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EFFICIENCY ANALYSIS FACTOR DETERMINATION STUDY FOR ÇİTGÖL MUNICIPALITY REGIONAL HEATING SYSTEM PROJECT WITH GEOTHERMAL ENERGY

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ABSTRACT

A big amount of energy need is currently supplied with fossil-based energy products. The decrease in current depleted fossil energy sources and some environmental problems from several sources bring new and renewable energy sources up. Geothermal energy stands out as renewable, environmental, and non-foreign dependent energy source among these sources [Özkaya at all, 2008, pp:1-pp:18].

A survey on energy productivity of the regional heating system project performed in Çitgöl Municipality was conducted. This survey includes 30-questions totally. This survey was prepared in five point likert scale, and it was met face to face with 98-people to perform reliability analysis. Results were evaluated with SPPS program. Cronbach alpha value was reached-0.812 in the analysis performed with SPSS and it was obtained pretty reliable (good) level. As a result of committed factor identification studies, it was seen that 15-questions of 30-under four factors are meaningful after the results of committed analyses.Also, eigen value factor table data was investigated. Defined factors are as below; Factor 1:Energy usage information, Factor 2:Correct usage of energy, Factor 3:Physical environment, Factor 4:Efficient usage of energy. Data set line chart was investigated for these four meaningful factors, and it was observed that the scope between fourth and fifth factors was significantly lost. These factors explain-60,815 % of total variance. This survey study will be applied to 500-people in Çitgöl Municipality later, and PLS study will be performed based on defined factors and hypotheses. Thisarticlewaspresented as an oral presentation in "International Congress On Afro-EurasianResearch III,2017"

Keyword: Geothermal Energy, Çitgöl Municipality, Factor Analysis

1. INTRODUCTION

A big amount of required energy in the world is supplied with fossil-based energy products (coal, petrol, and natural gas) [Key World Energy Statistics,2012]. It emerged an issue of trust against these energy sources after 1973 petrol crisis [Gürbüz, 2009, pp:1-7]. After this crisis, the world countries tended towards new energy sources. At the same time, intensely created environmental pollution resulted from fossil sources has expedited this searching, as well. In

this period, energy sources that are actually known for a long time but has been pushed into background because of non-competing with fossil fuels have started to re-become important [Yılmaz, 2012, pp:33-54; Koçak, pp:217-233]. Turkey is among lucky countries with regards to geothermal energy, and it is ranged as third in the sorting of renewable energy sources and usage in our country. Turkey ranges as first in Europe with located 170 geothermal area, and existence of around 1000 thousand hot and mineral water source that lower temperature limits are accepted as 20^0C [Yılmaz, 2012, pp:33-54; Koç and Şenel,2013,pp:32-44]. From a different point of view, the effort of keeping our environment clean and leaving a livable world to next generations have urged people to find new, healthy, clean, and renewable energy sources. The one of these most important energy sources is geothermal energy.

One of geothermal energy usage areas is regional heating system in Turkey, as well. Geothermal regional heating applications are generally more productive than those performed with traditional energy sources (coal, petrol etc.). Conducted studies show that regional heating systems operated in our country can be work more efficiently [Şener, 2003]. Also, production cost of geothermal energy is lower than other energy sources. This cost falls more when integrated usages are discussed [Şimşek, 1999, pp. 2.; DPT Özel İhtisas Komisyonu Raporu, 2001, pp. 2.; Eltez, pp :1-2 (1997).; DPT "Jeotermal Enerji Çalışma Grubu Raporu", pp: 20, 26, 36, 38, 41-43, 45-46, 58-60 (2007).]. Geothermal energy is a boundless and renewable energy sources. Because water creating geothermal fluid is meteoric-based, reservoir rocks in underground is continuously fed, and exhaustion of this rocks are not possible as long as there is no over usage compared with feeding [MTA,1996, pp:1].

The most efficient method to provide energy productivity is energy conservation. Energy conservation can be described as minimizing energy necessity with using devices providing energy conservation under favour of preventing current energy losses without decreasing economic growth and progress, inhibiting social and economic level of welfare, reducing standards of life, and decreasing quality and performance [Çalıkoğlu, 2004, pp:59-64].

Energy productivity is a far-reaching concept that also includes energy conservation. Energy productivity involves production of energy sources, transmission, and consumption, and expresses the most efficient usage of energy in these stages. Studies that will be performed within the scope of energy productivity should be involved precautions for both consumer and supplier [İslatince, Haydaroğlu, 2009, pp:155].

Regions like Afyon-Sandıklı and Kütahya-Simav use geothermal energy for touristic purposes and heating purposes for a long time. Approximately 80 % of their population makes use of geothermal energy for heating. Regional heating project was performed in in Çitgöl Municipality subordinated Simav district, Kütahya city which has population around 4000 people more recently. A survey study was conducted to specify productivity analysis factor in this study.

When questions were prepared in survey study, and factors were specified in SPSS program, following criteria are considered:

In order to use geothermal energy productively, it's extremely important that consumers have energy variety and awareness of these energies cost, have energy usage information namely having information for right usage of energy, and have information about how physical environment that they use energy should become to provide the most proper conditions for the right usage of energy.

Knowledge of consumers about system components, automation, calorimeter, thermometer, smart valve, and thermostat for energy usage information has to be measured in energy usage.

As for right usage of energy, by knowing that the purpose is heating in geothermal energy, considering factors that might affect environment temperature negatively and understanding whether given service from service provider comes ideally or not are important for right usage of energy.

As for physical environment, it was aimed at measuring whether the place that energy is used satisfies the conditions or not. As a result of all these subjects, variables show up for energy productivity. We created rating scale by considering these conditions in our work when we improved our scale. Scale that we created is as below:

Following 5 questions to define education level;

ED1; Using energy economically contributes to national economy and my own budget,

ED2; The most productive way for heating is geothermal energy,

ED3; Application of energy productivity in public offices contributes to economy more,

ED4; Training for productive usage of energy is very beneficial,

ED5;Conscious consumers provide energy conservation better.

Following 5 questions to define physical environment;

F1; Energy productivity and conservation precautions were taken in our building,

F2; Our building was insulated for productivity and conservation,

F3; Calorimeter usage is truer for energy productivity,

F4; Thermometer usage is important for energy productivity,

F5; Usage of smart valve and thermostat is important for energy productivity.

Following 3 questions to define for seasonal effect;

M1; Decreasing air temperature affects my heating negatively,

M2; Heating with geothermal energy in cold weathers is better than heating with coal,

M3; I turn of heater cores instead of opening window to reduce environment temperature when the air weather is hot.

Following 5 questions to define price;

Fi1; Installing geothermal energy system to my building is more advantageous than heating with coal,

Fi2; Automation and calorimeter system pay for itself in 4-5 years,

Fi3; Maintenance of geothermal energy installment is lower-priced,

Fi4; Equipment costs used in geothermal system pay for itself in a short time.

Following 3 questions to define substructure quality;

A1; Substructure services provided by municipality is enough,

A2; Geothermal energy labor by municipality is enough,

A3; It is better if municipality performs geothermal managership.

Following 3 questions to define energy productivity;

EN1; Geothermal energy provides uninterrupted energy,

EN2; Heating with geothermal energy is more advantageous than heating with coal,

EN3; Using geothermal energy in public offices increases productivity.

We created our final scale (evaluation scales) by using subjects that have meaningful correlation amongst the numbers when we evaluated the result of pilot application performed with 30 surveys to factor analysis.

2. METHOD

2.1.Instrument and Data Collection

This study survey is a quantitative cross-sectional study that is used as a data collection tool. Therefore, a self-contained and well-structured survey was developed, and afterwards, it was distributed to consumers who switched to heating system with geothermal energy as a voluntary participation. Research period took place between July 1, 2017 and August 1, 2017. Finally, it was conducted survey study to totally 98 people according to final scale. Participant profile that participates in this survey was shown in Table 1, while survey results were shown Table 2.

Reliability analysis of survey with 98 response was performed in SPSS program. Cronbach alpha value was reached 0.812 in the analysis performed with SPSS and it was obtained pretty reliable (good) level. Hair et al. asserted that reliability of scale could be generally accepted if Cronbach alpha value is between 0,70-0,90 for every structure [Hair at all.,1998;Hair at all. 2012a. pp: 414-433.]. Also, eigen value factor table data was investigated, and it was detected four meaningful factors. Data set line chart was investigated for these four meaningful factors, and it was observed that the scope between fourth and fifth factors was significantly lost. This survey study will be applied to 500 people in Çitgöl Municipality later, and PLS study will be performed based on defined factors and hypotheses.

Table 1: Participant Profile

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

Table 2: Survey Results

M	1	%	2	%	3	%	4	%	5	%
ED1					3	3,1	11	11,2	84	85,7
ED2					6	6,1	11	11,2	81	82,7
ED3					5	5,1	11	11,2	82	83,7
ED4					4	4,1	31	31,6	63	64,3
ED5			1	1	4	4,1	9	9,2	84	85,7
F1	5	5,1	12	12,2	11	11,2			70	71,4
F2	16	16,3	7	7,1					75	76,5
F3			1	1,0	2	2,0	31	31,6	64	65,3
F4			1	1,0	2	2,0	31	31,6	64	65,3
F5			3	3,1	1	1,0	31	31,6	63	64,3
M1	58	59,2	10	10,2	20	20,4			10	10,2
M2			2	2,0	3	3,1	11	11,2	82	83,7
M3	11	11,2					9	9,2	78	79,6
Fi1			1	1,0	3	3,1	22	22,4	72	73,5
Fi2			1	1,0			20	20,4	77	78,6
Fi3			2	2,0	1	1,0	31	31,6	64	65,3
Fi4			2	2,0	2	2,0	9	9,2	85	86,7
A1					2	2,0	4	4,1	92	93,9
A2					2	2,0	5	5,1	91	92,9
A3			2	2,0	2	2,0	11	11,2	83	84,7
EN1			2	2,0	3	3,1	11	11,2	82	83,7
EN2					3	3,1	5	5,1	90	91,8
EN3	2	2,0	1	1,0	1	1,0	20	20,4	74	75,5

2.2. Measurement Model

2.2.1. Inter-Item Correlation Matrix

Table 3: Reliability Test Results Correlation Matrix

	Fi2	F4	F5	F3	E4	Fi1	m3	m2	A3	E1	A2	En2	E5	Fi3	En3
Fi2	1,000	0,395	0,315	0,395	0,398	0,455	-0,057	-0,014	-0,106	-0,183	-0,066	0,022	0,162	0,365	0,035
F4	0,395	1,000	0,541	0,489	0,491	0,421	0,450	0,206	0,148	0,171	0,025	0,032	0,039	0,450	0,170
F5	0,315	0,541	1,000	0,385	0,545	0,385	0,365	0,155	0,106	0,125	0,006	0,011	0,012	0,450	0,120
F3	0,395	0,489	0,385	1,000	0,491	0,300	0,450	0,322	0,148	0,171	0,025	0,119	0,039	0,450	0,170
E4	0,398	0,491	0,545	0,491	1,000	0,299	0,455	0,384	0,270	0,328	0,328	0,207	0,034	0,451	0,167
Fi1	0,455	0,421	0,385	0,300	0,299	1,000	0,378	0,108	0,133	0,218	0,057	0,023	-0,074	0,274	0,013
m3	-0,057	0,450	0,365	0,450	0,455	0,378	1,000	0,490	0,486	0,622	0,163	0,061	-0,027	0,417	0,383
m2	-0,014	0,206	0,155	0,322	0,384	0,108	0,490	1,000	0,296	0,262	0,043	0,060	0,009	0,187	0,188
A3	-0,106	0,148	0,106	0,148	0,270	0,133	0,486	0,296	1,000	0,288	0,154	0,117	-0,073	0,133	0,142
E1	-0,183	0,171	0,125	0,171	0,328	0,218	0,622	0,262	0,288	1,000	0,348	0,230	0,103	0,373	0,160
A2	-0,066	0,025	0,006	0,025	0,328	0,057	0,163	0,043	0,154	0,348	1,000	0,432	-0,096	0,160	0,116
En2	0,022	0,032	0,011	0,119	0,207	0,023	0,061	0,060	0,117	0,230	0,432	1,000	-0,057	0,149	0,079
E5	0,162	0,039	0,012	0,039	0,034	-0,074	-0,027	0,009	-0,073	0,103	-0,096	-0,057	1,000	0,300	0,056
Fi3	0,365	0,450	0,450	0,450	0,451	0,274	0,417	0,187	0,133	0,373	0,160	0,149	0,300	1,000	0,353
En3	0,035	0,170	0,120	0,170	0,167	0,013	0,383	0,188	0,142	0,160	0,116	0,079	0,056	0,353	1,000

Cronbach alpha method, which is a widespread method, was used to measure reliability of scale and internal consistency. Cronbach alpha value was 0.812, and it shows that 15 questions taking place in scale magnificently states the total showing a homogenous structure (Table 3). Hair et al. asserted that reliability of scale could be generally accepted if Cronbach alpha value is equal to 0,70 or higher for every structure [Hair at all.,1998;Hair at all. 2012a. pp: 414-433.].

2.3.Structural Model

2.3.1. Evaluation of Suitability of Data Set for Factor Analysis

In order to evaluate whether data set is suitable of not for factor analysis, Bartlett Test and Kaiser- Meyer- Olkin Test (KMO) were performed. KMO test is 72 % (0,727) in our study as

seen in Table 4. Barlett test is meaningful (Sig.) because it's higher than 0,50 (0.72>0.50). This shows that there are high correlations between variables [Kalaycı,2017, pp:122,153].

Table 4: Results of Bartlett Test and Kaiser – Meyer – Olkin (KMO) Test

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0,727
Bartlett's Test of Sphericity	Approx. Chi-Square	511,140
	Df	105
	Sig.	0,000

2.3.2. Determination of Factor Numbers of Data Set

We looked at factor analysis line graph to define factor numbers first. We specified factor at the number of that the point starting scope loss referred in factor analysis line graph in Figure 1. According to graph, line graph significantly starts to lose its scope as from 4th factor. Therefore, we can limit factor number as 4.

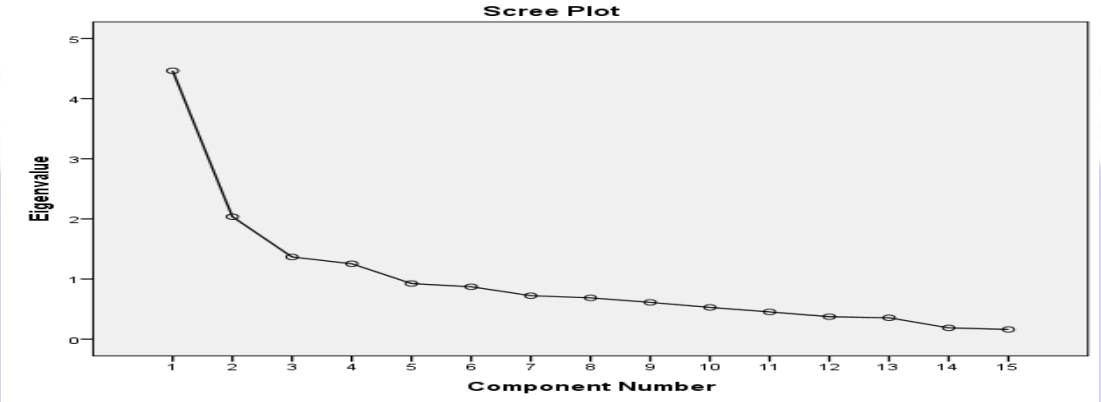

Figure1.Factor Analysis Line Graph

Right after, we specified factors that eigen values are higher than 1 as a meaningful in defining factor numbers. Factors that eigen values are higher than 1 are shown in Table 5. First factor explains 22,886 % of total variance. First and second factors explain 39,871 % of total variance while fourth factor explains 60, 815 % of total variance.

Table 5:Eigen Value Factor Table

	Total	% of Vari.	% Cum.	Total	%of Vari.	% Cum.	Total	% of Vari.	% Cum.
1	4,464	29,761	29,761	4,464	29,761	29,761	3,433	22,886	22,886
2	2,037	13,579	43,339	2,037	13,579	43,339	2,548	16,985	39,871
3	1,367	9,113	52,453	1,367	9,113	52,453	1,695	11,303	51,174
4	1,254	8,362	60,815	1,254	8,362	60,815	1,446	9,641	60,815
5	0,925	6,169	66,984						
6	0,872	5,810	72,794						
7	0,723	4,818	77,612						
8	0,687	4,581	82,194						
9	0,612	4,080	86,273						
10	0,528	3,521	89,794						
11	0,453	3,018	92,813						
12	0,374	2,492	95,305						
13	0,355	2,369	97,674						
14	0,188	1,252	98,926						
15	0,161	1,074	100,00						
16	4,464	29,761	29,761						

2.3.3. Rotation Stage

The purpose of rotation is to obtain interpretable meaningful factors. Rotated factor matrix is seen in Table 6. This matrix is the final result of factor analysis. It is seen correlations between original changeable and its factor in matrix. If a changeable has a big weight as an absolute value under which factor, there is affiliation between that changeable and that factor. Factor range has to be 0.30 or higher for data set. Weights over 0,50 or over are accepted as pretty good [Hair at all, 1998]. As a result of committed factor identification studies, it was seen that 15 questions of 30 under four factors are meaningful after the results of committed analyses. When it is looked at Table 6, four factors and weights of every changeable under factors were given (Factor loadings- Correlation coefficient between changeable and factors). In table 6, the biggest weight is seen under third factor and the row that A2 changeable is found.

Table 6: Rotated Component Matrix

	1	2	3	4
Fi2	0,750	-0,393	-0,012	0,152
F4	0,751	0,209	-0,036	0,089
F5	0,723	0,152	-0,028	0,048
F3	0,659	0,245	0,019	0,153
ED4	0,663	0,303	0,327	0,097
Fi1	0,677	0,114	0,029	-0,196
M3	0,352	0,839	0,059	0,112
M2	0,182	0,643	-0,070	0,059
A3	0,067	0,665	0,101	-0,137
ED1	0,051	0,621	0,399	0,233
A2	0,005	0,136	0,842	-0,027
EN2	0,047	-0,004	0,804	0,008
ED5	-0,015	-0,135	-0,096	0,823
Fi3	0,530	0,200	0,197	0,600
EN3	0,062	0,372	0,059	0,462

Cronbach Alpha formula from which is a internal consistency reliability coefficient was used on the purpose of specifying reliability of defined factors. Internal coefficient belongs to all scale was found as 0,812.

Table 7: Cronbach Alpha (α) Reliability Analysis Results of Defined Factors

	Cronbach's Alpha	N of Items	Mean	Variance	Std. Deviation
1	0,812	6	27,85	6,337	2,517
2	0,688	4	18,84	5,210	2,283
3	0,600	2	9,80	0,412	0,642
4	0,476	3	14,06	1,831	1,353

2.3.4. Nomenclature of Defined Factors

In order to be named factors, we classified factors that have big changeable under factor. Expressions collected under every group of factor wereexamined, and suggested factor names were shaped after receiving opinion from 2 separate area experts. It was specified Fi2, F4, F5, F3, E4, Fi1 substances as first factor, m3, m2, A3, E1 substances as second factor, A2, En2 substances as third factor, E5, Fi3, En3 substances as fourth factor. It was named Factor 1 as energy usage information, Factor 2 as right usage of energy, Factor 3 as physical environment, and Factor 4 as productive use of energy. After nomenclature stages, it was tested Pearson Correlation Coefficient to see relation between factors each other. First, points of substances were found by taking average value of deviation in each factor (variance) for this, and it was analyzed with obtained data. Pearson Correlation Coefficient is shown with R, and takes value between -1 and 1. If R is equal to -1, there is full negative linear relationship

between changeable, if R is equal to 1, there is full positive linear relationship, and if R is equal to 0, there is no relationship. Obtained data at the end of analysis shows relationship (Table 8) [Kalaycı,2017, pp:122,153].

Table 8: Pearson Correlation Coefficients

Correlations

	Fac1	Fac2	Fac3	Fac4
Fac1:Energy usage Information	1	,426**	0,108	,366**
Fac2:Right usage of energy	,426**	1	0,195	,357**
Fac3:Physical environment	0,108	0,195	1	0,110
Fck4:Productive usage of energy	,366**	,357**	0,110	1

**. Correlation is significant at the 0.01 level (2-tailed).

2.3.5. Evaluation of Defined Factors

Minimum, maximum, average, standard deviation, and variance of points taken from independent changeable constituting subscale of defined factors were presented in Table 9. When averages of points taken from scale of sample were evaluated; it is seen that energy usage information, right usage of energy, physical environment, and productive usage of energy are high. Therefore, we can tell that factors obtained in this study are useable factors in studies about energy productivity.

Table 9: Points of Factor Subscales

	N Statis.	Min. Statis.	Max. Statis.	Mean Statis.	Std. Dev. Statis.	Skewness Statis.	Kurtosis Statis.
Energy usage Information	98	3,83	5,00	4,6412	,41956	-,504	-1,544
Energy usage Information	98	3,25	5,00	4,7092	,57065	-1,929	2,242
Physical environment	98	3,00	5,00	4,8980	,32075	-3,856	16,520
Productive usage of energy	98	3,00	5,00	4,6871	,45108	-1,566	2,518

3. RESULTS and DISCUSSION

In this study, it was performed definition study of productivity analysis factor for Citgol municipality regional heating system project with geothermal energy. As a result of performed validity and reliability analyses, it was reached 4 factors composed 15 substances. Variance ratio explained by 4 factors in scale is 60,815 %. Defined factors are; Factor 1: energy usage information, Factor 2: right usage of energy, Factor 3: physical environment, and Factor 4: productive usage of energy. It was seen that there are positive and negative oriented relationship between these factors by testing Pearson Correlation Coefficient. As a result of performed analysis, it was seen that energy usage information affected right usage of energy and productive usage of energy as high and positive correlation, while it affected physical environment as positive correlation. Right usage of energy affects physical environment as positive correlation, while it affects productive usage of energy as pretty high correlation. Physical environment affects productive usage of energy as high positive correlation (Table 8).

Average of given answers to substances creating energy usage information factor is 4,64, and survey responders certainly agreed with that automation, calorimeter, thermometer, smart valve, and thermostat usage is important. Average of given answers to substances creating right usage of energy factor is 4,70, and survey responders certainly agreed with that cores should be turned off in hot weathers, geothermal energy is more economic, municipality

should operate managership, and geothermal energy contributes to national economy. Average of given answers to substances creating physical environment factor is 4,89, and survey responders stated in the way that they certainly agreed that services provided by municipality is enough and geothermal energy usage is economic. Average of given answers to substances productive use of energy factor is 4,68, and survey responders expressed in the way that they certainly agreed that consumers should be conscious, maintenance should be less and geothermal energy has to be used in public offices (Table 9).

As a result of conducted survey study, following basic factors shown up in energy productivity; consumer information (usage and usage education of automation and calorimeter system, thermometer, smart valve, thermostat etc.), right usage of energy (turn of heater cores instead of opening window, monitoring right usage of system etc.), physical environment (insulation of environment used energy, required heater cores size for ideal heating conditions etc.), productive usage of energy (conscious consumer, usage in public offices, well-kept installment etc.). This study is a suggestion set that its reliability and validness was demonstrated. Factors will be evaluated with structural equation modeling in future. It is thought that it will increase the success of system based upon findings. It is also thought that the system installed by considering these factors will make possible to the most efficient usage.

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