other types of information provision. LCT-based and alternative information were created for promoting two pro-environmental behaviors: waste separation and refill product purchase. Designed information was distributed through a web-based survey conducted in Bangkok, Thailand and its vicinity. The LCT-based information about both waste separation and refill products had significant impacts on improving the respondents' attitudes toward the target behaviors, but its effects on behavior improvement in both cases were insignificant. Compared with the alternative information provided, the LCT-based information was significantly more useful in relation to both target behaviors. The results of the present study suggest the possibility and opportunity for using the LCT concept for both promotion of and education on sustainable consumption.

Key words: information provision, life cycle thinking, pro-environmental behavior, refill products, waste separation

1. Introduction

Pro-environmental behavior (PEB), also known as environmentally-conscious, green or sustainable behavior, plays an important role in transitioning to a sustainable society. Toward that end, environmental education and dissemination of environmental information can be key to inducing consciousness and changed behavior among people.

Information provision has shown its efficacy in fostering behavioral change; it helps people understand details on how to engage in new behaviors and the effectiveness of behavioral changes (Schultz, 2002; Kaiser & Fuhrer, 2003). Information and knowledge can be categorized into four types: procedural, declarative, impact and social-norm (Kaiser & Fuhrer, 2003). Procedural knowledge refers to information about how to perform or achieve a particular behavior, e.g., how to

recycle (Schultz, 2002). Declarative knowledge is the ability to provide facts on something, e.g., what climate change is. Impact or effectiveness knowledge refers to that on consequences of actions, e.g., the environmental impact of using bottled water (Bolderdijk et al., 2013). Lastly, knowledge of social norms, particularly descriptive norms, includes information about what others do, e.g., how many people use their own cup or tumbler at cafes (Lee et al., 2015).

Reports on the efficacy of information provision on behavioral change vary depending on information type and target behavior. Procedural knowledge has been widely provided to promote recycling behavior. It can increase the level of people's knowledge on recycling and raise their recycling rates even from low levels. Lack of this type of knowledge is, however, seen as a barrier to recycling (Schultz, 1999, 2002).

Social descriptive norms have been reported as a

strong predictor of recycling (Schultz, 2002), and both descriptive and injunctive social norms affect reduction of littering in public places (Cialdini et al., 1990). Lee et al. (2015) found that just providing declarative information by itself about an existing environmental program could increase people's intention to engage in purchasing the products proposed by the program.

In addition to the above information types, life cycle thinking (LCT) in information dissemination is being more commonly included. To implement sustainable consumption and production and a shift toward a circular economy, LCT is a vital concept (Lewandowska et al., 2018). This concept provides an opportunity to expand one's focus from the narrow specific stages of one product's life cycle to consider its entire life cycle and its consequences for the environment (UNEP, 2012). The entire life cycle includes extraction of materials from nature, manufacturing, shipping and transporting, and the use and disposal of a product. Along this chain, natural resources are utilized and disposed of accompanied by the generation of pollutants. A thorough consideration of all the impacts throughout the entire life cycle would help avoid unawareness of the problem shifting from one to another stage of the cycle. In the academic field, the concept of LCT has been applied to environmental impact assessment of products and services, and calculating the impact of life-cycle assessment (LCA) helps inform and guide consumers in making environmentally-friendly daily purchasing decisions.

Tsuda et al. (2013) examined the literature on the utility of LCT-based information and found that it has been disseminated to consumers in various forms such as numeric data (e.g., a product's carbon footprint), supply chain map visualization and documentary films. They found that although some LCT-based information was available and disseminated in the literature, an evaluation of its effect on environmental consciousness and behavior was still lacking.

Relevant studies on the effect of LCT-based information on consumers' preferences and perceptions include Upham et al. (2011) and Kikuchi-Uehara et al. (2016a, 2016b). Upham et al. (2011) found that although the respondents favored carbon labeling, they showed confused, questioning and misunderstanding responses to the labeled samples. Additional information was needed to improve understanding. Providing LCT-based information is also important in addition to providing a final figure based on LCA calculations like carbon footprints. Kikuchi-Uehara et al. (2016 b) applied the LCT concept to create information on environmental impacts for reusable and disposal shopping bags and determined the effectiveness of the information on respondents' environmental awareness. They found that LCT-based information was effective at improving environmental awareness of respondents with lower LCT skills.

The present study aims to evaluate the effect of

LCT-based information on people's attitudes and behaviors, and compare the effect of LCT-based information with other types of information provision. We aim to expand knowledge into the context of developing societies, where environmental deterioration has emerged at an alarming rate but little research on PEBs exists. Southeast Asia, one of the most dynamic regions in the world, had the most rapid rate of carbon dioxide emissions during 1990–2010. In fact, about 90% of emissions arise from developing countries, namely Indonesia, Malaysia, the Philippines, Vietnam and Thailand (Asian Development Bank, 2015). As one of the fastest-growing cities and a major contributor to the region's emissions, Bangkok, the capital of Thailand was selected as the study area.

In Thailand, the concept of LCT had been chiefly employed for quantifying the environmental impact of products and services, i.e., LCA and footprints (Gheewala & Mungcharoen, 2017). Ecolabels, namely green labels (Type 1), SCG eco value (Type 2), carbon reduction labels (Type 3) and energy labels (other types), have been used to inform consumers for over a decade (Mungkung et al., 2021). Nonetheless, no studies focusing on the effect of LCT-based information had been accomplished yet in Thai society.

2. Materials and Methods

2.1 Target PEBs

Two target behaviors were selected from the results of our previous study in Bangkok (Phuphisith et al., 2017) investigating people's practice rates of 49 PEBs, reasons for conducting or not conducting each behavior, and perceptions toward the environment and PEBs. The two selected target behaviors were 'waste separation' and 'refill product purchase.' For 'waste separation,' our previous study showed that it was perceived as the most environmentally-friendly action (29.0%), but practiced less often by the respondents (50.7% respondents 'always' or 'often' practiced it). In contrast, 'refill product purchase' was conducted by many respondents (79.0%), but less perceived as an environmentally-friendly action (2.5%).

2.2 Information Design and Treatment Groups

To determine the effects of LCT-based information, three groups were established for each behavior according to the information types provided and codes shown in Table 1. The information types provided were: no information (WC and RC), information based on LCT (WL and RL) and alternative information such as descriptive norms for waste separation (WA) and product information on refill products (RA). Previous studies have demonstrated the importance of social norms to recycling (e.g., Schultz, 2002; Iyer & Kashyap, 2007); thus, one of the social norms — the descriptive norm — was adopted

for alternative information on waste separation (WA).

For ‘refill product purchase,’ information about the availability of products is considered essential for engaging in this behavior. This issue relates to the factor of perceived behavioral control (PBC), which refers to one’s perceptions about difficulties and controllability over behavioral performance. According to the Theory of Planned Behavior (Ajzen, 1991), PBC is one of the key determinants for predicting the intention to perform a behavior. Therefore, product availability information was provided to the RA group.

The details of the LCT-based information for waste separation (WL) were on how waste separation could reduce environmental impacts from the life-cycle viewpoint, using illustrations on process chains and a textual explanation (Fig. 1). The information included an explanation that waste separation could decrease the amount of garbage going to landfills and, thereby reduce greenhouse gas (GHG) emissions from landfills. In addition, recycled waste, such as from plastic bottles and aluminum cans could be substituted for virgin materials and thus contribute to environmental impact reduction. The WA information was about descriptive norms; the number of people carrying out waste separation in Bangkok was presented together with the corresponding numbers for Seoul and Tokyo (Fig. 2). The number of people carrying out waste separation in Bangkok was taken from our previous results (Phuphisith et al., 2017), and the numbers for Seoul and Tokyo were cited from Lee et al. (2013).

The LCT-based information for purchasing refill products (RL) showed how much the environmental load could be reduced by using refill products instead of single-use products (Fig. 3). The environmental impact was presented as the percentage of total GHG reduction throughout the life cycle based on the estimations by Shimpo et al. (2012). Instead of showing the exact GHG values, the approximate impact reduction from switching from single-use bottles to a refillable bottle was shown. For RA information, available refill products were shown with brand examples in each category (Fig. 4). Here, 12 product categories were presented: body soap, hand soap, dishwashing liquid, liquid detergent, softener, spray starch, bleach, kitchen cleaner, bathroom cleaner, floor cleaner, car/air freshener and instant drink powder.

2.3 Questionnaire Surveys

2.3.1 Questionnaire Survey on Attitude Changes and Intentions

The designed information was presented through an online questionnaire, consisting of five parts: (1) socio-demographics; (2) attitudes before receiving the information and current practices; (3) information provision; (4) comprehensibility, usefulness and prior knowledge about the information provided; and (5) attitudes and intentions after receiving the information.

Table 1 Information provision groups.

Information provided		Waste separation (W)	Refill products (R)
(C) Control group—no information		WC	RC
(L) LCT information		WL	RL
(A) Alternative information		WA	-
(A) Alternative information	Descriptive norm	WA	-
	Product availability	-	RA

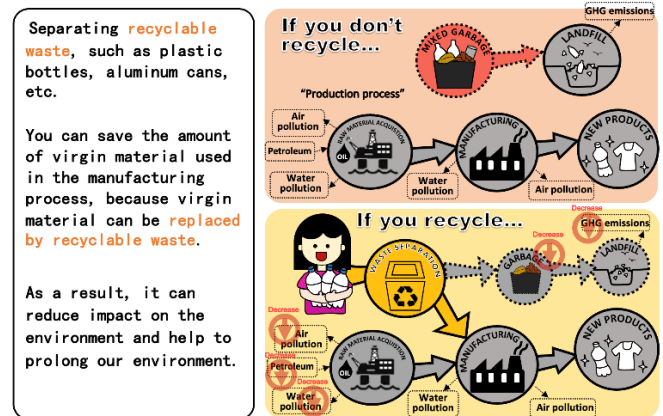
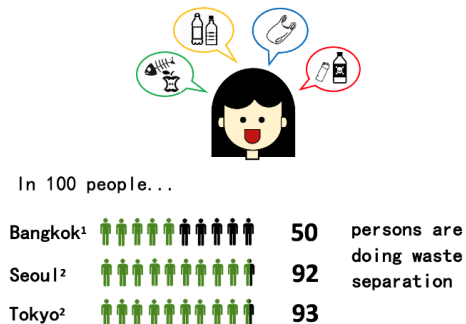


Fig. 1 LCT-based information about waste separation presented to Group WL.

Do you know how many Thai people are doing waste separation?



¹ Surveyed in 2015. ² Surveyed in 2010 in Seoul and 2011 in Tokyo (Lee et al., 2013)

Fig. 2 Descriptive norm information about waste separation presented to Group WA.

How much environmental impact can you prevent by using refill products?

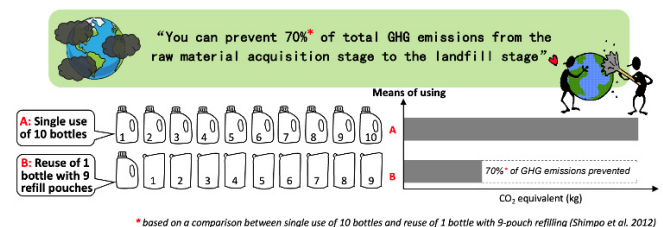


Fig. 3 LCT-based information about refill products presented to Group RL.

All items were provided in the form of closed questions.

First, the respondents were asked about their socio-demographics, including gender, age, education level, family size and house type. Then they were asked about their attitudes toward waste separation or purchase of refill products. The questions were adapted from the studies of De Young (1990) and Kikuchi-Uehara et al.

Nowadays, there are many product categories sold in refill packages.



Fig. 4 Product information about refill product categories presented to Group RA.

(2016 a). Two questions were used: “How important is waste separation/purchasing refill products to preserving the environment and conserving our natural resources?” ($A1_{\text{before}}$) and “How important is waste separation/purchasing refill products to environmental management?” ($A2_{\text{before}}$). The respondents were requested to indicate their degree of agreement on a six-point scale ranging from ‘strongly agree’ to ‘strongly disagree.’ Then, they were asked about their current waste separation or refill product purchase practices. The practices were measured on a six-point scale ranging from ‘always’ to ‘never.’ In addition, the respondents of the W-group were asked to select waste types they separated from among the choices provided, which included wet waste, newspapers and paper, aluminum cans, glass, milk cartons, plastic bottles, lamps, batteries and spray bottles, and other. Respondents of the R-group were asked to select categories of refill products they purchased from among the choices provided, which included body and hand soap, dishwashing liquid, liquid detergent, household cleaners, car/air freshener, instant drink powder and other.

After responding to the above questions, the respondents were presented one type of information according to their assigned group as described in Table 1. Then the respondents were asked about their perceptions of the comprehensibility and usefulness of the information provided, using a six-point scale ranging from ‘strongly agree’ to ‘strongly disagree.’ They were also asked about their prior knowledge concerning the information provided. The WA respondents were asked whether they had ever thought about the differences in practices between Bangkok, Tokyo and Seoul (K_{WA}). The answer choices were: “The size of differences is ‘larger,’ ‘a bit larger,’ ‘similar,’ ‘a bit smaller,’ ‘smaller’ than/to what I

thought,” and “I’ve never thought about this before.” The WL respondents were asked whether they had been aware of (i.e., had knowledge of) the mechanism of environmental-load reduction by waste separation (K_{WL}). The answer choices were: I was aware of it ‘very much,’ ‘much,’ ‘fairly much,’ ‘slightly,’ ‘seldom’ and ‘never.’ The RL respondents were asked whether they had been aware of GHG reduction resulting from use of refill products instead of single-use products (K_{RL}) with the same answer choices as provided to the WL group. The RA respondents were asked to select the product categories they had never been aware of before from the choices provided (K_{RA}). One more choice was also prepared for the respondents who were aware of all the categories: “I am aware of all the categories listed here.”

The respondents were then asked about their attitudes and intentions to perform the target behaviors. Question A1 was asked again after information provision ($A1_{\text{after}}$), and an additional question about attitude was also asked: “Do your daily activities have impacts on environmental problems due to resource use, product manufacturing, product transportation or disposal?” ($A3_{\text{after}}$). The respondents were requested to indicate their agreement using a six-point scale ranging from ‘strongly agree’ to ‘strongly disagree.’ For intentions, the respondents were asked how much they would try to perform or keep performing the target behaviors in the following one month, using a six-point scale ranging from ‘absolutely’ to ‘never.’

No information was provided to the control groups (WC and RC); therefore, they were promptly asked question $A3_{\text{after}}$ followed by the above-described question on their intention to perform the target behavior.

The questionnaire was initially developed in English and then translated into Thai. To avoid misunderstanding of the questions and to check for any difficulties in answering, the Thai version was preliminarily tested with 10 Thai members of the University of Tokyo (nine students and one faculty member) during 19–23 September 2016, and was revised reflecting their comments. The questionnaire was distributed through a web-based survey by Intage Inc. (Japan) during 12–24 October 2016, and there was a total of 2,446 respondents. All respondents were Thai citizens living in Bangkok and its vicinity, aged 20–59 years.

2.3.2 Questionnaire Survey for Follow-up Practice

One month later, another survey was conducted to follow up on the respondents’ actual practices. The follow-up questionnaire was sent to all respondents who had participated in the previous survey. The questionnaire consisted of two parts: (1) target behavior practice rates and (2) reasons for not performing the behavior.

The W-group were asked whether they had performed waste separation in the previous one month or not, using a six-point scale ranging from ‘always’ to

'never.' If they selected 'never,' 'rarely,' or 'seldom,' they were asked to select one reason from the following list: 'forgot,' 'bothersome,' 'time consuming,' 'inconvenient,' 'no one does it,' 'no rule,' 'no consideration,' 'cost,' 'no chance to do,' 'not environmentally-friendly,' 'not cool,' 'not necessary to do' and 'other.'

The R-group were asked whether they had tried to increase their refill product purchasing in the previous one month. The respondents were asked to choose an answer from this list: 'increased greatly,' 'increased to some extent,' 'did not change my behavior,' and 'never used refill products.' The respondents who selected 'did not change my behavior' or 'never used refill products' were asked to select one reason from the list shown above.

The follow-up survey was conducted using the same company as for the previous survey (Intage Inc., Japan) during 10–17 November 2016. A total of 1,093 respondents replied, representing 45% of the respondents who had replied to the previous questionnaire.

3. Results

3.1 Prior Knowledge, Comprehensibility and Usefulness of Information Provided

The socio-demographic characteristics of all the subgroups were similar. The ratio of males to females was 50% and most respondents were in their 20s or 30s, had an undergraduate degree and lived in detached houses with a family size of 3–5 people.

Concerning previous knowledge, most of the WA respondents thought that the differences between performing waste separation in Bangkok compared to Tokyo and Seoul were larger or a bit larger than what they had imagined (K_{WA}). One-third of the WL respondents said they had been fairly aware (30.9%) and another one-third had been well aware (29.4%) of the mechanism of environmental-load reduction through waste separation (K_{WL}). The respondents who had never, seldom or slightly been aware of the mechanism accounted for 15%. One-third of the RL respondents said they had been fairly aware (30.3%) of environmental-load reduction through use of refills instead of single-use products (K_{RL}). Another third of respondents had never (8.6%), seldom (5.9%), or slightly (14.2%) been aware of it. Among the RA respondents, 32% said that they had been aware of all categories presented in the information provided, and 36% had not been aware of one category. The least known category was car and air refill products (36.3%), followed

by instant drink products (19.5%).

Concerning the respondents' degree of understanding of the information, scores of 1–6 were provided from 'strongly disagree' to 'strongly agree.' Between the two types of information, LCT-based information showed slightly higher average scores (WL, 5.48; RL, 5.56) than alternative information types (WA, 5.45; RA, 5.53), but the differences were not significant (t -test, $p>0.05$).

The average scores on usefulness are presented in Table 2. Between two significantly different scores on usefulness, LCT-based information showed higher average scores than the alternative information types (t -test, $p<0.05$).

3.2 Effects on Attitudes and Intentions

The same questions about attitude were asked of the respondents before and after they received the information, and the differences in scores between $A1_{\text{before}}$ and $A1_{\text{after}}$ were analyzed by paired t -test to determine the effects of information on attitude change. The differences between $A1_{\text{before}}$ and $A1_{\text{after}}$ were small for waste separation cases (WA and WL) and not significantly different (Table 3). However, RL and RA groups showed significantly higher scores for $A1_{\text{after}}$ than $A1_{\text{before}}$ (t -test, $p<0.05$). The RL showed a higher average score of change than the RA, but the difference was not significant ($t = 1.08$, $df = 812$, $p=0.28$). In addition, Cohen's d effect size was calculated for determining the size of each information type's effect on attitude. A relatively minor effect was observed in the W groups ($d < 0.2$, Fritz et al., 2012) while a small ($d = 0.2$) to medium ($d = 0.5$) level was observed in the R groups. It should be noted that the score of $A1_{\text{before}}$ was already high and there was limited room for improvement as measured by the six-point scale. The average scores of $A1_{\text{before}}$ for waste separation were higher than those for refill products. De Young (1990) also found that a high antecedent attitude toward recycling (4.40 out of a maximum of 5) was a possible reason for unimproved attitude (4.21 of 5) after an education program.

To deal with this issue, additional analyses were carried out; the respondents were divided into two groups:

Table 2 Mean scores on usefulness of information types.

Group	N	Mean	S.D.	t-test
WL	411	5.55	0.59	p=0.025
WA	407	5.45	0.71	
RL	409	5.61	0.64	p=0.001
RA	405	5.46	0.63	

Measuring question: 'Do you think this information is helpful?' using a six-point scale.

Table 3 Mean scores of attitudes after and before.

Group	Attitude (after)		Attitude (before)		Effect size (Cohen's d)	Paired t-test (two-tailed)
	Mean	S.D.	Mean	S.D.		
WL	5.66	0.56	5.66	0.61	0.01	p=0.866
WA	5.70	0.59	5.69	0.56	0.02	p=0.749
RL	5.56	0.66	5.33	0.72	0.32	p<0.005
RA	5.45	0.68	5.28	0.76	0.23	p<0.005

Measuring question: "How important is waste separation (WL, WA) /purchasing refill products (RL, RA) to preserving the environment and conserving our natural resources?" using a six-point scale.

low and high $A1_{\text{before}}$ levels. The cut-off point was set based on the proportion of respondents' answers. Respondents who had rated $A1_{\text{before}}$ at '6' were counted as the high baseline group (WA_{high} and WL_{high}), whereas the respondents who had rated at '5' or lower were counted as the low baseline group (WA_{low} and WL_{low}). The results showed that the average scores of changes were larger in the low baseline groups for both information types, 0.50 for WA_{low} ($n = 109$) and 0.49 for WL_{low} ($n = 112$), than those in the whole sample groups, 0.01 for WA ($n = 407$) and 0.00 for WL ($n = 411$), and these increases were also significant (t -test, $p < 0.01$). The almost equal size of attitude changes between WA_{low} (0.50) and WL_{low} (0.49) indicated slightly different effects of information types on changes in attitude among the low baseline groups.

Most respondents in both high baseline groups, 87% for WA_{high} ($n = 298$) and 83% for WL_{high} ($n = 299$), showed no change after receiving information. The average scores were slightly negative (WA_{high} , -0.17 ; WL_{high} , -0.18), with no significant effect of information types (t -test, $p > 0.05$).

The effects of information provision were also investigated for differences between baseline practices and intentions. The scores on practice rate asked before and intention to do asked after information provision were compared. It is important to note, however, that the questions themselves were different (current practice rate and intention to do) and different measuring scales were used: 'always,' 'often,' 'sometimes,' 'seldom,' 'rarely,' and 'never' for practice; but 'absolutely,' 'certainly,' 'possibly,' 'moderately,' 'may not,' and 'never' for the intention scale. Therefore, with careful interpretation, the differences between practice and intention could be compared only among the same behavior: waste separation or refill product purchase.

The average scores on differences between baseline practice and intention to perform waste separation are shown in Table 4. The scores were calculated from the intention score minus the baseline practice score. The score of the WA group was higher than that of WL group. The scores of both treatment groups were lower than the control group score, but there were no significant differences between the scores of the control and treatment groups (t -test, $p > 0.05$). In short, there were no differences between the respondents with and without the information in terms of changes between baseline practices and intention to perform waste separation.

For refill products (Table 4), both treatment groups had significantly higher scores than the control group (t -test, $p < 0.05$), with the score of the RL group non-significantly higher than that of RA group.

3.3 Effects on Follow-up Practice

One month later, another survey was carried out to follow up on changes in behaviors of all the respondents that participated in the first survey. The response rate

range was 41.7%–48.3% for all subgroups. The numbers of females were higher than males in all subgroups, but the other major characteristics were similar to those in the first survey.

The average scores on state of practice during the month are shown in Table 5; the scores were calculated from 'never' = 1 to 'always' = 6. The scores of the treatment groups (WA , WL) were lower than those of the control group (WC), but the differences were not significant (t -test, $p > 0.05$). That is, there was no significant difference in follow-up practices between the respondents with and without information provision. Although follow-up practices were asked about using the same scale as for the baseline practice rates—a six-point scale—no direct comparison was possible because the questions differed slightly. The follow-up survey used the words 'previous month,' but no specific period had been indicated in the previous survey. The difference in the wording could have some impact on the respondents' perceptions or feelings in their reports about their practices.

For refill-product behavior, the respondents were asked about their practices using a four-point scale, and the average scores were calculated from 'never or not used' = 1 to 'increased greatly' = 4. Both treatment groups (RL , RA) had higher scores than the control (RC), but the differences were not significant (t -test, $p > 0.05$; Table 5).

In addition to the practice rates, the respondents who selected 'never,' 'rarely' or 'seldom' for the previous-month target behaviors were asked to choose one reason for not doing so. The three waste separation groups (WC , WL and WA) showed similarities in major reasons for not

Table 4 Mean scores of baseline practices and intentions by groups.

Group	Mean change	S.D.	t-test	
			Comparison	p-value
WC	0.51	0.99		
WL	0.47	1.07	WC vs WL	$p = 0.532$
WA	0.50	1.06	WC vs WA	$p = 0.823$
RC	0.41	0.93	RC vs RL	$p = 0.001$
RL	0.64	1.08	RC vs RA	$p = 0.039$
RA	0.56	1.20	RL vs RA	$p = 0.348$

Measuring questions for baseline practice: 'How often do you do waste separation?' (WC , WL , WA); 'How often do you buy refill products?' (RC , RL , RA). Measuring questions for intention: 'How much will you try to do or keep doing waste separation within this month?' (WC , WL , WA); 'How much will you try to buy or keep buying refill products within this month?' (RC , RL , RA). All responses were measured using a six-point scale.

Table 5 Follow-up scores of practices by groups.

Group	N	Mean	S.D.	t-test	
				Comparison	p-value
WC	186	4.52	1.36		
WL	176	4.36	1.44	WC vs WL	$p = 0.283$
WA	176	4.51	1.29	WC vs WA	$p = 0.910$
RC	198	2.75	0.90		
RL	188	2.86	0.89	RC vs RL	$p = 0.257$
RA	169	2.76	0.95	RC vs RA	$p = 0.912$

Measuring questions for baseline practice: 'Last month, did you do waste separation?' (WC , WL , WA); 'Last month, did you try to increase your purchase of refill products?' (RC , RL , RA). All responses were measured using a six-point scale.

doing so. Most of the respondents did not practice waste separation for the following reasons: 'forgot,' 'bothersome,' 'inconvenient,' and 'no chance to do.' For purchasing refill products, a variety of reasons for not purchasing were observed across the three groups (RC, RL and RA). The most common reasons were 'inconvenient,' 'forgot,' 'cost' and 'no chance to do.'

4. Discussion

Our results showed that LCT-based information was highly useful for introducing the LCT concept to the general public and significantly more useful than alternative information for both target behaviors. The LCT-based information provided was also understandable. These findings provide support for the use of the LCT concept through information provision, as well as educating the public. The average scores on previous knowledge of the LCT information provided were 4.59 and 4.10 (of 6.00) for waste separation and purchasing refill products, respectively. A lower level of previous knowledge was observed for information on specific details—in this case the 'calculated quantity' of GHG reduction from using refill products. Thus, such quantitative data together with some explanation based on LCT could be more useful toward encouraging public knowledge.

Our results showed that information provision had positive impacts on respondents' attitudes and intentions toward both target behaviors, but non-significant impacts on behavior improvement. These findings are similar to others in the literature showing that information provision did improve respondents' knowledge (Schultz, 1999; Bolderdijk et al., 2013) and intentions (Lee et al., 2015), but was unsuccessful in improving their behaviors (Schultz, 1999; Lee et al., 2015). Regarding behavioral theories, internal variables such as attitudes, knowledge and intentions are important determinants for engaging in PEBs (Ajzen & Fishbein, 1977). Performing PEBs is, however, also a function of external variables (Guagnano et al., 1995; Olander & Thøgersen, 1995; Kollmuss & Agyeman, 2002). Information provision can influence such internal variables, but improvement of internal variables alone cannot change behaviors without considering external factors. Considering the results of refill-product purchasing, both of the provided information types increased people's attitudes and intentions toward refill-product use. Nevertheless, some respondents could not increase their behavior practice rate for the following reasons: 'inconvenient,' 'forgot,' 'cost,' and 'no chance to do.' The reason of cost indicates that prices of the existing refill products are perceived as not consumer-friendly. The reason of inconvenience implies that the respondents want to perform the action, but cannot or are not yet ready for it. In the case of purchasing refill products, this may be due to the availability of preferred products or brands. The reason of no chance to

buy indicates much stronger external influences: it is assumed that people want to perform the action or they are ready to, but there is no way or chance for them to purchase the products. This was supported by the characteristics of the respondents who selected 'no chance to do,' most of whom were in their 20s and lived in family groups of 3–5 members. Young people have fewer chances to purchase household products when they live with other family members.

The effects of information type differed between the two target behaviors. The LCT-based information on refill products had a greater effect than the alternative information on changes in attitudes, intentions and behaviors; whereas the results were opposite for waste separation. Although the differences between LCT-based and alternative information were not statistically significant for either target behavior, the impacts observed in the study and the high level of usefulness of the LCT-based information indicated its benefits and potential for use as another valuable type of information to enhance people's attitudes and behaviors. Additionally, the LCT concept would be useful in school education to encourage children's awareness of possible connections between their daily behaviors and the environmental consequences, which may help in long-term development of understanding and attitudes toward environmentally-friendly society and behaviors.

Other pragmatic interventions should also be introduced and implemented along with information-intensive campaigns and environmental education for achieving behavioral change. Examples of behavior-changing tools include gaining commitment, developing community norms, improving infrastructure and using prompts (McKenzie-Mohr, 2000). For instance, to promote purchasing refill products, marketing price campaigns, a variety of product brands and quick reminders presented on the product shelf may be used together to remove cost barriers, inconvenience and the problem of forgetting to purchase refill products.

5. Conclusions

The present study has applied the concept of LCT to the designing of information provided to foster the PEBs of waste separation and purchase of refill products. The effects of LCT-based information were investigated regarding changes in people's attitudes, intentions and behaviors, and compared with those of other information types.

The results showed that the average score of knowledge about the mechanism of environmental-load reduction through waste separation was higher than that of information about GHG reduction through use of refill products. The LCT-based information about both behaviors was significantly more useful than the alternative information provided.

The effects of LCT-based information on changes in

attitudes, intentions and behaviors differed depending on the target behavior. The LCT-based information about refill products had significant effects on changes in attitudes and intentions, but not on follow-up practices. However, LCT-based information about waste separation had a significant effect on attitude change, particularly in respondents with a low baseline attitude level, but had no significant effect on intention and follow-up practices. The results indicate that information based on LCT can improve people's attitudes toward target behaviors, but additional support is needed to facilitate behavioral change.

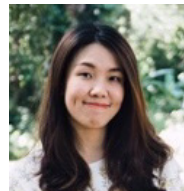
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