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Evaluation of Geothermal Energy Efficiency Factors by using Sem-pls for Citgöl Municipality

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Abstract

The fact that the global scale of energy resources is limited and the fact that they start to run out has increased the tendency towards renewable energy sources and has encouraged its use. One of there new able energy sources is geothermal energy. In Turkey geography, Kütahya region is one of the rich regions in terms of geothermal energy. Simav district, Çitgöl municipality, Naşa municipality Kütahya province is the are a using geothermal energy. While Çitgöl Municipality is using geothermal energy only for thermal springs until 2017, it started to use this energy for heating purposes in 2017. Regional heating system project has been commissioned in Çitgöl Municipality. As a result of our work in the context of energy efficient use of consumers; We identified energy efficiency, energy use, energy use information and physical environment factors. A face-to-face survey has been conducted in order to understand how effective the factors we determine are in increasing energy efficiency. Data collected from this questionnaire were tested using the partial least squares structural equation modeling (Smart PLS) approach.A common method to measure the reliability and internal consistency of the scale was Cronbach alfa. The Cronbach alpha values show the degree of internal consistency because it changes from 0,625 for energy efficiency to 0,889 for physical environment. Composite Reliability (CR) and Average Variance Extracted (AVE) tests were conducted to measure convergent validity. If the Cronbach alpha value for each structure is equal to or greater than 0.70, the reliability of the scale is generally accepted. CR value is between 0.841 and 0.944. However, it is recommended that the AVE must exceed 0.50 to ensure convergent validity. The value of AVE was between 0,579 and 0,894.This study consists of t-test, factor and regression analysis.

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The results show administrative, theoretical and practical results for efficient use of the energies. This study presented International Congress On Afro - Eurasıan Research III October 19-21, 2017 / İstanbul [13].

Keywords: Geothermal Energy; Energy Efficiency; Using Energy Properly.

1. Introduction

It is known that energy is one of the key components of economic and social development and plays a vital role in raising living standards. It is also a well-known fact that sustainable development will be possible with a sustained and high quality energy supply [7]. Population growth, industrialization and technological developments all over the world increase the energy need every passing day. Today, much of the energy needs are met by fossil-based energy products. New and renewable energy sources have come into being due to the reduction in available fossil fuels and the environmental problems caused by some sources. Geothermal energy is a source of energy that is renewable, environmentally friendly, and non-environmentally dependent among these sources [9]. However, pollution caused by the use of primary energy sources are limited in Turkey; the development of renewable energy sources and technologies is compulsory [8]. When petroleum based energy sources in Turkey, followed by the lack of external dependence and costs, given the importance of renewable energy and environmentally friendly geothermal property with public space is increasing with each passing day. Turkey is also one of the areas of energy in the heating system. In general, traditional energy sources (fossil, hydrothermal, etc.) are used in the heating system. Geothermal energy has recently started to be used in district heating systems. The studies show that the geothermal district heating systems that are being operated in our country can be used much more efficiently [10]. The regions like Afyon-Sandıklı, Kütahya-Simav use geothermal energy for both tourism and heating purposes. Almost 80% of the population benefit from geothermal energy for warming purposes. Nearly 4000 inhabitants of Kütahya province, Simav district, Çitgöl town have recently applied district heating system with geothermal energy. Studies conducted in Turkey, although there are many studies to measure the efficiency of use is analyzed; no studies have been conducted on the efficiency of geothermal energy use. For this reason, we first tried to determine the factors affecting geothermal energy efficiency. In this study we also focused on assessing the factors we have identified.

1.1. Literature Review and Hypotheses

Despite the fact that there are many studies in the literature with general energy efficiency, studies on geothermal energy efficiency have not been found. Energy efficiency is the most effective method of ensuring energy efficiency. Energy savings can be achieved through the use of high-tech equipment that will provide energy efficiency, the evaluation and recovery of energy related wastes and the prevention of current energy losses, without reducing the amount of energy consumed, economic growth and development, without compromising social and economic welfare, can be defined as the reduction of energy requirements to the lowest [2]. Energy efficiency is a broad concept that includes the concept of energy saving. Energy efficiency refers to the production, transmission and consumption of energy resources and the use of energy in these phases at the highest efficiency. Energy efficiency activities include measures that cover both the area of

consumption and the supply side of energy [6]. Geothermal energy; removal of resources, submission of subscriptions and usage processes are the main factors in measuring productivity. We have worked to determine the efficiency-related factors, including the subcomponents of these substances. Factors we have identified; energy use information, using energy properly, physical environment and energy efficiency.

We developed our hypotheses by interpreting these factors in our work. Hypothesis:

H1:Energy use information relates positively to energy efficiency.
H2:Energy use information is related positively to using energy properly.
H3: Using energy properly is related positively to the physical environment.
H4:Energy use information is positively associated with energy efficiency.
H5:The correct use of energy is associated with the physical environment in a positive way.
H6: The physical environment is positively related to energy efficiency.

2. Method

2.1. Instrument and Data Collection

This is a quantitative cross-sectional study that uses the survey as a data collection tool. We used the materials we used to determine the factors affecting geothermal energy efficiency. Participation was distributed to users who were completely volunteer and switched to a warm-up system with geothermal energy. The research period was between 1 July and 1 August 2017.

2.2. Rating Scales

In this study, related structures were deified using verified material from previous researches.

Energy use information;

EB1 Energy efficient training is very useful.

EB2 The use of calorimeters is more accurate for energy efficiency.

EB3 It is important to use a thermometer for energy efficiency.

EB4 Intelligent valves, thermostats are important for energy efficiency.

EB5 Maintenance of geothermal energy installation is less costly.

Using energy properly;

ED1 Energies contribute to the country's economy and its own budgeting use.

ED3 When the air is hot, turn off the pads instead of opening the glass to reduce the ambient temperature.

Physical environment;

F1 Our energy efficiency and saving measures have been taken.

F2 Insulation has been made for efficiency and saving in our superiority.

Energy efficiency;

EV1 Boiler is more advantageous than heating with coal, to set up geothermal energy system.

EV2 The automation and calorimeter system amortizes itself within 4-5 years.

All items were measured using a five-point likert-type scale ranging from "I agree" to "I definitely do not agree".

2.3. Exhibitor Profile

Descriptive statistics of the sample, 90% of the participants are male, 10% are female. The 41-50 age range represents the largest age range with 49%. Education status is represented by the largest group of secondary education with 80%. Participants' Income Level was found to be 64% in the range of 1501-3000. It is determined that the Building Status is Independent with 66%, the Building Age is between 38% and 21 years, and the Uninsured Building Rate is 62.

Table 1: Participatory demographics and background

Participant Profile	Frequency	Person/ Percentage
Gender	Male	88 / 90
	Female	10 / 10
Age	31-40	20 / 20
	41-50	48 / 49
	Over 51	30 / 31
Education Level	Secondary Education	78 / 80
	Associate Degree	20/ 20
Income State	0-1500 TL	25 / 26
	1501-3000 TL	63 /64
	3001-4500 TL	10 / 10
Building State	Detached	65 / 66
	Multistory	33/ 34
Building Insulation State	Yes	35 / 36
	No	63/ 64
Building Age	1-5 Year	18 / 19
	6-10 Year	12 / 12
	11-15 Year	12 / 12
	16-20 Year	18 / 19
	Over 21 Year	38 /38

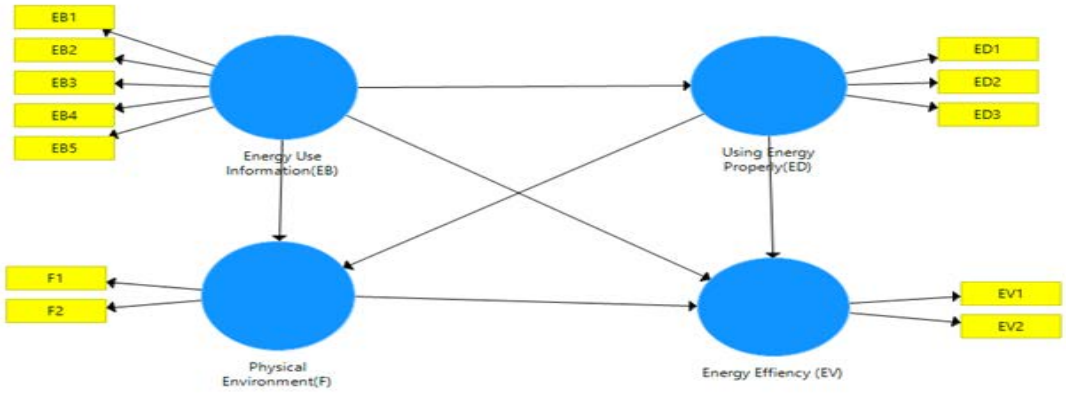

Figure1: Conceptual model

2.4. Data Analysis and Results

This study uses Structural Equation Modeling (SEM) approach with Partial Least Square (PLS) as an analysis method. PLS examines psychometric properties and provides appropriate evidence of whether or not relationships exist [3]. In this study, data analysis was performed according to a two-step methodology using SmartPLS 3.00. To test the content, convergent and discriminant validity of structures using the first step measurement model. The second step is to test the structural model and hypotheses.

2.5. Measurement Model

Cronbach alpha, a common method used to measure the reliability and internal consistency of the scale, was used. The Cronbach alfa values show the degree of internal consistency as it changes between 0,625 (Energy Efficiency) and 0, 889 (Physical environment). Composite Reliability (CR) and Average Variance Extracted (AVE) tests were conducted to measure convergent validity. The CR and AVE values for the structures in the study model are above the acceptable levels. Hair at all. said that the reliability of the scale was generally accepted when the Cronbach alpha value for each structure was equal to or greater than 0.70[5]. Fornell ve Larcker said that, the CR value for each structure must exceed 0.70, but the AVE must exceed 0.50 in order to achieve convergent validity [3] (Table 2- 3).

Table 2: Reliability and convergent validity test results

	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
Energy Effiency (EV)	0.625	0.842	0.727
Energy Use Information(EB)	0.818	0.873	0.579
Physical Environment(F)	0.889	0.944	0.894
Using Energy Properly(ED)	0.717	0.841	0.641

Table 3: Descriptive analysis and discriminant validity

	Energy Effiency (EV)	Energy Use Information(EB)	Physical Environment(F)	Using Energy Properly(ED)
Energy Effiency (EV)	0.853			
Energy Use Information(EB)	0.547	0.761		
Physical Environment(F)	0.200	0.034	0.946	
Using Energy Properly(ED)	0.130	0.529	-0.297	0.801

2.6. Structural Model

In addition to the PLS Algorithm, bootstrapping was applied and 98 cases, 5000 samples and no sign were selected to evaluate the importance of the path coefficients.

The results of the PLS-SEM analysis show, as in Table 4, the evaluation of structural model estimates and formulated hypotheses. Based on the study model results shown in Table 4, 6 hypotheses were statistically significant. Thus, our hypotheses H1, H2, and H5 are supported by taking three stars, and our hypotheses H3, H4 and H6 are rejected.

The R2 values of the endogenous concealed structure are also obtained using the PLS algorithm procedure. R squares (R^2) specify the amount of variance explained by the exogenous variables [1]. As an endogenous concealed structure, the R2 value for energy efficiency is 0.349, which is quite high.

Using energy correctly shows the effect size at R2 = 0.279 and the physical environment R2 = 0.138. The multiple regression model is based on R2 and if R2 is between 0.02 and 0.12 the model is weak, 0.13 and 0.25 moderate, and 0.26 and above are good [4].

Table 4: Hypothesis test results

Hyp	Path Connections	M	STDEV	T value	P value	Decision
H1	Energy use information(EB)->Energy effiency(EV)	0,688	0,189	3,325	0,001	Accept***
H2	Energy use information (EB)->Using Energy Properly (ED)	0,536	0,061	8,713	0	Accept ***
H3	Energy use information (EB)->Physical Environment(F)	0,278	0,161	1,639	0,102	Rejection
H4	Using Energy Properly (ED)-> Energy effiency (EV)	-0,174	0,108	1,532	0,126	Rejection
H5	Using Energy Properly (ED)-> Physical Environment (F)	-0,437	0,086	5,054	0	Accept ***
H6	Physical Environment -> Energy effiency (EV)	0,131	0,089	1,469	0,142	Rejection

The GoF measures have been proposed as core values for globally validating the PLS model [11; 12].The research model achieved a GoF of 0.43, which was rated as a GoF that was greater than the cut-off value of 0.36. These results indicate that this model performs well (Table 5).

Table 5: Global validation (GoF)

Scale	Endogenous Concealed Structure	Results
R^2	Energy effiencey	0,349
	Using energy properly	0,279
	Physical environment	0,138
GoF		0,438

3. Conclusion

As Turkey is dependent on foreign largely in terms of the use of primary energy to the country and is envisaged to increase steadily in the coming years in this case, the energy in an important input to the position of industrial production, efficient use is more important. Brought by the risks that occur in dependence on foreign energy, Turkey to be minimized, producing energy efficiently, it is necessary to transmit and consume. In our study, we accepted our hypotheses H1, H2 and H5, and rejected our H3, H4 and H6 hypothesis. Energy use information; energy efficient training, use of calorimeters, measurement of ambient temperature, use of intelligent valves and thermostats revealed a positive relationship between energy efficiency and energy use. Using energy properly; using energy saving, closing the ponds to reduce the ambient temperature when the weather is hot, and orienting to other energy sources in the cold piles are positively related to the physical environment. Energy efficiency; (such as the insulation of the energy consuming environment, the honeycomb sizes required for ideal temperature conditions, etc.), user information (such as automation and calorimetry system, thermometer, smart valve, use of thermostats and training of their use etc.), energy use to close the honeycomb, to follow the correct functioning of the system, etc.) has been proved to be positively related. Even if the physical environment provides adequate conditions for energy efficiency, it has proved that the efficiency alone is weak.

4. Discussion

Based on these factors in the district heating system projects to be made using geothermal energy, we propose that the design of the system should be prepared and the trainings to be given to the subscriptions should be determined. This is a proven set of propositions for reliability and validity. These factors have been proven to be important for the systems to be installed. Considering these factors, it is considered that a system that is established will enable the most efficient use.

5. Recommendations

It is recommended that this work be done in all municipalities using geothermal energy and natural gas. It is anticipated that this study will increase energy efficiency in municipalities by 30%. As a continuation of this work, predictions of energy needs of municipalities can be made with artificial intelligence. This work can also be recommended for other energy methods.

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