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Article

Who's Active Actor? The Analysis of Moderating Impact of Opportunity and Cost on Personal Energy Saving Behavior and Public Policy Participation

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ABSTRACT

Background: In order to combat climate change, research into the drivers of energy saving is critical. The aim of this study is to analyze the effects of value factors and theory of planned behavior factors on energy saving behavior and policy participation in terms of moderating effects of opportunity and cost.

Methods: The data was collected in 2022 through the "National Opinion Survey on Energy" by the Center for Energy Transition Policy Research under Social Science Research Institute, Ajou University. The population is adult men and women over the age of 19 living nationwide in Korea, and the sampling frame is a master panel held by Hankook Research, a specialized research organization, with more than 760,000 people. The sampling method utilized a proportional representation sampling method that varies by region, gender, and age. The survey methodology was a web survey via mobile phone and email, and the survey period was conducted from May 30 to June 3, 2022. Data was collected from 1571 people, with a maximum margin of sampling error of ±2.5 percentage points at the 95% confidence level, assuming random sampling. To analyze the determinants of energy saving behavior, the study executed regression analysis. To checked moderation effects by cost and opportunity, it examined interaction effects.

Results: The results showed that respect for life, hedonic value, openness to change, attitudes, norms, and sense of control had significant effects on energy saving behavior, while selfish and altruistic values, hedonic value, openness to change, norms, and attitudes had effects on policy participation related with energy saving. In addition, the moderation effect analysis revealed six interaction effects, of which opportunity and cost were variables moderating effect of biospheric value on policy participation and attitude on policy participation.

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Conclusions: Based on the above findings, the research implications are as follows. First, we confirm the multidimensionality of energy saving behavior in that that the variables explaining energy saving behavior are not consistent from a theoretical perspective. Second, we verified that opportunities and costs that individuals face have an effect through interactions with variables that do not significantly explain behavior.

KEYWORDS: energy conservation; behavior; policy engagement; opportunity; cost

BACKGROUND AND PURPOSE OF THE STUDY

In the modern world, energy is a critical resource and is recognized as an international competitive advantage. In particular, the emergence of global paradigms such as carbon neutrality, which aims to combat climate change and curb global warming, and global regulations such as low-carbon energy policies are rapidly changing the landscape of energy demand and supply. Currently, the most frequently discussed topics are carbon neutrality and energy transition, which are being studied in various fields.

A study by Lee [1] shows that in addition to traditional security, e.g., national defense, we need to have the ability to prepare for non-traditional security. Energy and climate change are the most prominent non-traditional security areas in the world. Korea first published a special report jointly organized by Green Growth Commission and the Korea Meteorological Administration in 2010 to evaluate the impact of abnormal weather and seek effective countermeasures. Since 2011, it has published a joint abnormal climate report jointly organized by the Office for Government Policy Coordination and the Korea Meteorological Administration. In 2010, a sustained heat wave in the summer resulted in 81 days with average temperatures above normal, abnormally low temperatures in the spring, and heavy rainfall in the Seoul metropolitan area. In 2011, a cold snap lasted 39 days, and in 2012, four typhoons made landfall between July and September (Kanun, Bolaven, Denbin, and Sanba). In 2014, it saw another springtime anomaly, with the longest period of snowfall on the East Coast occurring from February 6–14. In 2015, it had anomalous high temperatures in November and December, and in 2016, it had anomalous high temperatures in the spring, a heat wave in the summer, and 304% above normal rainfall in October. From 2017 to 2019, summer heat waves and abnormally high temperatures in May and October have been occurring continuously, and in 2019, the highest number of typhoons with an impact of 7 was recorded [2]. Also, in 2021, it saw extreme weather events such as heat waves and wildfires in the U.S.A., heavy snowfall and cold snaps in Brazil, and unusual cold snaps and heavy snowfall in the United Kingdom, France, and Italy. In the U.S.A., Texas has declared a state of emergency with temperatures plummeting to minus 18 degrees Fahrenheit, and Western Europe has experienced 100-year rainfall and flooding. South Korea also

experienced a combination of cold snaps and early summer weather in April, and heavy rains caused major damage in 2022.

As such, climate change is a major threat to modern society, and the world's response to climate change and future plans are receiving increasing attention. Korea is dealing with carbon neutrality and energy transition by setting it as a national task and is exploring various alternatives to realize it. The Energy Efficiency Innovation Strategy announced by Korea government in 2019 provides tax benefits and facilities for energy-saving facilities and equipment and raises the need to reorganize the consumption efficiency rating system and standby power reduction system for improving the efficiency of electrical appliances. Furthermore, in order to supplement the inadequacy of energy-saving incentives due to low consumer sensitivity and inefficient pricing system for high-efficiency products compared to advanced countries, Korea government is proposing improvement directions such as establishing an efficiency evaluation system, enhancing support for performance improvement of old buildings, and promoting the distribution and dissemination of high-efficiency products. In this trend of carbon neutrality or energy transition, it needs to give mainly focus on the acceptance of energy transition [3].

However, recent studies on energy saving have been mainly related to the effectiveness of energy saving in facility improvement and design and system construction [4]. Also they have been mainly focused on a few situations in the past. Therefore, there are not many studies on energy saving behavior and policy participation in term of cost and opportunity in recent years. In this study, we explore the variables that affect individual choice by using the concepts of energy saving behavior and policy participation as dependent variables, and draw implications by identifying the interaction effects of opportunities and costs for individuals in this relationship.

THEORETICAL BACKGROUND

TPB and Energy Saving Behaviors

The definition of an energy-saving behavior is the act of habitually conserving energy or selectively purchasing high-efficiency energy-using appliances to reduce energy consumption [5]. Shin [6] found that energy saving is more meaningful when it is actually expressed in behavior. Olsen [7] found that energy saving behavior is influenced by interpersonal pressures and contingencies, and that household economics and government requirements also drive energy saving behavior.

There are many ways to look at energy saving. Research is being conducted at the national level, in terms of governments, businesses, organizations, and individuals. In general, discussions and studies have been conducted from a relatively large-scale perspective to set macro-level policy direction or discourse. In a study by Par [3], conservation behavior

was classified into five dimensions: individual, physical environment, neighbors, and system, in order to understand and intervene in the energy saving behavior. Even if individuals are the smallest unit of these groups, they are final factor to do the energy saving. Therefore, it is very important to study the energy-saving behavior at the individual level.

A useful theory for understanding individual behavior is Ajzen's [8] TPB (Theory of Planned Behavior). It is a model that adds the variable of perceived control to the TRA (Theory of Reasoned Action) and theorizes that attitudes toward behavior, subjective norms, and perceived behavioral control influence behavioral intention, and that behavioral intention determines behavior [8]. According to this theory, behavioral intention is explained by attitudes toward the behavior, subjective norms, and perceived efficacy [3].

TPB has been widely used in green behavior research. For example, a study by Young et al. [9] confirmed the attitude toward behavior, subjective norms, and perceived behavioral control influence behavioral intention through a meta-analysis [10].

Our study assumed that the variables in TPB such as energy saving-related attitudes, norms, and feelings of control will influence individuals' ability to engage in energy saving practices and participation into government policies at individual level.

There are empirical studies that explain energy-saving behavior by applying the TPB. For example, Shi et al. [11] applied the TPB and demonstrated that the attribution of responsibility and awareness of consequences are crucial prerequisites for personal norms. Personal norms positively influence energy-saving intentions. Interestingly, information publicity has a significant positive effect on both the intention and behavior to save energy, while self-efficacy only significantly affects energy-saving intentions. Moreover, Chan and Bishop's [12] study revealed that moral norms, subjective norms, and perceived behavioral control (PBC) were predictors of recycling intention. Furthermore, moral and subjective norms indirectly influenced behavior through recycling intention. As a result, the TPB demonstrated both direct and indirect relationships in the context of recycling behavior. Moreover, Zhang & Li [13] show that environmental attitudes, subjective norms, information publicity, lifestyles, and perceived behavioral control have significantly impact on residents' energy-saving behavior.

Research has also been conducted on the influence of three components in TPB—attitude, norms, and self-efficacy—on energy conservation behavior.

First, regarding attitude, Zhang et al. [14] demonstrated that concern about energy issues serves as a precursor to energy-saving intentions and behaviors.

Second, in terms of norms, Nolan [15] highlighted that the impact of normative social influence on energy conservation behavior is often underestimated. The study revealed that perceptions of social norms

significantly influence individual intentions and actual behaviors related to energy conservation. Zhang et al. [14] further posited that personal responsibility and social norms, from a normative perspective on energy issues, are antecedents to energy-saving intentions and behaviors. Also, Zhang et al. [16] investigated the influence of personal norms, responsibility, and outcome awareness based on the norm activation model. Their findings indicated that these factors have a significant impact on energy-saving behavior.

Third, concerning self-efficacy, Thøgersen and Grønhøj [17] employed a social cognitive approach to examine household electricity conservation. They analyzed the psychological factors influencing behavior and concluded that self-efficacy and social support play crucial roles. Zhang et al. [14] found that from a normative dimension, as perceived controllable responsibility for environmental issues increases, it triggers energy-saving intentions and behaviors.

Since the strong power of attitude, norm and sense of strong in human behavior exist, they induce not only private actions, e.g., personal energy saving, but also pubic actions, e.g., participation into public policy related with energy saving. Therefore, we propose the following hypothesis.

Hypothesis 1: According to TPB, the more concerned people are about wasting energy (attitude), the guiltier they feel about wasting energy (norm), or the higher the perceived efficacy of energy saving (sense of control), the more likely they are to adopt energy-saving behaviors.

Hypothesis 2: According TPB, the more concerned people are about wasting energy (attitude), guilty people feel about wasting energy (norm), or the perceived efficacy of energy saving (sense of control), the more likely they are to participate into public policy related with energy saving.

Values and Energy Saving Behaviors

Personal values are used as a relatively stable basis for evaluating one's own and others' behavior [18]. Personal values have received attention as a key variable in explaining individual differences in certain behaviors or choices [19]. To know the role of value, Rokeach [20] developed the measurement tool for terminal and instrumental values (36 questions). Later, the empirical research by Schwart [21,22] made a significant contribution to reveal the universal value structure of individuals. Schwartz and Bilsky [18,23] attempted a large-scale study of values using data from several countries and proposed a theory of the universal content and structure of people's values. They defined values as ideal end states or behaviors, transcending concrete situations, central to the choice or evaluation of actions and events, and as concepts or beliefs that can be consequenced in order of relative importance.

A more detailed look at the types of values and items covered in Schwartz's [21] theory is as follows (see Table 1): Values can be categorized into several types, each with specific definitions and representative value items. First, 'Security' refers to the safety, harmony, and stability of society.

It stresses the secured stable relationship between oneself and those with whom one identifies. It valued the family safety, belonging, and cleanliness. 'Conformity' refers to refraining from behaviors or impulses that may violate social expectations and norms, including respect for parents and self-control. 'Tradition' refers to respecting and practicing the customs and ideas of a traditional culture or religion, such as humility and devotion. 'Benevolence' aims to preserve and enhance the well-being of those close to you, and includes genuine friendship and forgiveness. 'Universalism' emphasizes understanding and protecting the well-being of people and nature, and includes equality and environmental protection. 'Self-direction' emphasizes thinking and acting independently, exemplified by freedom and creativity. 'Stimulation' is the pursuit of mystery and challenge, exemplified by a colorful life. 'Hedonism' emphasizes sensory pleasure and gratification, seeking pleasure and joy in life. 'Achievement' seeks success that is recognized by social standards, with influence and success being the primary values, and finally, 'Power' is the desire to dominate and control social status and resources, exemplified by social authority and prestige.

Table 1. Value types and value items suggested by Schwartz's [21] theory.

Value Type	Definition	Representative value items
1. Security	Safety, harmony, and stability of society, yourself, and those who identify with you	Family safety, country safety, social order, belonging, strong, clean, returning the favor
2. Conformity	Refraining from behaviors, tendencies, and impulses that violate social expectations and norms and may harm others	Obedient, honoring parents and elders, politeness, self-discipline
3. Tradition	Accept, honor, and implement the customs and ideas of traditional cultures or religions	Respect for tradition, neutral, humble, accepting of his share in life, dedicated
4. Benevolence	Preserve and enhance the welfare of those close to you	Spiritual life, meaningful life, mature love, true friendship, loyal, forgiving, helpful, honest, responsible
5. Universalism	Understanding, recognizing, embracing, and protecting the well-being of people and nature	Equality, inner harmony, world peace, harmony with nature, wisdom, beautiful world, social justice, generous, protecting the environment
6. Self-direction	Think and act independently	Freedom, self-esteem, privacy, creativity, choosing their own goals, independent, curious
7. Stimulation	Excitement, mystery, and challenge	A colorful life, a fun life, a bold life
8. Hedonism	Pleasure and sensory gratification for yourself	Pleasure, enjoying life, indulgent
9. Achievement	Personal success through competence as seen by social standards	Influential, ambitious, competent, intelligent, successful
10. Power	Social status and prestige, control, or dominance over people and resources	Social power, wealth, authority, social recognition, maintaining face

Source: Kim & Choi [19].

In this study, we use hedonism and openness to change as an individual's value variable in Schwartz's value typology. We set two values as independent variables which have impact on the personal energy saving and public participation into policy related with energy savings.

Values, as fundamental belief systems, empirically influence environmental and energy issues including energy saving behaviors [24,25]. Poortinga et al.'s [26] study examined the relationship between values, environmental concern, and environmental behavior, specifically focusing on household energy use. Their findings demonstrate that individuals' value orientations significantly impact their environmental concern and actions. Also, Stern et al. [27] found that individuals who prioritize self-transcendent values engage in more energy-saving behaviors.

In the another values, value research has consistently examined the impact of egoistic, altruistic, and biospheric values on energy conservation. For example, Snelgar [28] compared structural models of values from the VBN (values-beliefs-norms) theory with selfish values, altruistic values, and biosphere values. Structural equation modeling was used to compare the three-factor structure of values and the four-factor structure in which biosphere values divided into two dimensions for plants and animals. The results showed that the four-factor structure was more appropriate. Moreover, Ibtissem [29] investigated the relationship between individuals' value orientations and their beliefs about the consequences of energy conservation. Their findings revealed that anthropocentric and altruistic values significantly influence individuals' perceptions of the positive outcomes associated with energy-saving behaviors. Individuals who strongly endorse these values tend to be more sensitive to the environmental, social, and economic benefits of energy conservation. Conversely, egoistic and econocentric values were not found to have a significant impact on individuals' awareness of these consequences of energy savings. According to Zhang et al. [14], fundamental values towards humans and nature significantly influence individuals' energy conservation intentions and behaviors. Based on those research, we propose the hypothesis as follows.

Hypothesis 3-1: The more people value such as altruistic values, harmony with non-human life, openness to change, the more energy-saving behavior will occur.

Hypothesis 3-2: The more people have egoistic values or hedonic values are preferred, the less energy-saving behavior will occur.

Hypothesis 4-1: The more people value such as altruistic values, harmony with non-human life, openness to change, the more they will participate in energy saving policies.

Hypothesis 4-2: The more people have hedonic values or egoistic values, the less they will participate in energy saving policies.

Opportunity-Cost and Energy Saving Behavior

On the other hand, there are studies that highlight the multidimensionality and inconsistency of behaviors. Human behavior does not always have a consistent direction with the consciousness or intention associated with it. After Park and Heo [30] examined the relationship between individual environmental awareness and pro-environmental behavior, they reported the inconsistency between them. Also, they found that there were both studies, such as Schultz et al. [31], that showed consciousness to be an important causal factor in individual behavior, and studies that such value was not statistically significant variable. However, those finding do not mean that intention-behavior research is irrelevant; rather, they promotes more research on the intention-behavior gap and the case of influence intensity, and highlights the multidimensionality of human behaviors.

In this context, this study aimed to explore the variables that influence the relationship between variables from value theory and TPB theory and energy saving behavior. To this end, the opportunity and cost variables were set as moderating variables. Two variables are a condition for the behavior to actually occur because people always think the opportunity and cost in terms of rational thinking.

An opportunity refers to situations where individuals can recognize their contributions. When individuals are provided with situations or information indicating that they can solve energy-saving issues, they are more likely to actively engage in energy-saving behaviors. According to Zhang et al. [14], having good products that enable energy conservation as an opportunity to solve energy issues induces energy-saving intentions and behaviors. Abrahamse et al. [32] reviewed intervention studies aimed at household energy conservation. They analyzed the impact of behavior change programs on energy savings. As a result, they found that tailored feedback and goal setting as opportunity variables were effective in inducing the behavior.

Cost refers to the amount of energy or effort required to perform a specific action. As the cost of energy-saving increases, individuals' conservation behaviors are likely to decrease. Conversely, when the benefits of energy-saving behaviors are high, it will lead to more practical actions. Poortinga et al. [33] investigated household preferences for energy-saving measures by using conjoint analysis. After evaluating the preferences for various measures, they concluded that economic incentives play a significant role in energy savings. Abrahamse et al. [34] demonstrated that while socio-demographic factors determine overall energy consumption, psychological variables are more strongly associated with changes in energy use, which often necessitate cognitive effort. Sensing of cost is key variable to influence energy savings.

Based on those theories, will examine the moderating effects of opportunity and cost by testing for interaction effects.

Hypothesis 5: Opportunity and cost will moderate the relationship between value factors and energy saving behavior/policy participation.

Hypothesis 6: Opportunity and cost will moderate the relationship between TPB factors and energy saving behavior/policy participation.

Based on the above discussion, the research model for this study is as follows in Figure 1. However, energy saving behavior is defined as personal action, which is individual behavior, and policy participation is defined as public action.

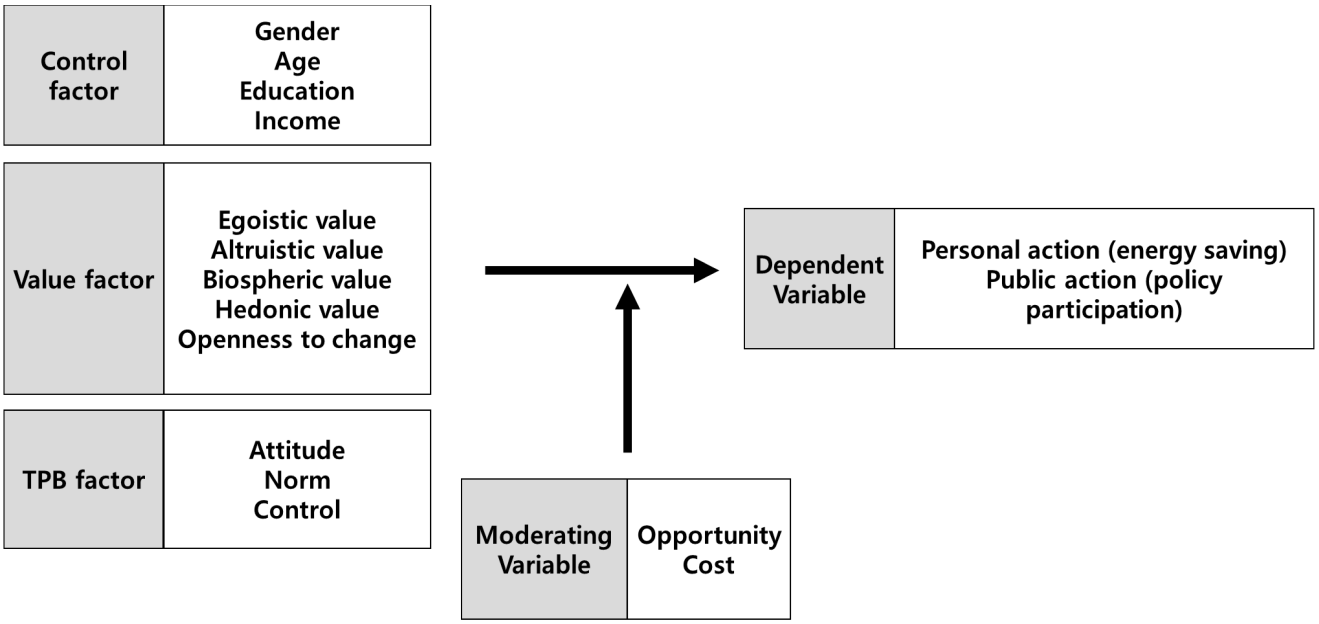


Figure 1. Research model.

SAMPLING AND MEASUREMENT

Collecting Data

The data used in this study is from the "National Opinion Survey on Energy" conducted by the Center for Energy Transition Policy Research under Social Science Research Institute, Ajou University. The survey was conducted from May 30 to June 3, 2022, using a professional survey company, and 1571 people were surveyed using a proportional sampling method by region, gender, and age. The survey method was a web survey via mobile phone and email, and the period was from May 30 to June 3, 2022.

In terms of the characteristics of the sample, 772 (49.1%) of the 1571 participants were male and 799 (50.9%) were female, with 255 (16.2%) in their 20s, 233 (14.8%) in their 30s, 294 (18.7%) in their 40s, 314 (20%) in their 50s, and 475 (30.2%) in their 60s. In terms of education, 791 people had a high school diploma or less (50.4%), and 779 people had a college degree or higher (49.6%). The average monthly household income was 823 (52.4%) below 5 million won, and 748 (47.7%) above 5 million won, and the logarithm was used for analysis.

Metrics and Reliability Analysis

This paper aims to analyze the determinants of energy conservation behavior and policy participation. First, energy conservation behavior is set as the dependent variable, which divides into personal action and public action. Variables in value theory and TPB were set as independent variables. In detail, value factors consisted of egoistic values, altruistic values, egoistic values, biospheric, hedonic value, and openness to change. TPB factors consisted of Attitude (concern about energy waste), Norm (guilt about energy waste), and Sense of Control (efficacy of energy saving). The reliability analysis results for each measurement item are shown in the following Table 2, and the reliability analysis results are all Cronbach's α values above 0.7.

Table 2. Metrics and reliability analysis results.

Distinguish	Factors	Variable name	Contents	Reliability	Scale
Dependent variable	Energy conservation	Personal action	I practice energy-saving behaviors more aggressively than others	0.704	5 point
			I buy energy-efficient products to save energy, even if they cost more than regular products		
		Public action	I participate in public projects and programs related to energy saving, even if I have many constraints	0.730	5 point
			I cooperate with government policies related to energy saving, even when faced with difficult situations		
Independent variable	Value factor	Egoistic value	Social power: control and dominance over others	0.705	7 point
			Wealth: material possessions and money		
			Authority: command, leading position		
			Influence: having an effect on another person or event		
		Altruistic value	Equality: equal opportunity for all	0.855	7 point
			Peace on Earth: life without war and conflict		
			Social justice: righting injustice, helping the underdog		
			Helping hands: working for the well-being of others		

Table 2. *Cont*.

Distinguish	Factors	Variable name	Contents	Reliability	Scale
Independent variable	Value factor	Biospheric value	Respect the Earth: harmonizing with non-human species	0.914	7 point
			At one with nature: living in tune with nature		
			Environmental Protection: conservation		
			Pollution Prevention: protecting natural resources		
		Hedonic value	Happiness: pleasure, fulfillment of desires	0.872	7 point
			Enjoy life: food, sex, leisure, and more		
			Self-complacency or indulgence: doing things that give you pleasure		
		Openness to change	Curiosity: interest in everything, exploration	0.829	7 point
			Challenge: a life full of newness, change, and variety		
			Interesting life, stimulating experiences		
	TPB	Attitude	I'm very concerned about carbon dioxide emissions, which contribute to climate change due to overuse of energy	0.847	5 point
			Overuse of energy is causing serious environmental problems, including climate change		
		Norm	You'll feel personally guilty if you don't conserve energy	0.756	5 point
			I regret a lot about the wasted energy		
		Control	My efforts to conserve energy can be of great benefit to future generations	0.828	5 point
			If I save energy, I will contribute to improving the quality of life in our society		
Moderating Variable	Opportunity		There are many products and devices around you that can help you save energy	0.804	5 point
			I own many products or devices that can save energy		
	Cost		My energy-saving behaviors are costly	0.712	5 point
			There are too many institutional barriers to my energy-saving behavior		

ANALYSIS RESULTS

Descriptive Statistics

In order to understand the trends of the variables that constitute the research model, the results of the descriptive statistical analysis were reviewed (see Table 3 & Figure 2). The Likert scale of the main variables was used to check the mean and standard deviation. The dependent variable, personal action, i.e., energy saving behavior, showed a higher mean value of 3.51 than public action, i.e., public participation (3.11). In the value factor, Altruistic value (5.51), Biospheric (5.41), Openness to change (4.78), Hedonic value (4.68), and Egoistic value (4.2) appeared in that order (see Figure 1). It was confirmed that the response samples had a high awareness of altruistic values such as equality, harmony, and social assistance, and a relatively high awareness of harmony with nature and environmental protection. In addition, the TPB variables had an average value of Attitude (3.72), Control (3.49), and Norm (3.12). Through these results, it was confirmed that the attitude of concern about climate change and the degree of recognition that one's own efforts are worthwhile were relatively high. In the opportunity and cost variables, the average of the opportunity variable was 3.16, and the average of the cost was 2.98. This result is a response to the content about the opportunity for climate change behavior because individuals have products or devices for energy conservation, and the cost or institutional constraints for individuals to practice energy conservation. Our data showed that people seem to be reached a somewhat intermediate level of opportunity and cost burden for practicing energy conservation behavior. In other words, since values in opportunity and cost show an intermediate average value of them rather than a result that is biased to one side, we confirmed the need for additional analysis of the opportunity and cost variables.

Table 3. Descriptive statistics.

Variables	N	Minimum	Maximum	Mean	S.D
Personal action	1571	1	5	3.51	0.74
Public action	1571	1	5	3.11	0.77
Egoistic values	1571	1	7	4.20	1.05
Altruistic values	1571	1	7	5.51	0.98
Biospheric value	1571	1	7	5.41	1.04
Hedonic value	1571	1	7	4.68	1.11
Openness to change	1571	1	7	4.78	1.01
Attitude	1571	1	5	3.72	0.80
Norm	1571	1	5	3.12	0.78
Control	1571	1	5	3.49	0.75
Opportunity	1571	1	5	3.16	0.77
Cost	1571	1	5	2.98	0.72

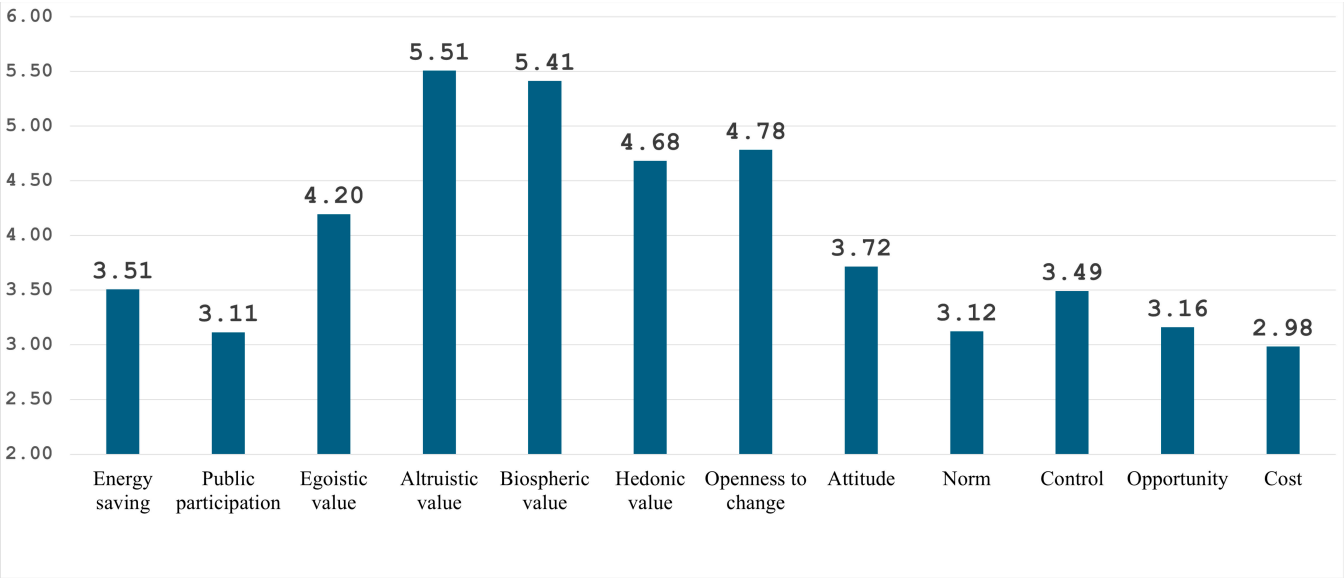


Figure 2. Descriptive statistics.

Correlation Analysis

Correlation analysis was conducted to analyze the relative influence of the independent and dependent variables of this study (see Table 4). As a result of the analysis, the absolute value of the significant correlation coefficient was 0.056 for the minimum correlation coefficient between egoistic values and biosphere (harmony with living things) and 0.766 for the maximum correlation coefficient between egoistic values and biosphere (harmony with living things). In general, a correlation coefficient of more than 0.6 is considered to be autocorrelation problem, but this study confirmed that there is no autocorrelation between variables other than the altruistic value-biosphere relationship. The biosphere refers to the entirety of life on Earth or the places where life lives. In this study, the biosphere was measured by harmonizing or protecting these creatures, which is similar to the nature of an individual's altruistic value. Such attributes of two variables seem to induce a high correlation.

The results of the correlation between the variables of the value factor and personal action and public action showed that egoistic value, altruistic value, biosphere, and openness to change were positively related to energy saving behavior and policy participation. On the other hand, hedonic values were negatively correlated with energy saving behavior but not with policy participation. Biosphere ($r = 0.392$, $p < 0.001$) and altruistic values ($r = 0.311$, $p < 0.001$) showed high effect sizes between value factors and action behaviors, while biosphere ($r = 0.275$, $p < 0.001$), openness to change ($r = 0.198$, $p < 0.001$), and altruistic values ($r = 0.184$, $p < 0.001$) showed relatively high effect sizes for policy participation. In the value factor-opportunity relationship, selfishness, altruism, biosphere, and openness to change were positively related, and in the value factor-cost

relationship, selfishness, hedonic value, and openness to change were positively related.

The attitudinal, normative, and perceived control variables that comprise the TPB had relatively high positive correlations with both practice behavior and policy participation, with effect sizes greater than .5 for perceived control-practice behavior (r = 0.557, $p < 0.001$), perceived control-policy participation (r = 0.507, $p < 0.001$), and norm-policy participation (r = 0.515, $p < 0.001$). This shows that individuals' perceived control over the situation regarding energy saving and guilt over waste are highly correlated with energy personal action and public action. In addition, norms (r = 0.475, $p < 0.001$) and sense of control (r = 0.510, $p < 0.001$) were highly positively correlated with the moderator variable opportunity, indicating that having the resources to realize energy savings is positively related to norm of guilt over wasting energy and sense of efficacy in energy saving.

Table 4. Correlation analysis results.

Variables			1	2	3	4	5	6	7	8	9	10	11	12
1	Personal action		1											
2	Public action		0.640**	1										
3	Value factor	Egoistic value	0.061*	0.125***	1									
4		Altruistic value	0.311***	0.184***	0.088***	1								
5		Biospheric value	0.392***	0.275***	0.056*	0.766***	1							
6		Hedonic value	−0.066**	−0.036	0.277***	0.221***	0.152***	1						
7		Openness to change	0.166***	0.198***	0.291***	0.378***	0.380***	0.502***	1					
8	TPB factor	Attitude	0.430***	0.296***	−0.010	0.390***	0.475***	−0.008	0.175***	1				
9		Norm	0.473***	0.515***	0.072**	0.221***	0.326***	−0.050*	0.113***	0.333***	1			
10		Control	0.557***	0.507***	0.065**	0.360***	0.443***	−0.007	0.201***	0.507***	0.561***	1		
11	Opportunity		0.525***	0.550***	0.133***	0.164***	0.237***	−0.010	0.189***	0.262***	0.475***	0.510***	1	
12	Cost		0.122***	0.294***	0.150***	0.013	0.015	0.061*	0.118***	0.020	0.260***	0.162***	0.258***	1

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Regression Analysis

Regression analysis was conducted to identify the variables that affect energy saving behavior and policy participation. Four types of regression analyses (opportunity → action, cost → action, opportunity → policy-participation, cost → policy-participation) were conducted with the

dependent variables, action and policy participation, and the control variables, opportunity and cost, respectively. The VIF (Variance Inflation Factor) test for the variables used in this analysis showed a minimum of 1.051 and a maximum of 2.899. The VIF test is usually used to determine the existence of multicollinearity when the VIF is 10 or higher, or strictly speaking, 5 or higher. In this study, the VIF value did not exceed 3, which excluded the possibility of multicollinearity.

In Table 5, model 1 is the result of the analysis in which energy saving behavior is set as the dependent variable, and value factor, TPB factor, and opportunity to use as control variables. The model fit was obtained with F = 102.397 (p < 0.001), and the explanatory power of the model was 45.8%. Among the value factors, biosphere and hedonic value variables were found to influence energy saving behavior. Biosphere is a value related to coexistence such as harmony with nature, and it can be interpreted that the more important it is, the higher the energy saving behavior. On the other hand, the more hedonic values are pursued, the lower the energy saving behavior. The variables of TPB were all found to have a positive causal relationship with energy saving behavior, and the opportunity variable was also found to have a positive causal relationship, suggesting that having resources to realize energy saving has a positive effect on saving behavior.

Model 2 is the same model as Model 1, with behavior as the dependent variable and opportunity cost as the variable. The model fit of Model 2 was F = 82.998 (p < 0.001), and the explanatory power of the model was 40.6%. The analysis of the variables showed that in the value factor, biosphere and hedonic values had a significant causal relationship as in Model 1, and additionally, openness to change had a positive effect. The variables of the TPB were all found to have a positive effect, as in Model 1. Variables in TPBT is significant in both Model 1 and Model 2 because the variables are set to explain the individual's behavior. On the other hand, cost, which is used to explain the individual's sense of control, did not show a significant causal relationship with energy saving behavior. Since the cost of energy saving behavior does not explain the relationship with the dependent variable, it is necessary to consider the relationship between the two. Cost as conceptualized in this study means that there is a cost or institutional constraint to energy saving. However, since the general public is likely to perceive energy saving as a reduction in individual costs or expenditures, it is possible that none significance of cost in this study is due to a conceptual conflict with the cost variable.

Model 3 and 4 are models with policy participation as the dependent variable. Model 3 has a model fit of F = 91.408 (p < 0.001) and an explanatory power of 43%, while Model 4 has a model fit of F = 77.595 (p < 0.001) and an explanatory power of 39%. In Model 3, egoistic value, hedonic value, and openness to change were found to influence policy participation. In Model 4, altruistic value is a significant variable along with egoistic value, hedonic value, and openness to change. In this study,

we hypothesized that increasing altruistic values would increase policy participation, but the results of the analysis were in the negative direction. This means that altruistic values such as equality and social justice do not lead to cooperation with the government on energy saving, suggesting the need to consider the multidimensional nature of behavior.

Regarding policy participation, the TPB variables, norms and sense of control were found to have a positive effect. On the other hand, the attitude variable has no significant effect, which is different from previous studies that attitude leads to behavior. This suggests that individuals' normative or efficacious factors influence their participation in government energy-saving policies, but attitudes do not, suggesting that the multidimensionality of behaviors needs to be considered.

In the above regression analysis, we analyzed the impact of value and TPB variables on behavior. The results show that some variables consistently cause behavior, while others do not. The next step is to explore the moderating factors that influence the relationship between these variables. In particular, we will focus on the variables that did not produce consistent results on energy saving behavior or policy participation.

Table 5. Regression analysis.

Distinguish		**Energy saving behavior (Personal action)**				**Participation in energy saving policy (Public action)**			
Categories		**Model 1**		**Model 2**		**Model 3**		**Model 4**	
		b	**Beta**	**b**	**Beta**	**b**	**Beta**	**b**	**Beta**
(Constant)		0.240		0.296		0.369		0.091	
Control variable	Gender	−0.023	−0.016	−0.023	−0.016	−0.129***	−0.084	−0.109***	−0.071
	Age	0.072***	0.141	0.074***	0.146	0.046***	0.087	0.057***	0.108
	Education	0.065*	0.044	0.070*	0.048	0.087**	0.057	0.098**	0.064
	Income	0.040*	0.042	0.062**	0.064	−0.007	−0.007	0.021	0.021
Independent 1: Value factor	Egoistic value	0.000	0.000	0.012	0.017	0.030*	0.042	0.035*	0.047
	Altruistic value	0.016	0.021	0.004	0.005	−0.046	−0.058	−0.060*	−0.077
	Biospheric value	0.060**	0.084	0.061**	0.087	0.027	0.036	0.038	0.051
	Hedonic value	−0.032*	−0.048	−0.043**	−0.065	−0.044**	−0.064	−0.055**	−0.080
	Openness to change	0.014	0.020	0.036*	0.05	0.0730***	0.096	0.090***	0.119
Independent 2: TPB factor	Attitude	0.131***	0.143	0.132***	0.144	0.036	0.037	0.044	0.046
	Norm	0.126***	0.133	0.190***	0.201	0.240***	0.243	0.278***	0.282
	Control	0.185***	0.187	0.276***	0.281	0.170***	0.165	0.263***	0.255
Moderator	Opportunity	0.266***	0.279	-	-	0.306***	0.307	-	-
	Cost	-	-	0.023	0.023	-	-	0.172***	0.163
F value		102.397***		82.992***		91.408***		77.595***	
R^2		0.463		0.411		0.434		0.395	
adjusted R^2		0.458		0.406		0.430		0.390	

*p < 0.05, **p < 0.01, ***p < 0.001.

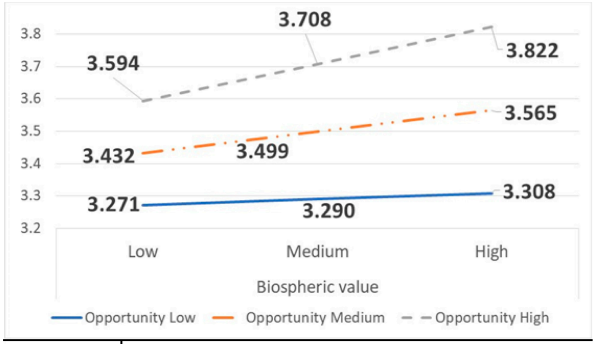
Analyze Interaction Effects

We conducted a moderating effect analysis by opportunities and costs. The analysis method was Baron & Kenny's three-step test method to confirm variables and interaction terms, and the simple slope effect verification was conducted on the results.

First, as a result of the analysis with personal action as the dependent variable and opportunity as the moderator variable, it was confirmed that the biosphere among the value elements had an interaction effect with opportunity. In Figure 3, the biospheric value was found to have a positive effect on personal action, and in the process, the group with high awareness of opportunity (B = 0.110***, S.E = 0.031, t = 3.523) and the group with medium awareness (B = 0.064***, S.E = 0.023, t = 2.835) showed an increase in practical behavior. When comparing these two groups, the higher the awareness of the rights to life, the more personal action increases in people who recognize opportunities for energy conservation than in people with medium awareness. In other words, people with high biospheric value take personal action, and the increased awareness of energy-saving opportunities acts as a mechanism to induce more active practice behavior.

Second, the results of the analysis with personal action as a dependent variable and cost as a moderator variable confirmed the moderating effect of the attitude variable in the TPB factor. In Figure 4 The attitude of concern about energy waste had a positive effect on personal action, and in this process, the group that perceived the cost of energy saving practices as low (B = 0.205***, S.E = 0.030, t = 6.903) or average (B = 0.127***, S.E = 0.022, t = 5.678) showed higher personal action. In other words, the group that perceived the cost of energy-saving as low was confirmed to have a stronger degree of personal action as the level of attitude increased compared to the group that perceived it as average.

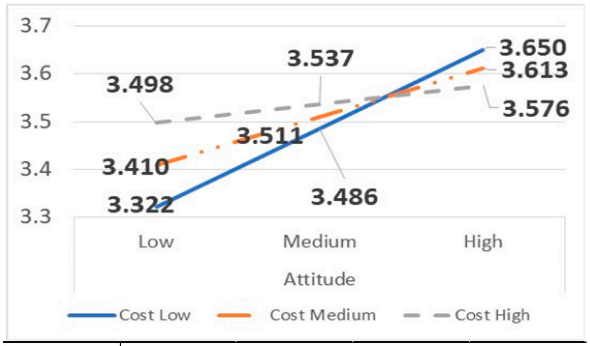
Personal action is affected by various independent variables, but is also moderated by opportunity and cost. Behavior is determined by individual values and attitudes, but it is possible to enhance the effect of energy conservation by facilitating this process. The opportunities and costs invested in this study refer to the resources related to energy conservation that individuals have or the costs required for individuals order to achieve the goal of energy conservation.



Personal action	Biospheric × Opportunity			
	B	S.E	B	S.E
Biospheric value	0.059**	0.022	0.063**	0.023
Opportunity	0.268***	0.022	0.271***	0.022
Interaction terms	-		0.060*	0.026
F value	66.744***		64.007***	
R^2	0.464		0.466	
Adjusted R^2	0.457		0.459	
		B	S.E	t
Simple slope test	Low	0.018	0.029	0.615
	Medium	0.064**	0.023	2.835
	High	0.110***	0.031	3.523

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Figure 3. Results of cost interaction effect analysis on the relationship between personal action and biospheric value.



Personal action	Attitude × Cost			
	B	S.E	B	S.E
Attitude	0.125***	0.022	0.127***	0.022
Cost	0.029	0.021	0.036	0.021
Interaction terms	-		−0.108***	0.026
F value	54.802***		53.513***	
R^2	0.416		0.422	
Adjusted R^2	0.408		0.414	
		B	S.E	t
Simple slope test	Low	0.205***	0.030	6.903
	Medium	0.127***	0.022	5.678
	High	0.049	0.029	1.679

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

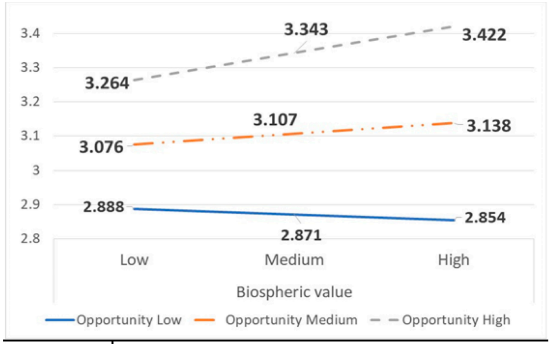
Figure 4. Results of the analysis of the interaction effect of cost on the relationship between personal action and attitude.

Figures 5–8 show the moderating impact of opportunity and cost on public participation.

First, in Figure 5, the analysis results with opportunity as the moderator variable confirmed that the biosphere has an interaction effect with the opportunity variable. Unlike the previous personal action analysis results, the moderating effect was confirmed only in the group with high awareness of opportunity (B = 0.076*, S.E = 0.033, t = 2.281). With public action as the dependent variable, the higher the biosphere, the higher the level of policy participation, and in this process, the group with high energy saving opportunities participates more actively in the policy.

The following is the analysis results with public action as the dependent variable and cost as the moderator variable. In the relationship between value factors and policy participation, the moderating effect was confirmed in egoistic values, and in the TPB variable, the moderating effect was confirmed in the attitude and norm variables.

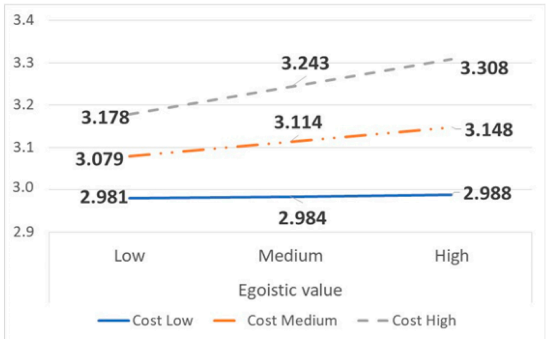
In Figure 6, the moderating effect of cost on the relationship between egoistic values and public action is as follows. Egoistic values have a positive (+) effect on public action. From the perspective of moderator variables, in the case of the group that feels that “there are many costs or institutional restrictions in practicing energy conservation” and thus the cost is high (B = 0.062, S.E = 0.020, t = 3.067), the degree of public action increases as egoistic values increase. On the surface, it is easy to think that public action will decrease when egoistic values are high. However, egoistic values are a value that values material wealth, authority, and influence, so they do not only have a negative effect. Paradoxically, egoistic value increases the energy saving when costing the cost. In this context, if we explain the moderating effect in the relationship between egoistic values and public action, the group that thinks that there are many costs or restrictions for energy conservation actively takes public action the more because they think that their wealth or power is important. This can be considered from two perspectives. One is that since they think that wealth and power are important, if there are many costs or restrictions for energy conservation, they judge that participating in government policies is more effective. The second is a situation where the government strongly feels institutional constraints related to energy conservation, and policy participation is considered a way to preserve wealth and power.



Public action	Biospheric × Opportunity			
	B	S.E	B	S.E
Biospheric value	0.025	0.024	0.029	0.024
Opportunity	0.303***	0.024	0.306***	0.024
Interaction terms	-		0.060*	0.028
F value	59.850***		57.368***	
R^2	0.437		0.439	
Adjusted R^2	0.430		0.431	
Simple slope test		B	S.E	t
	Low	−0.017	0.031	-0.540
	Medium	0.030	0.024	1.237
	High	0.076*	0.033	2.281

*p < 0.05, **p < 0.01, ***p < 0.001.

Figure 5. Results of the analysis of the interaction effect of opportunity on the relationship between public action and biospheric value.



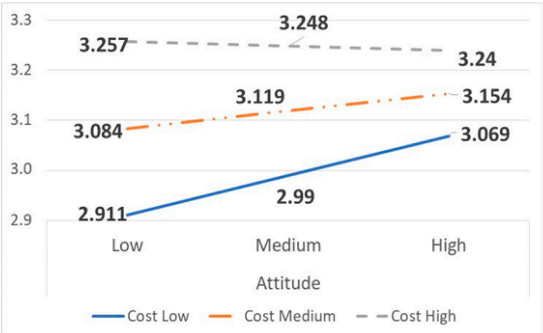
Public action	Egoistic value × cost			
	B	S.E	B	S.E
Egoistic value	0.033*	0.016	0.033*	0.016
Cost	0.178***	0.023	0.179***	0.023
Interaction terms	-		0.041*	0.019
F value	52.284***		50.142***	
R^2	0.404		0.406	
Adjusted R^2	0.397		0.398	
Simple slope test		B	S.E	t
	Low	0.003	0.021	0.156
	Medium	0.033*	0.016	2.116
	High	0.062**	0.020	3.067

*p < 0.05, **p < 0.01, ***p < 0.001.

Figure 6. Results of the analysis of the interaction effect of cost on the relationship between public action and egoistic value.

In Figure 7, the following is an analysis of the moderating effect of cost on the relationship between attitude and public action. The regression analysis results showed that attitude toward energy conservation did not significantly affect public action. However, the analysis results that set cost as a moderator variable showed that the interaction term between attitude and cost was significant. The results of the simple slope test to confirm the effect are as follows. The group that perceives the cost of energy conservation as low (B = 0.098**, S.E = 0.031, t = 3.130) has a higher level of concern about excessive energy use, and they thus participate in public action. This suggests that recognizing the cost of energy conservation can induce the public action.

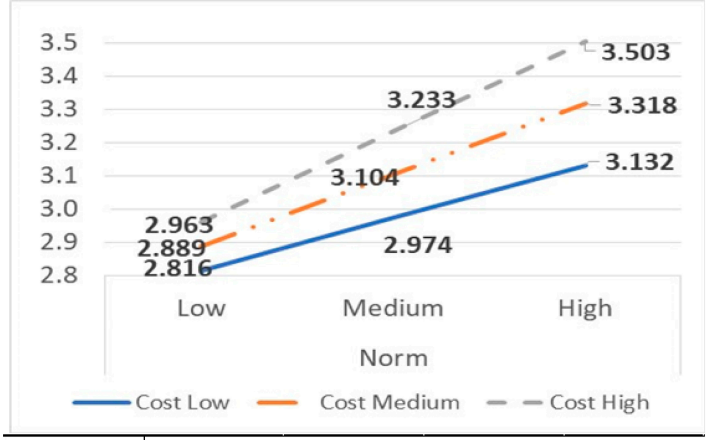
Finally, in Figure 8, the moderating effect of cost was also confirmed in the relationship between norms and energy conservation public action. It was confirmed that the level of policy participation greatly increased as the norms such as guilt or regret related to energy conservation increased in the group that thought the cost of energy conservation was high (B = 0.348***, S.E = 0.033, t = 10.4). Meanwhile, the group with an intermediate perception of cost was confirmed as B = 0.276***, S.E = 0.025, t = 11.177, and the B value of the low group was 0.203***, S.E = 0.032, t = 6.436. In summary, as the cost increases, the influence of the norm on public Action increases. In other words, it can be emphasized that the change in the norm has a greater influence on public action under a high cost situation.



Public action	Attitude × cost			
	B	S.E	B	S.E
Attitude	0.043	0.024	0.044	0.024
Cost	0.174***	0.023	0.179***	0.023
Interaction terms	-		-0.075**	0.028
F value	52.083***		50.148***	
R^2	0.403		0.406	
Adjusted R^2	0.396		0.398	
		B	S.E	t
Simple slope test	Low	0.098**	0.031	3.130
	Medium	0.044	0.024	1.855
	High	−0.011	0.031	−0.342

*p < 0.05, **p < 0.01, ***p < 0.001.

Figure 7. Results of the analysis of the interaction effect of cost on the relationship between public action and attitude.



Public action	Norm × cost			
	B	S.E	B	S.E
Norm	0.271***	0.025	0.275***	0.025
Cost	0.178***	0.023	0.179***	0.023
Interaction terms	-		0.100***	0.029
F value	51.726***		50.148***	
R^2	0.402		0.406	
Adjusted R^2	0.394		0.398	
Simple slope test		B	S.E	t
	Low	0.203***	0.032	6.436
	Medium	0.276***	0.025	11.177
	High	0.348***	0.033	10.400

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Figure 8. Results of the analysis of the interaction effect of cost on the relationship between public action and norm.

FINDINGS AND DISCUSSION

The purpose of this study was to analyze the determinants of energy saving behavior and policy participation through value factor variables and TPB variables in relation to energy saving, and to analyze their effects using opportunity and cost variables as moderating variables.

First, in Model 1 of Table 5, among the value factors, biospheric and hedonic values, which are variables related to coexistence such as harmony with living things, were identified as significant variables. As for the variables comprising the TPB, all three variables were found to be significant: attitude toward energy saving, norms such as guilt over waste, and a sense of control variable consisting of a sense of efficacy in energy saving. The opportunity variable, measured by the possession of resources related to energy saving, was also significant.

In Model 2, the TPB variables, biospheric and hedonic value were found to be significant as in Model 1, and openness to change was found to be an

additional significant variable. But in Model 2, when a variable for energy saving cost was added, it did not have a significant effect.

Next, the variables affecting participation in energy saving policies are shown in Model 3, where egoistic value, hedonic value, and openness to change are significant variables in the value factor. In the analysis of Model 4 where the cost variable was introduced instead of the opportunity variable, egoistic value, altruistic value, hedonic value, and openness to change were found to be significant variables. Among the TPB factors, attitudinal variables such as concern about energy waste were not significant. The fact that egoistic value was found to be a significant variable in contrast to the dependent variable, that altruistic value does not lead to participation in energy-saving policies, or that it indicates negative (−) influence, and that attitudinal variables explaining behavior are not significant raise the need to consider the multidimensionality of participatory behavior. On the one hand, it is possible that egoistic values such as having personal wealth and power are related to government policies.

Overall, biospheric and openness to change in values have a positive effect on personal action behavior, while hedonic values have a negative effect on personal action behavior and public policy participation. In TPB, attitudes, norms, and feelings of control are the factors that decrease action behavior and policy engagement. Notably, contrary to the hypothesis, selfish values drive policy engagement and altruistic values decrease policy engagement. These findings suggest that self-interest should be reflected in motivation factor in policy participation.

Opportunity and cost factors induce action and policy participation, but it is unexpected that cost factors induce action and participation. This finding suggests that respondents are willing to participate even if it costs them money, which suggests that participants are willing to share costs in energy conservation.

To further analyze the relationship between independent and dependent variables, we conducted a moderation analysis using opportunity and cost variables, and found interaction effects of moderation variables in six independent-dependent relationships (biospheric value-personal energy saving action, attitude-personal energy saving action, biospheric value-policy participation, egoistic value-policy participation, attitude-policy participation, and norm-policy participation). Based on the above, in Table 6, we summarize the results of the hypothesis testing as follows. Table 6 is organized as follows. the ‘+’ and ‘−’ symbols indicate the direction of influence of the variable in the hypothesis and, and blank exists, if there is no significant effect. The bottom four rows of the table are the results of testing for interaction effects.

Table 6. Hypothesis test results.

Concept		Research Hypothesis	Verification results			
			Personal action		Policy participation	
			Model 1	Model 2	Model 3	Model 4
Value Factor	Egoistic value	−			+	+
	Altruistic value	+				−
	Biospheric value	+	+	+		
	Hedonic value	−	−	−	−	−
	Openness to change	+		+	+	+
TPB	Attitude	+	+	+		
	Norm	+	+	+	+	+
	Control	+	+	+	+	+
Moderating Variable	Opportunity × Value factor		(1/5)		(1/5)	
	Opportunity × TPB factor		(0/3)		(0/3)	
	Cost × Value factor			(0/5)		(1/5)
	Cost × TPB factor			(1/3)		(2/3)

Note: The "+" and "−" signs in the research hypothesis column indicate the positive/negative directionality of the hypothesis. The four columns below the verification results column indicate the results of the verification of the hypothesis in each model, and a blank space means that there was no significant influence.

There are two notable findings. First, the moderating effect of opportunity on the relationship between biospheric value and policy participation, and second, the moderating effect of cost on the relationship between attitude and policy participation. The independent variables, biosphere and attitude, did not affect policy participation in Model 3 and 4 of Table 5, respectively. However, interaction effects with the moderating variables were found to exist. This result shows that even if a variable does not directly affect energy saving behavior or policy participation, its influence may be caused by other factors.

In this study, the moderating variables are the resources that individuals possess and the costs associated with energy saving, such as burden. This suggests that in situations where personal values or behavioral motivators influence behavior, environmental and psychological burdens may moderate the relationships. This suggests that in order to engage individuals in energy saving practices or policies, it is important to consider their perceived burden and context.

CONCLUSION

The theoretical implication of this study is that it confirms the arguments that the variables in value theory and TPB that explain individual behavior may not lead to energy saving behavior. In particular,

it confirms the need for research on various causal mechanism of behavior by verifying that variables that do not affect behavior have a significant interaction effect with moderating variables.

The limitations of this study include, first, the inability to reflect behavioral intention in the TPB theory model to check the effects of independent and moderating variables. In TPB, independent variables do not directly affect behavior but are expressed through behavioral intention. However, this study focused on analyzing the relationship through moderating variables, so it was not possible to verify full causal relationship between causal factors, behavioral intention, and behavior. To compensate for this, future research should establish a research model that reflects behavioral intention and verify the role of intention by using moderation and mediation analysis.

Second, we did not reflect all ten value items proposed by Swartz. Since personal values determine behavior and influence motivation, future research should complement this by covering all of value items.

DATA AVAILABILITY

The dataset of the study is available from the authors upon reasonable request.

AUTHOR CONTRIBUTIONS

Conceptualization, SK and SJ; Methodology, SJ; Validation, SK; Formal Analysis, MK; Investigation, MK; Resources, SK; Data Curation, SJ; Writing—Original Draft Preparation, SJ; Writing—Review & Editing, SK; Visualization, MK; Supervision, SK; Project Administration, SK; Funding Acquisition, SK.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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