EMPIRICAL STUDY ON CONSUMER UNDERSTANDING AND SATISFACTION FOR SUBSIDIZED HOME INSULATION PERFORMANCE

by

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Abstract

The housing eco-points system was one of the subsidy programs to help improve the insulation performance of homes. The Japanese government provides at least as much in subsidy payments for the insulation costs of new homes compared to insulation repair costs of existing homes. This is one of the reasons that the existing home market in Japan has not grown, and insulation repair of existing homes lags in Japan. A basic premise of this study is that it is more effective to support measures for existing homes, rather than new homes, because the degree of improvement of living comfort and awareness of energy-saving could potentially be higher among people who live in the former than the latter.

This study is based on an online survey for consumers who had participated in the housing eco-points system to investigate consumer awareness and satisfaction for the eco-points system, as well as to provide additional insights into energy efficiency policies. The study (and online survey) assumes that consumer perceptions and awareness for home insulation changed after the usage of the housing eco-point system. The number of effective responses to the survey was 1,007, out of which 50.3% (507 samples) lived in new homes, and 49.7% (500 samples) lived in existing homes. The recovery rate of this survey was 80.3%.

This survey found that people who lived in existing homes with insulation repairs significantly acknowledged the effects of the insulation. They agreed with the following statements: (after the insulation) “Noticed less condensation”, “Feeling more comfortable,” and “Realized that electricity expenses became cheaper.” Because people living in existing homes experienced changes in the insulation performance in the same houses, they easily recognized the improvement in insulation performance.

Surprisingly, the result of the logistic analysis (Model #1) revealed that the satisfaction level of people who used the subsidy for new homes was 2.01 times higher than people who used it for existing homes. This is partly attributed to the higher monetary payments provided for the new homes. The results of the logistic analysis (Model #2) showed that “Applying (for the subsidy) by oneself” had a positive influence on their perception about energy-saving. On the other hand, receiving subsidy payments without knowing the condition had a negative influence on their perceptions about energy conservation. Thus, an enhanced subsidy policy of insulation for existing homes could contribute not only to reducing CO_2 emission from residential homes, but also to increasing energy conservation awareness among consumers.

In addition, this study found that respondents who understood insulation performance had a higher rate of satisfaction with the housing eco-points system. These respondents have reported thinking more about energy-saving after they have received the subsidy. Therefore, it is also important to consider how appropriate information is provided to consumers when the government implements energy conservation subsidy policies.

1 Introduction

It is generally known that Japanese homes have shorter lives than those in foreign countries. Although there are many unoccupied homes in Japan, about 800,000 over new ones are built every year. The existing home market has not grown in Japan because the majority of government subsidies are provided to new homes. For example, the Japanese government provides at least as much in subsidy payments for the insulation costs of new homes compared to insulation repair costs of existing homes.

The insulation repair of existing homes is an important issue in CO_2 reduction. Prioritizing subsidies for existing homes over those for new homes is desirable because of the expected effect and volume. The expected effect is greater since existing homes have lower insulation prior to any repairs, and the volume of existing homes occupies the bulk of the housing market.

One such subsidy was the "housing eco-points system" that was in place from 2010 to 2012. Consumers who built new homes and those who improved the insulation performance of their existing homes applied for the subsidy, and received financial support up to 300,000 JPY (equivalent to approximately: 2,680US$ as of 6/28/2017). One of the policy goals of this subsidy program was to improve residential energy efficiency, and reduce CO_2 emissions from homes.

This study intends to assess not only the amount of money involved as in Fujisawa (2013), which analyzed the financial effect of the housing eco-points, but also to assess the understanding of consumers' energy conservation achieved through the subsidy system and the behavioral change in energy-saving behaviors.

The housing eco-points system had some unique characteristics. One such characteristic was a self-assessment system that consumers carried out during the subsidy application process. Lynham et al. (2016) verified that visualizing energy conservation creates a "learning effect," which leads to actual reduction in energy consumption. The self-assessment system as well as the visualization of energy conservation seemed to increase consumer knowledge. This study considers that the subsidy application process itself has a learning effect, which leads to energy-saving.

This study aims to contribute to discussions on energy conservation subsidy policies through the use of on an online survey for consumers who had participated in the housing eco-points system to investigate consumer awareness and satisfaction for the eco-points system, as well as provide additional insights into energy efficiency policies. It assumes that consumer perceptions and awareness for home insulation changed after the usage of the eco-point system. The analysis method used is the logistic regression model.

A basic premise of this study is that it is more effective to support measures for existing homes, rather than new homes, because the degree of improvement of living comfort and awareness on

energy-saving could be higher among people who live in the former than the latter. There are two hypotheses used in this study. One is that consumers living in existing homes have an understanding of the performance of insulation repair, and thus their satisfaction would be higher (Hypothesis 1). The other is that consumers who are exposed to the "learning effect" will begin to be more conscious about energy conservation (Hypothesis 2).

This paper is organized as follows: Section 1 gives a brief overview of this study. Section 2 summarizes the literature on energy saving subsidy schemes, such as the housing eco-points system in Japan. Section 3 describes the data of the questionnaire survey, and the analysis method used in this study. Section 4 provides the logistic regression analysis results. Section 5 offers a conclusion and suggests a proposed effective subsidy system.

2 The housing eco-points system in Japan

Consumers who have made improvements to the insulation performance of their homes can receive various support from the government including incentives in legal applications, tax treatment, and subsidies as well as financial support for additional financing and preferential interest rates for home mortgages (Table 1). Those who purchase new homes can benefit from all of these support programs. However, owners of existing homes can only benefit from these programs when it involves a large-scale repair. For example, existing home owners cannot benefit from preferential interest rates, loan tax cuts or additional financing because they do not usually finance normal insulation repair with loans. Thus, the subsidies, among all the promotion policies, are the easiest-to-use program for insulation repair in existing homes.

Table 1: Insulation performance promotion policies

Method	Policy
Law	Law amendment
Tax	Loan tax reduction, Property tax preferential treatment
Economic incentives	Subsidy
Financial	Additional financing, preferential interest rate

The housing eco-points system was a subsidy program in Japan with the following characteristics.

A) There were two subsidy periods from Jan. 2010 to July 2010 (the former half), and from Nov. 2011 to Oct. 2012 (the latter half).
B) The purpose of the former half was economic stimulus. On the other hand, the purpose of

the latter half was as reconstruction aid for the Great East Japan Earthquake.

C) The budget of the subsidy was limited. When the budget was spent, the program ended even before the end of the subsidy period.

D) To benefit from the subsidy program, consumers had to carry out a self-apply.

E) The housing eco-points is similar to the home appliance eco-points system. As such, it was already familiar to consumers.

2.1 Period of the housing eco-points

The housing eco-points project was implemented from 2010 to 2012, and has since been completed. The implementation of housing eco-points was not continuous throughout this period, and was limited to two distinct periods (former half and latter half) as mentioned earlier. The effect of the housing eco-points was large. For example, the number of insulation repairs in existing homes was much higher during the housing eco-point subsidy periods (Figure 1). This phenomenon was only for existing homes, and there was no clear relation between the number of new homes and the housing eco-points since the number of new homes depends on the overall economic situation.

Source: Ministry of Land, Infrastructure and Transport
"Housing statistics," "The building repair and renovation investigation"

Figure 1: The number of newly built homes and insulation repairs

2.2 Purpose of the housing eco-points system

There were two main purposes of the housing eco-points system. The purpose of the former half was economic stimulus. Hence, consumers who benefitted from the system received a financial support of up to 300,000 Japanese Yen, which they could use for anything. On the other hand, the purpose of the latter half was as reconstruction aid for the Great East Japan

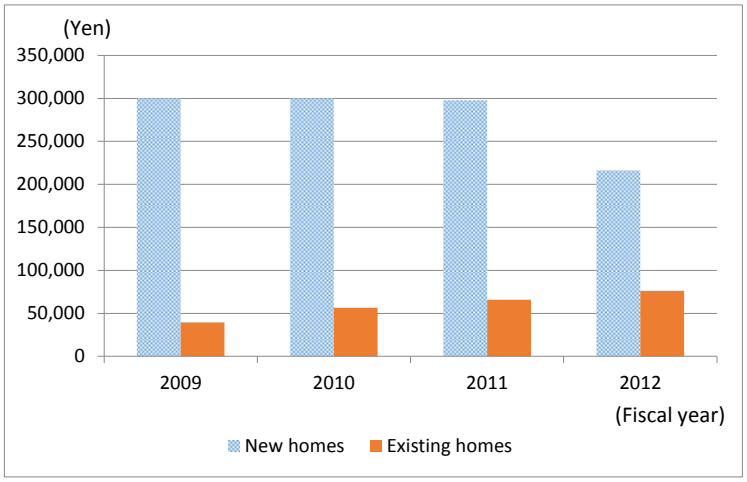
Earthquake. Consumers who benefitted from the system received financial support of up to 250,000 JPY (equivalent to approximately: 2,233US$ as of 6/28/2017), which could only be used to buy certain products from Northeast Japan, where the disaster occurred on March 11, 2011 (Table 2). There were other restrictions on the amount of money and usage in the latter half of the housing eco-points system. Consumers in the former half could invest further which such as additional or quality improvement of construction, in their own homes using eco-points, but those in the later consumers half could not.

Table 2: Difference in the contents of the housing eco-points system in the two periods

	Former half (2010)	The latter half (2011-12)
Maximum amount	300,000 Yen	250,000 Yen
Use application	Unconstrained	Restricted
Restrictions	-	For purchase of certain product from Northeast Japan only

2.3 Budget of the housing eco-points system

Consumers who built new homes, and those who improved the insulation performance of their existing homes applied for the subsidy, and received financial support of up to 300,000 JPY. However, in the fact, the budget of the housing eco-points allocated for existing homes and for newly built homes was not equal (Figure 2). There were many applications from existing homes, but the budget for this segment was small. The situation was the opposite for new homes.



Source: Ministry of Land, Infrastructure and Transport
"The enforcement situation of house eco-points"

Figure 2: The mean application price

The ratio of new homes to eco-points subsidy amount was large. At the end of the system period, the total number of eco-points approved was 1,007,945cases (new homes) and 734,995 cases

(existing homes). Moreover, the budget amount itself was limited. Once the budget was spent, the program ended before the end of the stated period. If the housing eco-points were given only to existing homes, there was a possibility that this system could have been permanently implemented rather than being time bound.

2.4 System of the housing eco-points system

The housing eco-points system was based on self-declaration. This is a unique characteristic compared to other government subsidies. There were two major ways to apply for the housing eco-points: own application and application by technical experts (such as contractors).

The application requirements required the applicants to certify how the repair would improve insulation performance. Consumers had to learn about the insulation of their homes, and had to complete an application form detailing the insulation of their own homes. Especially, in existing homes where consumers were expected to manage the construction plan, it was necessary for consumers to study and be able to document increased knowledge of insulation performance to receive the eco-points.

In other situations, some consumers enlisted the help of technical experts (such as contractors or construction companies) to apply for the eco-points. This tendency was often seen in newly built homes since the new homes were sold as a whole with no particular work order for only insulation.

2.5 Familiarity of the housing eco-points

The housing eco-points system was very similar to the home appliance eco-points subsidy. Therefore, consumers who applied for the housing eco-points were familiar with the names and institutions of the application process that were implementing the housing eco-points system. As the housing eco-points system began to be known more, the number of approved cases increased significantly in the later half (figure 1).

According to interviews documented in Fujisawa and Nishio (2011), a construction company employee explained that this housing eco-points system was easier to explain to consumers than other subsidy systems that aim to improve insulation performance. It was easy choice to use the familiarity system for people live in existing homes where they make a decision about the level of insulation performance themselves.

3 Data and Methodology

This section describes the data attained from the questionnaire survey, the attributes of the respondents, and the methodology of analysis used in this study.

3.1 Data summary

This study conducted an online survey for consumers who had benefitted from the housing eco-points system, assuming that consumer perceptions and awareness for home insulation changed after participating in the system. The purpose was to investigate consumer awareness about and satisfaction with the eco-points system, as well as to provide additional insights into energy efficiency policies. The questionnaire survey that was carried out online is summarized in Table 3. The online survey was divided into two phases. The first phase was a preliminary investigation that selected the samples, and the second phase was the final questionnaire survey for samples who had actually used the housing eco-points.

Table 3: Summary of questionnaire survey

Pre-investigation duration	February 4-6, 2014
Final investigation duration	February 8-10, 2014
Survey method	Online survey
Survey contents (27 questions)	1) Degree of comprehension of the housing eco-points system 2) Application content 3) Change in consciousness and awareness after receiving the housing eco-points 4) Satisfaction of the housing eco-points system 5) Information about the residence and other questions
Sample size (N)	1,007

The number of the effective answers was 1,007, in which 50.3% (507 samples) was for new homes and 49.7% (500 samples) was for existing homes. The recovery rate of this survey was 80.3%.

3.2 Attributes of the questionnaire respondents

The respondents were both men and women. The age range of respondents was different between those who lived in new homes and existing homes (Figure 3). Respondents with new homes were mainly in their 30s, followed by the 40s. Respondents with existing homes were mainly their 60s, followed by the 50s. Most of the respondents were married (Figure 4). Many respondents who lived in existing homes had no children living with them, because of their advanced age (Figure 5). Most respondents lived in detached homes (Figure 6).

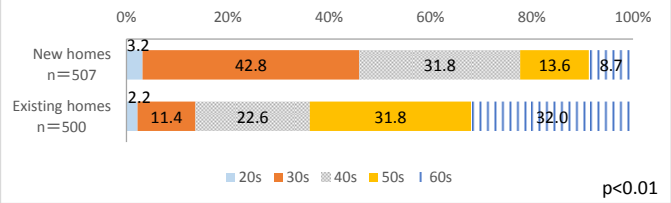


Figure 3: Age bands of respondents

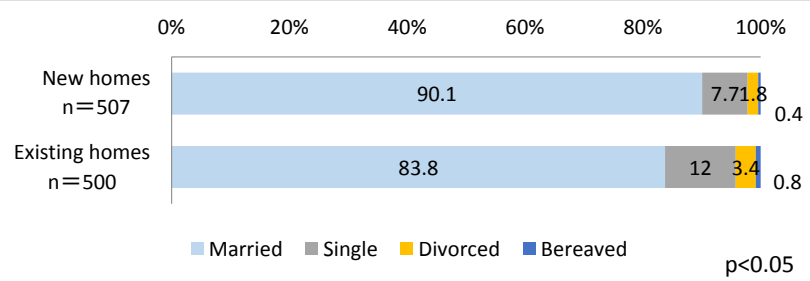


Figure 4: Marital status of respondents

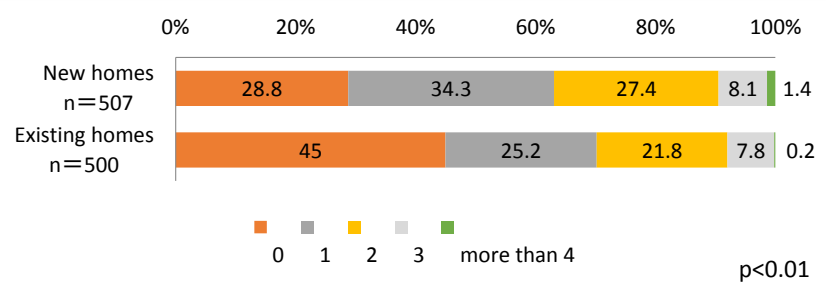


Figure 5: Number of children of respondents

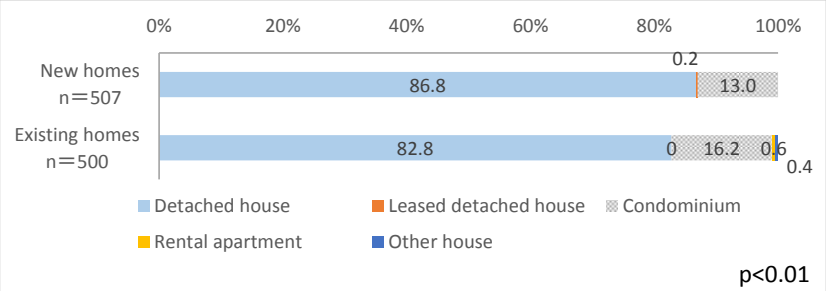


Figure 6: Housing type of respondents

3.3 Analysis methodology

The logistic regression analysis is based on the following equation.

$$Y=\beta_0+\Sigma\beta_i X_i+\varepsilon,$$

where Y is a binary variable that represents respondent satisfaction towards the housing eco-points system, e.g., satisfaction or no satisfaction, and X_i (i=1,…, n) is the i-th explanatory variable, e.g., understanding of energy efficiency policy.

This study presents two Models. Model #1 investigates customer satisfaction towards the housing eco-points system, (i.e., whether Y is satisfaction or no satisfaction), and Model #2 investigates whether began to think about energy-saving or not after comprehension of insulation performance (i.e., Yes or no, which began to think about energy-savings). The explanatory variables

representing an understanding or lack thereof of the energy efficiency policy in Model #1 were used as binary variables in Model #2.

Table 4: Descriptive statistics of the explanatory variables

Variable	Min	Max	Mean	Standard deviation
Gender dummy (0:Women, 1:Men)	0	1	0.60	0.491
Age [25-69]	25	69	47.60	11.376
Educational qualification dummy(1:More than university degrees)	0	1	0.58	0.494
Married dummy (0:No, 1:Yes)	0	1	0.90	0.298
Number of live-in children [0-more than 4]	0	4	1.06	1.001
Newly built home dummy (0:Existing house, 1:New house)	0	1	0.50	0.500
Detached house dummy (0:No detached, 1：Detached house)	0	1	0.85	0.358
Former half dummy (0:Latter half, 1:Formert half)	0	1	0.58	0.493
Applying by oneself dummy (0: Did nothing, 1: Did it by oneself)	0	1	0.51	0.500
Without knowing the subsidy condition (0:No, 1:Yes)	0	1	0.10	0.303
Satisfied dummy (0:No, 1:Yes)	0	1	0.90	0.295
Began to think about energy-saving (0:No, 1:Yes)	0	1	0.26	0.441
Understanding of insulation (0:No, 1:Yes)	0	1	0.23	0.423
Understanding of energy conservation standards (0:No, 1:Yes)	0	1	0.11	0.308
Felt that did improving environment (0:No, 1:Yes)	0	1	0.15	0.356
Impact of improving air quality (0:No, 1:Yes)	0	1	0.10	0.302
Realized that electricity expenses became cheaper (0:No, 1:Yes)	0	1	0.15	0.354
Feeling relief from a disease (0:No, 1:Yes)	0	1	0.02	0.149
Feeling more comfortable (0:No, 1:Yes)	0	1	0.14	0.349
Noticed less condensation (0:No, 1:Yes)	0	1	0.20	0.401

Table 4 provides descriptive statistics of the variables in the models. Variables describing personal attributes are “Gender dummy,” “Age,” “Educational qualification,” “Married dummy,” and “Number of live-in children.” The variables describing the residence are “Newly built home dummy” and “Detached house dummy.” Variables describing the application status are “Former half dummy,” “Applying by oneself dummy,” and “Without knowing the subsidy condition.” The variables after “Satisfied dummy” in Table 4 are dummy variables that take the value of 1 if the respondent answers Yes to the question in the questionnaire.

4 The analysis results

This section provides results from the questionnaire survey and the logistic regression analysis results.

4.1 The analysis of survey samples

The study found that people who live in existing homes that required insulation repairs significantly acknowledged the effects of the insulation. They agreed with the following

statements: (after the insulation) “Noticed less condensation, “Feeling more comfortable,” and “Realized that electricity expenses become cheaper.” Because people living in existing homes experienced changes in the insulation performance in the same house, they easily recognized the improvement in insulation performance (Figure 7). Furthermore, survey results clearly showed that people who repaired insulation in their homes were more conscious about energy conservation due to the higher level of understanding about subsidized insulation performance.

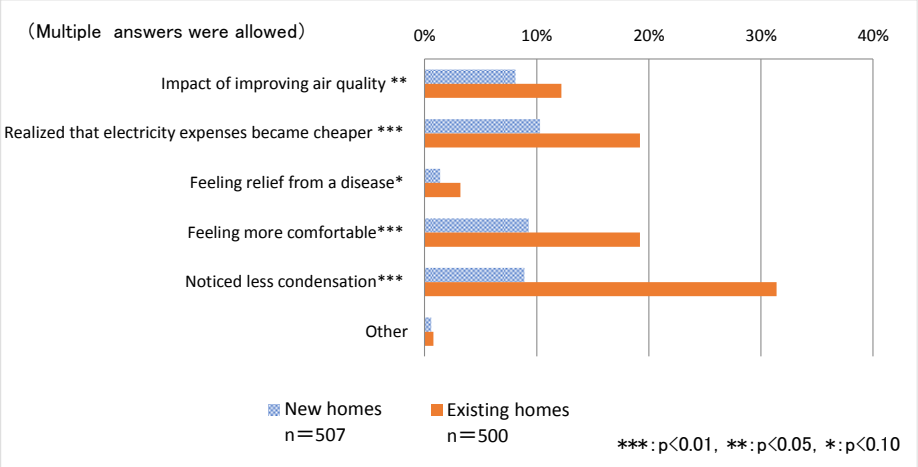


Figure 7: Assessment of insulation performance by respondent

4.2 The logistic regression analysis

This section describes the analysis results of Model #1 and Model #2.

(1) Model #1

The fitness of Model #1 was confirmed from the correct distinction rate and the Hosmer-Lemeshow test. The correct distinction rate was 90.4%, and as a result of the Hosmer-Lemeshow test, the P-Value was 0.112 (Table 5).

Table 5: Test of statistic Model #1

Statistic				Hosmer-Lemeshow test		
Logarithm likelihood -2	Cox-Snell R2 Square	Nagelkerke R2 Square	Distinction rate (%)	Chi-square test	Degree of freedom	P-Value
580.654	0.056	0.119	90.4	13.009	8	0.112

Table 6 shows the regression coefficient, the standard error and the odds ratio (EXP(B)) of the analysis result of Model #1. The results of the logistic analysis for Model #1 shows that “Newly built home dummy,” “Understanding of insulation,” “Former half dummy,” “Applying by oneself dummy,” and “Understanding of energy conservation standards” had a positive influence on whether a respondent showed satisfaction or not.

Table 6: Dependent variable: Satisfied dummy (Model #1)

Variable	B	Standard error	Wald	Significance probability	Exp(B)	95% confidence interval of EXP(B)	
						Lower	Upper
Gender dummy	-0.112	0.247	0.207	0.649	0.894	0.551	1.449
Age	0.006	0.012	0.212	0.645	1.006	0.982	1.031
Educational qualification dummy	-0.134	0.233	0.333	0.564	0.874	0.554	1.380
Married dummy	0.418	0.399	1.097	0.295	1.519	0.695	3.321
Number of live-in children	-0.027	0.124	0.048	0.826	0.973	0.763	1.241
Newly built home dummy	0.698	0.268	6.811	0.009	2.010	1.190	3.397
Detached house dummy	-0.405	0.369	1.209	0.272	0.667	0.324	1.373
Former half dummy	0.453	0.222	4.159	0.041	1.573	1.018	2.431
Applying by oneself dummy	0.457	0.233	3.844	0.050	1.580	1.000	2.496
Without knowing the subsidy condition	0.246	0.392	0.394	0.530	1.279	0.593	2.760
Began to think about energy-saving	0.143	0.285	0.254	0.615	1.154	0.661	2.016
Understanding of insulation	1.284	0.417	9.472	0.002	3.611	1.594	8.181
Understanding of energy conservation standards	2.171	1.025	4.484	0.034	8.763	1.175	65.334
Felt that did improving environment	0.026	0.388	0.005	0.946	1.026	0.480	2.194
Impact of improving air quality	0.999	0.632	2.494	0.114	2.714	0.786	9.373
Realized that electricity expenses became cheaper	0.055	0.419	0.017	0.895	1.057	0.465	2.404
Feeling relief from a disease	0.021	1.121	0.000	0.985	1.021	0.114	9.188
Feeling more comfortable	0.648	0.427	2.301	0.129	1.912	0.827	4.417
Noticed less condensation	-0.001	0.336	0.000	0.997	0.999	0.517	1.930
constant	0.897	0.764	1.376	0.241	2.451		

According to the odds ratio, “Newly built home dummy” and “Understanding of insulation” greatly increased the satisfaction level. It was revealed that the satisfaction of people who used the housing eco-points for new homes was 2.01 times higher than people who used it for existing homes. This is partly attributed to the higher monetary payments provided for the new homes. In addition, respondents who actually experienced improvement in the insulation performance were 1.59 times as likely to report satisfaction compared to those respondents who did not recognize the effects (Table 6).

Thus, Hypothesis 1 is rejected. Hypothesis 1 conjectured that consumers in existing homes would be more satisfied, but in fact, consumers in new homes were more satisfied. This is due to the fact that consumers in new homes received a higher amount of payment from the housing eco-points, which strongly influenced consumer satisfaction. The “Former half dummy,” which represented consumers who could use money from the housing eco-points as desired also had a statistically significant positive influence on satisfaction.

(2) Model #2

The fitness of Model #2 was almost confirmed from the correct distinction rate and the Hosmer-Lemeshow test. The correct distinction rate was 75.7%, and as a result of the Hosmer-Lemeshow test, the P-Value was 0.93 (Table 7).

Table 7: Test of statistic Model #2

Statistic				Hosmer-Lemeshow test		
Logarithm likelihood -2	Cox-Snell R2 Square	Nagelkerke R2 Square	Distinction rate (%)	Chi-square test	Degree of freedom	P-Value
1047.583	0.106	0.155	75.7	3.075	8	0.930

Table 8 shows the regression coefficient, the standard error and the odds ratio (EXP(B)) of the analysis result of Model #2.

The results of the logistic analysis (Model #2), this study found that "Understanding of insulation", "Felt attention to the environment" and "Understanding energy conservation standards" had a positive influence on thinking about energy saving. In addition, "Applying by oneself" had a positive influence on energy saving too. Moreover, the factor of respondents with "Realized that utility expenses became cheaper" urges them to consider energy conservation as an economic factor. On the other hand, receiving a subsidy “Without knowing the subsidy condition” had a negative influence on energy saving (Table 8).

Table 8: Dependent variable: Began to think about energy-savings (Model #2)

Variable	B	Standard error	Wald	Significance probability	Exp(B)	95% confidence interval of EXP(B)	
						Lower	Upper
Gender dummy	-0.066	0.170	0.148	0.701	0.937	0.671	1.308
Age	0.003	0.008	0.117	0.732	1.003	0.987	1.019
Educational qualification dummy	0.029	0.163	0.032	0.859	1.029	0.747	1.418
Married dummy	0.220	0.301	0.536	0.464	1.246	0.691	2.246
Number of live-in children	0.043	0.088	0.243	0.622	1.044	0.879	1.240
Newly built home dummy	0.068	0.180	0.143	0.705	1.070	0.753	1.522
Detached house dummy	-0.316	0.208	2.307	0.129	0.729	0.485	1.096
Former half dummy	-0.190	0.156	1.479	0.224	0.827	0.609	1.123
Applying by oneself dummy	0.386	0.159	5.861	0.015	1.471	1.076	2.010
Without knowing the subsidy condition	-0.900	0.347	6.712	0.010	0.407	0.206	0.803
Satisfied dummy	0.090	0.282	0.101	0.751	1.094	0.630	1.900
Understanding of insulation	0.532	0.181	8.634	0.003	1.703	1.194	2.429
Understanding of energy conservation standards	0.459	0.238	3.740	0.053	1.583	0.994	2.522
Felt that did improving environment	1.088	0.201	29.215	0.000	2.969	2.001	4.405
Impact of improving air quality	0.006	0.252	0.001	0.981	1.006	0.614	1.648
Realized that electricity expenses became cheaper	0.460	0.217	4.513	0.034	1.585	1.036	2.423
Feeling relief from a disease	0.393	0.523	0.567	0.452	1.482	0.532	4.129
Feeling more comfortable	0.131	0.225	0.338	0.561	1.140	0.733	1.772
Noticed less condensation	0.054	0.209	0.067	0.796	1.056	0.700	1.591
constant	-1.825	0.570	10.255	0.001	0.161		

The odds ratio is the largest with “Has adequate awareness of environmental issues” (i.e., about three times as high as the odds ratio without it). It is inferred that consumers’ awareness about energy conservation will greatly increase when they take action to improve insulation, which is good for the environment.

Hypothesis 2, which suggests that consumers who are exposed to the learning effect become more conscious about energy conservation, is supported. This is because, the attributes “Understanding

of insulation" and "Understanding of energy conservation standards" effectively present an opportunity to be more conscious about energy-saving.

5 Conclusions

This study showed that improvements in the level of understanding and satisfaction on subsidized insulation performance were higher for people who live in new homes than existing homes. This is due to the fact that consumers in new homes received a higher amount of payment from the housing eco-points, which strongly influenced consumer satisfaction.

Since the budget of the housing eco-points subsidy was limited, the program was terminated before the end of the period once the budget was spent. If the housing eco-points were given only to existing homes, there was a possibility that this system could have been permanently implemented rather than being time bound. When the government provides people who live in existing homes with more subsidies, it is expected that this would promote consumer understanding of insulation performance and increased awareness on opportunities for energy-savings.. Thus, an enhanced subsidy policy of insulation for existing homes could contribute not only to reducing the CO_2 emission from homes, but also to increasing energy-saving awareness among consumers.

In addition, this study found that respondents who understood insulation performance had a higher rate of satisfaction. These respondents began to be more aware about energy conservation after they received subsidy payments. The subsidies are not simply economic incentives. They also promote on their perception about energy -savings by increasing awareness through institutional designs of the subsidy such as the self-application process. Therefore, it is also important to consider how appropriate information is provided to consumers when the government implements energy-saving subsidy policies.

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