The effect of environmental concern on renewable energy attitude and usage intention : a case of Turkey

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Abstract

Energy use-related environmental and social concerns and problems have led to the development of renewable (RE) energy types such as wind, solar, hydraulic, and geothermal energy. Increasing environmental concerns, as well as public awareness and positive attitudes towards sustainable energy types, have played an important role in this development. The present study investigated the effects of the mentioned environmental concerns on the attitudes towards renewable energy and renewable energy usage intention with a proposed structural model. In the first part of the proposed model, the effect of environmental concerns on the awareness and perceived benefits of RE, and in the second part, the effect of awareness and perceived benefits of RE on the RE usage intention was examined. Structural Equation Modelling (SEM) was used to test the model. Regarding the fitness of the model, the chi-square value was calculated as 141.77, and the (χ^2/df) value as 2.36. Analysis results demonstrated that one unit increase in environmental concerns would increase awareness of RE by 0.63 and perceived benefits by 0.51 unit. It was also found that awareness of RE would increase the perceived benefits of RE and that especially the increase in awareness positively would affect RE usage intention.

Keywords Renewable Energy (RE), Environmental Concern, Awareness, Benefit, Structural Equation Model (SEM).

Introduction

Life is directly connected to the quality of the natural environment and the protection of natural resources. Environment and life are interdependent concepts. In the world's ecosystem, maintaining balance is a basic prerequisite for preserving life. Due to the increase in the production of technological goods (Lam et al., 2012), the intensification of agriculture (Ockenden et al., 2014), rapid urbanization, the intensity of transport, and the

enormous increase in demand for fossil fuels, environmental degradation and the impact of this degradation on human health is increasing day by day (Van Gent and Rietveld, 1993).

Air and environmental pollution caused by fossil fuels have many adverse effects on human life. To reduce the adverse effects of climate change, droughts threatening human life, forest fires, extreme precipitation events occurring at unexpected times, floods, and very harsh winters, it is necessary to radically reduce the share of fossil fuels in energy consumption and to turn to renewable energy types. According to the BP Statistical Review of World Energy 2019 report, the CO_2 value calculated on the basis of only coal, oil, and gas consumption in Turkey increased from 277.3 tons in 2008 to 390.2 tons in 2018. Turkey ranks 18th in the world in terms of the highest CO_2 emission (BP Statistical World Review of Energy, 2019).

Academic research in recent years has focused on the positive impact of environmental quality on human health. Pollution caused by the intensive use of fossil fuels causes adverse effects on human health and agricultural areas (Bhopal et al., 1988; Yang et al., 2002). People living in places near fossil fuel sources may be exposed to specific diseases due to the adverse effects of polluted air in the environment (Navarro-López et al., 2013). Cutchin et al. (2008) argue that "active industrial zones, especially power plants generating petrochemicals, lead to increased stress and diseases among people."

It is possible to define RE as "energy generated from natural resources and continuously replenished by natural processes." Renewable energy is extremely important in that it reduces countries' dependency on imports by meeting the energy needs with domestic natural resources, ensures sustainable energy use from various natural resources, and minimizes the environmental damage caused by energy consumption. Today, approximately 20 percent of global energy consumption is obtained from renewable resources. Although dependence on fossil fuels remains high in the current situation, the use of renewable energy has been increasing over the years (Australian Renewable Energy Agency, 2019).

Due to the increasing environmental problems caused by increasing energy demand and the risk of fossil fuel depletion, recent research has focused on energy management and renewable energy resources (International Energy Agency [IEA] 2019). Global RE generation capacity increased to approximately 2.738 GW. Of the total generated RE, approximately 55% was obtained from solar energy, 28% from wind energy, and 11% from hydroelectric energy (Renewables Global Status Report -REN21, 2019). Using renewable energy resources is of vital importance to secure the future of all humanity. The accumulation of carbon dioxide in Earth's atmosphere causes global warming. The resulting temperature rise will cause the climate to change, the melting of polar glaciers, the rise of sea levels, and consequently the flooding of fertile agricultural areas. The first step to be taken to prevent global warming is to reduce the use of fossil fuels and make the energy infrastructure suitable for using renewable energies (Çukurçayır and Sağır, 2008).

Despite significant advances in RE generation in recent years, Turkey's energy system still relies heavily on fossil fuels. This problem causes some other problems such as the depletion of fossil fuels, social, economic and environmental damages, and regional imbalance (Çelikler and Aksan, 2016). Therefore, it is necessary to design a sustainable energy system based on RE practices and to measure public awareness of and attitudes towards RE.

Studies have been conducted in many countries to investigate public awareness of and attitude towards RE usage. In a study conducted in the Greek municipality of Nikaia, Ntanos et al. (2018) investigated the factors shaping public opinion about RE resources and public awareness of RE resources. In the study, it was determined that the Greek public had positive attitudes towards RE systems. In addition, it was determined that there was a correlation between the perceived benefits of RE usage and the willingness to pay for RE. Kardooni et al. (2016) investigated the factors affecting RE technology acceptance in Malaysia. They found that renewable energy cost correlated with perceived ease of use and perceived benefits of RE and that perceived ease of use and perceived benefits correlated with renewable energy usage intention. Fornara et al. (2016) proposed and tested a model on the intention to use RE resources at the household level in Italy. As mentioned above, the acceptance of RE among the public can be increased through social studies to be designed. It is necessary to raise public awareness of the importance of RE and explain the benefits of using RE to people. After consultation with the public, it should be the task of relevant stakeholders to increase the acceptance of such energy policies (Van der Werff and Steg, 2015).

The present study investigated the effects of environmental concerns on the attitudes towards renewable energy and renewable energy usage intention with a proposed structural model. In the first part of the proposed model, the effect of environmental concerns on the awareness and perceived benefits of RE, and in the second part, the effect of awareness and perceived benefits of RE on the RE usage intention were examined. Structural Equation Modeling (SEM) was used to test the model.

Renewable Energy in Turkey

RE usage in Turkey has been increasing in recent years. As of the end of 2018, 37.3% of Turkey's total electricity generation was from coal, 29.8% from natural gas, 19.8% from hydraulic energy, 6.6% from wind energy, 2.6% from solar energy, 2.5% from geothermal energy, and 1.4% from other resources. The vast majority of generated RE is obtained from hydroelectric energy. On the other hand, although the proportion of modern RE resources such as wind and solar in total RE generation has increased over the years, they have yet to reach satisfactory levels. In the first half of 2019, Turkey's installed power was at 90.421 MW. Of the aggregate installed power by the first half of 2019, hydroelectric energy accounted for 31.4%, natural gas 29%, coal 22.4%, wind 8%, solar 6%, geothermal 1.5%, and other resources 1.7% (Republic of Turkey, Ministry of Energy and Natural Resources, 2019).

Turkey's theoretical hydroelectric potential is 1% of that of the world and its economic potential is 16% of that of Europe. The theoretical hydroelectric potential in Turkey is 433 billion kWh, the technically viable potential is 216 billion kWh, and the economically viable hydroelectric potential is 140 billion kWh/year. It is accepted in Turkey that 5 MW wind power plants can be established per square kilometer in areas 50 meters above ground level and with wind speeds above 7.5 m/s. In light of these assumptions, the Atlas for Potential Wind Energy (APWE), where information regarding wind sources can be obtained, has been developed using a medium-scale digital weather forecast model and a micro-scale wind flow model.

Turkey's wind energy potential has been determined as 48.000 MW. The total area where this potential is achieved corresponds to 1.30% of Turkey's total surface area. According to Turkey's Atlas for Solar Energy Potential (ASEP), total annual sunshine duration 2.741 hours (7.5 hours on average per day) while the average

annual solar radiation is 1.527 kWh/m2.year (with a daily average of 4.18 kWh/m².day) (Republic of Turkey, Ministry of Energy and Natural Resources, 2019).

Geothermal resources in Turkey have a wide range of usage. Today, geothermal energy obtained in Turkey is utilized in areas such as electricity generation, heating (greenhouse and housing), thermal and health tourism, industrial mineral mining, fishing, and drying. The first electricity generation with geothermal energy was begun by Kızıldere Power Plant with a power of 0.5 MW, which was established by the General Directorate of Mineral Research and Exploration (MTA) in 1975. The global installed capacity of geothermal energy as of the end of 2018 was 14.9 GWe. The five countries that generate the most electricity from geothermal energy are the USA, Philippines, Indonesia, Turkey, and New Zealand. The total direct usage of geothermal energy exceeded 70.000 MWt, and the top five countries in terms of direct usage applications are the USA, China, Sweden, Belarus, and Norway (Republic of Turkey Ministry of Energy and Natural Resources, 2019).

Renewable energy resources are sustainable clean energy resources which are alternative to fossil fuels. Successful energy planning requires public involvement in the planning process because people play a fundamental role in environmental protection, climate change mitigation, and RE usage. This study aimed to investigate the factors affecting the intention of the people living in three Turkish provinces, namely Ankara, Tekirdağ, and Eskişehir, to use renewable energy. Located in the Central Anatolia region, Ankara is the capital of Turkey with the second largest population. Turkey's first renewable energy high school is in Ankara. The environmentally friendly high school generates 80% of its annual energy consumption with its solar energy panels and wind turbine. The high school does not only generate most of its energy needs but also trains experts in solar energy and wind energy systems (Republic of Turkey, Governorship of Ankara, 2017).

Eskişehir ranked second in the "most livable Turkish cities" survey conducted by CNBC-E Business and Forbes magazines and was chosen as the 12th safest city in the world. Two of the districts in Eskişehir are Tepebaşı and Odunpazarı. Tepebaşı Municipality, which hit the headlines and attracted international attention with the value it attaches to the environment and its environmental studies, obtains 20% of its total electrical energy consumption from the sun. Tepebaşı Municipality is continuing its efforts to reduce carbon emissions, which was committed within the framework of the "Covenant of Mayors" signed in 2013. Tepebaşı Municipality, which conducted successful studies in two main categories, namely solar energy and transportation, and seven other fields within the scope of the covenant, has so far generated a total of 676 thousand 733 kWh of electricity from solar energy and reduced its CO2 emission by 473 thousand 713 tons (Tepebaşı Municipality, 2019).

Tekirdağ is a Turkish province located in the Thrace region. Thrace accounts for 4.5% of Turkey's total annual energy generation. The annual solar energy potential in Turkey is 380 gW. On the other hand, Tekirdağ has an average annual solar radiation of 1400-1450 kWh/m². Wind, solar, and biogas are at the forefront as renewable energy resources in the region. According to the data from the General Directorate of Renewable Energy, Malkara, Şarköy, Çerkezköy, and Çorlu districts of Tekirdağ have suitable areas for wind power plants. Within the scope of the "TESKİ ve Güneş El Ele Enerjide Verimliliğe" (TESKI and Solar Hand in Hand to Achieve Energy Efficiency) Project implemented by the General Directorate of Tekirdağ Water and Sewerage Administration (TESKİ), the first solar power plant in Thrace was established in Muratlı district. Within the scope of the project, 315 mW (Megawatt) of electricity is planned to be generated annually, a certain amount of

the electricity consumption costs will be covered, CO2 emission will be reduced by 56.5 tons, and 4,700 trees will be saved annually (Republic of Turkey, Tekirdağ Metropolitan Municipality, 2017).

As a result of the literature review, it was found that although studies have been conducted in Turkey to reveal public attitudes towards the usage of basic energy resources, not many studies have been conducted to explore public attitudes and intention towards renewable energy usage. In addition, a data collection tool on the attitudes towards renewable energy usage was developed in the study.

Methods

This part of the study contains information about the research model, hypotheses, sampling, development of data collection tool, data collection, and some analyses. The research process is explained in the paragraphs below.

Hypotheses

The research model proposed in the study was formed based on the literature (Rezai and Ghofranfarid, 2018; Fornara et al., 2016; Çelikler and Aksan, 2016; Alam et al., 2014; Huijts et al., 2012).

Environmental Concern-Awareness and Perceived Benefits*:*

In recent years, various researchers and experts have proposed many theories and models to investigate people's behavioral intentions and identify socio-psychological factors that affect them (Martins et al., 2014; Irfan et al., 2020). Environmental concerns, destructive effects of fossil fuels (especially air pollution, climate change, biodiversity loss, destruction of agricultural lands, etc.), the sense of responsibility for environmental protection, and the sense of moral obligation have affected people's awareness of renewable clean energy resources (Huijts et al., 2012; Fornara et al., 2016; Irfan et al., 2020). Likewise, energy-related environmental and social issues have led to the development of sustainable energy technologies such as windmills, carbon capture and storage, and hydrogen cars, and positively affected the perceived benefits of RE. For example, given how important the climate change problem is, the idea that a technology that reduces CO2 emissions is beneficial for the environment has increased the perceived benefits of renewable energy resources (Huijts et al., 2012). In light of all this information, H_1 and H_2 have been proposed:

H_1: Environmental concern has a positive effect on the awareness of RE.

H_2: Environmental concern has a positive effect on the perceived benefits of RE.

Awareness-Perceived Benefits and Behavioral Intention:

According to the results of various studies, the awareness of the use of renewable energy has a direct impact on the behavioral intention to use renewable energy resources (Fornara et al., 2016; Kardooni, 2016; Irfan et al., 2020; Irfan et al., 2021). Awareness of the use of renewable energy means being aware of existing renewable energy technologies and knowing about their benefits, drawbacks, and how to use them. Indeed, the more people know about renewable energy, the more they know about its benefits, and the more willing they are to use it (Rezaei and Ghofranfarid, 2016; Fornora et al., 2016; Alam et al., 2014). Alam et al. (2014) state that the lack of awareness is the main negative factor affecting the purpose of using renewable energy. Insufficient knowledge of

the use of renewable energy in the developing world can negatively affect the acceptance of new energy resources. In light of all this information, H_3 and H_4 have been proposed:

H_3: As the awareness of RE increases, the perceived benefits of RE increase.

H_4: As the awareness of RE increases, RE usage intention increases.

Perceived benefit is an important factor enabling people to accept new technologies (Siegrist, 1999, 2000; Siegrist et al., 2007; Tanaka, 2004). In most of the studies, perceived benefits emerged as an important determinant of acceptance of a technology (Tanaka, 2004; Bickerstaff et al., 2008; Pidgeon et al., 2008; Spence et al., 2010; Visschers et al., 2011). This is because the energy supply is directly related to people's everyday lives. For example, people need electricity every day and use it for heating in winter (Visschers et al., 2011). Typically, people seek innovations that are relatively inexpensive, easy to use, and will provide more advantages for them in the future (Ahmad et al., 2014; Irfan et al., 2020). Therefore, the results of various studies demonstrate that the perceived benefits of renewable energy usage are one of the best predictive variables that directly affect behavioral intention (Afsharzade et al., 2016; Alam et al., 2014; Alam et al., 2011). In light of all this information, **H_5** has been proposed regarding the relationship between perceived benefits and behavioral intention:

H_5: As the perceived benefits of RE benefit increases, RE usage intention increases.

The research model

As shown in Figure 1, the model proposed in this study is composed of an exogenous latent variable (B: Environmental concern) and three endogenous latent variables (C: awareness of RE; D: Renewable energy benefit perception; E: Intention to use renewable energy).

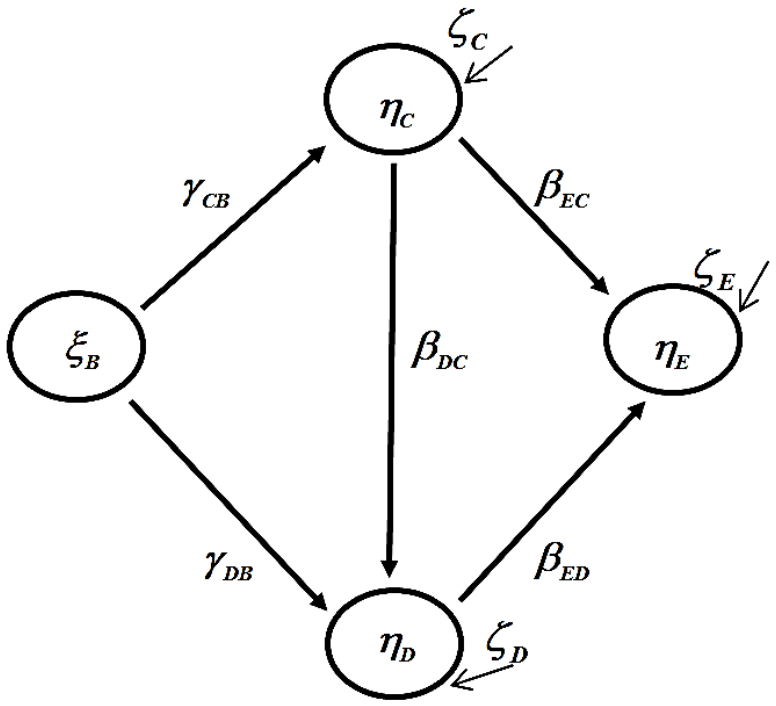

Figure 1. Proposed Research Model

B: Environmental Concern; C: Awareness of renewable energy; D: Perceived Benefit of renewable energy; E: Intention to use of renewable energy

The explanations of the notations used in the research model and SEM given in Figure 1 are given below.

Nomenclature

Symbol	Definition
η	Endogenous latent variable
ξ	Exogenous latent variable
ζ	Error term for endogenous latent variable
y	Observed variables of endogenous latent variable
x	Observed variables of exogenous latent variable
ε	Error term of observed variables of endogenous latent variables
δ	Error term of observed variables of exogenous latent variables
B	The coefficients matrix between endogenous latent variables
Γ	The coefficients matrix between exogenous latent variables

Λy	Matrix of the observed variables for endogenous latent variables
Λx	Matrix of the observed variables for exogenous latent variables
γ_{ij}	Direct influence of exogenous latent variable on endogenous latent variable
β_{ij}	Direct influence of endogenous latent variable on endogenous latent variable

The symbols in Figure 1 are defined below.

About Model, ξ_B : Environmental Concern, η_C : Awareness, η_D : Benefit, and η_E : Intention, ζ_C , ζ_D and ζ_E Error terms to Awareness, Benefit and Intention. γ_{CB} : The direct effect on Awareness of Environmental Concern, γ_{DB} : The direct effect on Benefit of Environmental Concern, β_{DC} : The direct effect on Benefit of Awareness, β_{EC} : The direct effect on Intention of Awareness, β_{ED} : The direct effect on Intention of Benefit.

Matrix representation and structural equations of the structural model are shown in detail in equation 1-6.

Structural equation

$$\eta = B\eta + \Gamma\xi_A + \zeta \tag{1}$$

$$\begin{bmatrix} \eta_C \\ \eta_D \\ \eta_E \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 \\ \beta_{DC} & 0 & 0 \\ \beta_{EC} & \beta_{ED} & 0 \end{bmatrix} \begin{bmatrix} \eta_C \\ \eta_D \\ \eta_E \end{bmatrix} + \begin{bmatrix} \gamma_{CB} \\ \gamma_{DB} \\ 0 \end{bmatrix} \begin{bmatrix} \xi_B \end{bmatrix} + \begin{bmatrix} \zeta_C \\ \zeta_D \\ \zeta_E \end{bmatrix} \tag{2}$$

Measurement equations:

$$y = \Lambda_y \eta + \varepsilon \tag{3}$$

$$\begin{bmatrix} C29 \\ C25 \\ C33 \\ D18 \\ D19 \\ D22 \\ E9 \\ E16 \\ E23 \end{bmatrix} = \begin{bmatrix} \lambda^{y}_{C29} & 0 & 0 \\ \lambda^{y}_{C25} & 0 & 0 \\ \lambda^{y}_{C33} & 0 & 0 \\ 0 & \lambda^{y}_{D18} & 0 \\ 0 & \lambda^{y}_{D19} & 0 \\ 0 & \lambda^{y}_{D22} & 0 \\ 0 & 0 & \lambda^{y}_{E9} \\ 0 & 0 & \lambda^{y}_{16} \\ 0 & 0 & \lambda^{y}_{23} \end{bmatrix} \begin{bmatrix} \eta_C \\ \eta_D \\ \eta_E \end{bmatrix} + \begin{bmatrix} \varepsilon_{C29} \\ \varepsilon_{C25} \\ \varepsilon_{C33} \\ \varepsilon_{D18} \\ \varepsilon_{D19} \\ \varepsilon_{D22} \\ \varepsilon_{E9} \\ \varepsilon_{E16} \\ \varepsilon_{23} \end{bmatrix} \tag{4}$$

$$x = \Lambda_x \xi + \delta \tag{5}$$

$$\begin{bmatrix} B12 \\ B17 \\ B21 \\ B27 \end{bmatrix} = \begin{bmatrix} \lambda^{x}_{B12} \\ \lambda^{x}_{B17} \\ \lambda^{x}_{B21} \\ \lambda^{x}_{B27} \end{bmatrix} \left[\xi_B \right] + \begin{bmatrix} \delta_{B12} \\ \delta_{B17} \\ \delta_{B21} \\ \delta_{B27} \end{bmatrix} \tag{6}$$

Data Collection and Sampling

The data collection tool used in the study consists of two parts: demographic information and attitudes towards RE. The demographic information section part contains questions about the gender and educational background of the respondent. The second part contains statements related to attitudes towards RE. These statements are measured on a 5-point Likert type scale (1-Strongly Disagree, 2-Slightly Agree, 3-Moderately Agree, 4-Strongly Agree, 5- Totally Agree). The data collection tool was formed by utilizing the studies of Arslan et al. (2012), Ahmed et al. (2014) and Rezai and Ghofranfarid (2018). The questionnaire was applied to 284 people living in Eskişehir, Ankara, and Tekirdağ provinces in Turkey through face-to-face interviews in May 2019. The model for attitudes towards RE in the data collection tool consists of four factors: Environmental Concern, Awareness of RE, Perceived Benefits of RE, and Intention to use RE.

Results

Of the respondents, 49.3% (f=140) were female and 50.7% were male (f=144). 3.2% (f = 9) were primary school graduates, 1.4% (f = 4) secondary school graduates, 22.5% (f = 64) high school graduates, and 72.9% (f = 207) university graduates.

Prior to structural equation modeling analysis, for the selection of the appropriate parameter estimation method to be used in SEM, it was tested whether the data were suitable for multivariate normal distribution. Since the chi-square value was calculated as 1179.514 ($p < 0.01$), it was concluded that the data set was not

suitable for multivariate normal distribution. Therefore, the robust maximum likelihood (Robust ML) method was used as the parameter estimation method. Figure 2 presents the standardized parameter estimates of the research model.

Table 1 presents the factors of the research model, the construct validity (CV) of the factors, standard loads, and R^2 values. Figure 2 presents the path diagram obtained from the data analysis, and Table 2 presents hypothesis test results and structural equations related to the model. Regarding the fitness of the model, Root Mean Square Error of Approximation (RMSEA) value was calculated as 0.069, Comparative Fit Index (CFI) value as 0.97, Fit Index Normed Fit Index (NFI) as 0.95, Incremental Fit Index (IFI) as 0.97, χ^2 value as 141.77, the Standardized RMR value as 0.06, and χ^2/df 141.77/60=2.36. When the results of the proposed models are examined, it can be said that the research model is within acceptable limits.

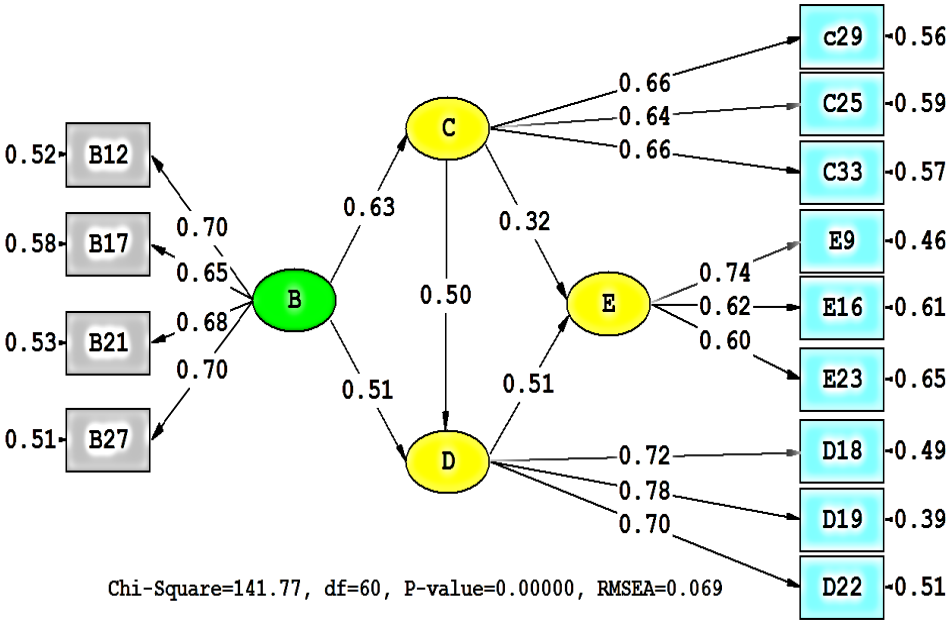

Figure 2. Path Diagram for Renewable Energy Use Model (LISREL8.80 Output)

B*: Environmental Concern*; ***C:*** *Awareness of renewable energy;* ***D:*** *Perceived Benefit of renewable energy;* ***E:*** *Intention to use of renewable energy*

As can be inferred from Figure 2, a one-point increase in the environmental concern exogenous variable results in a 0.63-point increase in the awareness of RE and a 0.51-point increase in the perceived benefits of RE. Also, a statistically significant positive relationship (0.50) was found between the awareness of RE and the perceived benefits of RE, which are the endogenous latent variables of RE. This value indicates that a one-point increase in the awareness of RE results in a 0.50-point increase in the perceived benefits of RE. In addition, a positive relationship (0.32) was found between the awareness of RE and RE usage intention. This value indicates that a one-point increase in the awareness of RE results in a 0.32-point increase in RE usage intention. Finally, a positive relationship (0.51) was found between the perceived benefits of RE and RE usage intention. It was determined that a one-point increase in the perceived benefits of RE results in a 0.51-point increase in RE usage intention.

Table 1. Factors, Standardized Factor Loads and Error Variances of the Research Model

Factors	Items	Standard Loading	R^2
Environmental concern(B): *CR=0.78*	B12: It annoys me that factory wastes cause environmental pollution.	0.70***	0.48
	B17: I'm concerned about the effects of air pollution on me and my family .	0.65***	0.42
	B21: The thought of not leaving a clean world to future generations worries me.	0.68***	0.47
	B27: I am afraid that environmental pollution will drag the world into an uninhabitable environment.	0.70***	0.49
Awareness (C): *CR=0.70*	C25:I am aware of the benefits of renewable energy	0.64***	0.41
	C29: Renewable energy reduces greenhouse gases.	0.66***	0.44
	C33: I can easily describe renewable energy.	0.66***	0.43
Benefit (D): *CR=0.78*	D18: The use of renewable energy provides benefits in reducing environmental problems.	0.72***	0.51
	D19: Given the high cost and polluting nature of fossil fuels (such as oil, natural gas, and coal), I believe it is extremely smart to use renewable energy.	0.78***	0.61
	D22: Renewable energy reduces air pollution.	0.70***	0.49
Intention (E): *CR=0.70*	E9 If I have a house, I can consider using renewable energy systems to meet my home's electricity needs.:.	0.74***	0.54
	E16: I use renewable energy, even though renewable energy is relatively expensive.	0.62***	0.39
	E23: I will use renewable energy even if the installation cost is high.	0.60***	0.35

*** p<0,01.

Table 2. Results of hypotheses

Hipotezler	Flow direction	Estimated of standardized parameters	Conclusion
H_1	B→C	0.63***	Supported
H_2	B→D	0.51***	Supported
H_3	C→D	0.50***	Supported
H_4	C→E	0.32***	Supported
H_5	D→E	0.51***	Supported

$$\eta_C = \gamma_{CB}\xi_B + \zeta_C = 0.63\xi_B + 0.60 \qquad R_C^2 = 0.40$$

$$\eta_D = \gamma_{DB}\xi_B + \beta_{DC}\eta_C + \zeta_D = 0.51\xi_B + 0.50\eta_C + 0.16 \qquad R_D^2 = 0.34$$

$$\eta_E = \beta_{EC}\eta_C + \beta_{ED}\eta_D + \zeta_E = 0.32\eta_C + 0.51\eta_D + 0.38 \qquad R_E^2 = 0.62$$

It can be inferred from Table 2 that all hypotheses are supported. As can be inferred from R^2 values, environmental concern explains 40% of the variance in the awareness of RE. Likewise, 84% of the variance in the perceived benefits of RE is explained by the variables of environmental concern and the awareness of RE. Finally, 62% of the variance in RE usage intention is explained by the variables of the awareness of RE and the perceived benefits of RE.

Conclusion and Discussion

Energy use-related environmental and social concerns and problems have led to the development of renewable (RE) energy types such as wind, solar, hydraulic, and geothermal energy. Increasing environmental concerns, as well as public awareness and positive attitudes towards sustainable energy types, have played an important role in this development. The present study investigated the effects of the mentioned environmental concerns on the attitudes towards renewable energy and renewable energy usage intention with a proposed structural model. In the research model, environmental concern was used as the exogenous latent variable and the awareness of RE, perceived benefits of RE, and RE usage intention were used as endogenous latent variables.

In the study, a positive relationship was found between environmental concern and the awareness of RE, and the relevant hypothesis was supported. Accordingly, as people's environmental concerns increase, their awareness of RE (as indicated by the statements of "Renewable energy reduces greenhouse gas," "I am aware of the benefits of renewable energy," and "I can easily define renewable energy") increases.

Also, a positive relationship was found between environmental concern and perceived benefits of RE, and the relevant hypothesis was supported. Accordingly, as people's environmental concerns increase, perceived benefits of RE (as indicated by the statements of "The use of renewable energy is effective in reducing environmental problems," "Given the high cost and polluting nature of fossil fuels (e.g. oil, natural gas, and coal), I believe it is extremely wise to use renewable energy," and "Renewable energy reduces air pollution") increase.

In addition, a positive relationship was found between the awareness of RE and the perceived benefits of RE, and the relevant hypothesis was supported. Accordingly, as people's awareness of RE increases, the perceived benefits of RE increase.

Besides, a positive relationship was found between the awareness of RE and RE usage intention, and the relevant hypothesis was supported. Accordingly, as people's awareness of RE increases, their intention to use RE (as indicated by the statements of "If I buy a house, I might consider using renewable energy systems to meet the electricity needs," "I use renewable energy, even though it is relatively expensive," and "I will use renewable energy even if the installation cost is high") increases. Finally, a positive relationship was found between the perceived benefits of RE and RE usage intention, and the relevant hypothesis was supported. Accordingly, as the public's perceived benefits of RE increase, their RE usage intention increases.

The literature review also yielded similar findings. In the study, a correlation coefficient value of 0.51 was found between the perceived benefits of RE →RE usage intention, and a correlation coefficient value of 0.32 was obtained between the awareness of RE →RE usage intention. Likewise, in a study investigating Jordanian middle school teachers' attitudes towards renewable energy usage with SEM, Rezai and Ghofranfarid (2018)

obtained a correlation coefficient value of 0.22 between the perceived benefits of RE →RE usage intention, and a correlation coefficient value of 0.45 between the awareness of RE →RE usage intention. Mirza et al. (2009) state that higher awareness levels enable users to make informed decisions and also increase the level of technology acceptance among people. The awareness variable has the most direct impact on RE usage intention (Alam et al., 2014). Our results indicate that as the awareness of RE and perceived benefits of RE increase, RE usage intention increases. The opposite is also true.

In a study investigating renewable energy usage intention at the household level with SEM, Fornara et al. (2016) reported a 0.15-unit positive relationship between the awareness of RE → behavioral attitudes. Ahmad et al. (2014) and Alam et al. (2011) state that when renewable energy users are faced with an innovation/technology, it is extremely important to make decisions by evaluating the benefits and costs of using technology compared to other technologies and by taking different aspects into account.

In a study investigating the intention to use renewable energy resources with SEM, Kardooni et al. (2016) found a statistically significant positive relationship between the awareness of RE and perceived benefits of RE. The said study also found a positive relationship between the perceived benefits of RE and renewable energy usage intention. Their results are consistent with the results of our study.

Hujits et al. (2012) state that environmental concerns and destructive effects of fossil fuels have affected people's awareness of renewable clean energy resources. The present study also found that environmental concerns have a positive effect on the awareness of RE and the perceived benefits of RE.

It was also determined in the study that the perceived benefits of RE have a mediating effect on the relationship between environmental concerns and RE usage intention. This indirect positive effect (B→D→E) was found to be statistically significant (0.68). The resulting indirect effect has the highest coefficient in the model. According to this finding, individuals with environmental concerns and a high level of perceived benefits of RE are more determined to use RE. It is recommended to carry out information and training activities to raise the level of environmental concern among people, to increase RE usage intention among the public, and to turn attitudes into behaviors.

In order to eliminate the adverse consequences of climate change and to protect fertile agricultural lands, emphasis can be placed on new and renewable energy resources, rather than on fossil fuels, in energy production. For a democratic energy plan and program that is in the public interest, integrated resource planning can be performed in the sector. It is thought that this planning, which will protect the public benefit, can only be carried out through democratic participation mechanisms by the wise selection of energy production resources, prioritizing renewable energy resources, the examination of energy consumption trends, concentration on demand-side management practices, more efficient use of energy, domestic production of energy equipment, minimizing the damage to the environment, reducing the adverse effects that cause climate change, and protection of the rights and interests of the people living where renewable energy investments are made.

Further research can include antecedent factors that may influence environmental concerns and RE behavioral factors in the models to be formed.

Reference

Afsharzade N, Papzan A, Ashjaee M, Delangizan S, Van Passel S, Azadi H (2016) Renewable energy development in rural areas of Iran. Renewable and Sustainable Energy Reviews, 65: 743-755

Ahmad A, Rashid M, Omar NA, Alam S (2014) Perceptions on renewable energy use in mediating role of attitude: mediating role of attitude. Jurnal Pengurusan, 41: 123-131

Alam S, Ali Y, Jani M (2011) An empirical study of factors affecting electronic commerce adoption among SMEs in Malaysia. J. Business. Economics and Management 12: 375-399

Alam S, Hashim N, Rashid M, Omar N, Ahsan NM.(2014) Ismail, Small-scale households' renewable energy usage intention: theoretical development and empirical settings. Renewable Energy, 68: 255-263

Australian Renewable Energy Agency, (2019) Access adress: https://arena.gov.au/renewable-energy-technologies/. Access date: 03.08.2019.

BP Statistical World Review of Energy, (2019) World Primary Energy Consumption By Resources (Million TEP; %), 2017. Access adress: https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2019-full-report.pdf. Access date:04.09.2019.

Bhopal R, Moffatt S, Pless-Mulloli T, Phillimore P, Foy C, Dunn C, Tate J (1988) Does living near a constellation of petrochemical, steel and other industries impair health? Occup. Environ. Med., 55: 812–822

Bickerstaff K, Lorenzoni I, Pidgeon NF, Poortinga W, Simmons P (2008) Reframing nuclear power in the UK energy debate: nuclear power, climate change mitigation and radioactive waste. Public Understanding of Science. 17: 145–169

Cutchin MP, Remmes MK, Owen SV, Goodwin JS (2008) Concern about petrochemical health risk before and after a refinery explosion. Risk Analysis, 28: 598–601

Çelikler D, Aksan Z (2019) The development of an attitude scale to assess the attitudes of high school students towards renewable energy sources. Renewable and Sustainable Energy Reviews 54: 1092-1098

Çukurçayır MA, Sağır H (2008) Energy Problem, Environment and Alternative Energy Sources. Selcuk University Institute of Social Sciences Journal, 20: 257-278

Fornara F, Pattitoni P, Mura M, Strazzera E (2016) Predicting intention to improve household energy efficiency: the role of value-belief- norm theory, normative and informational influence, and specific attitude. Journal of Environmental Psychology, 45: 1–10 https://doi.org/10.1016/j.jenvp.2015.11.001.

Huijts NM, Molin, EJ, Steg L (2012) Psychological factors influencing sustainable energy technology acceptance: a review-based comprehensive framework. Renewable and Sustainable Energy Reviews, 16: 525-531

Intertnational Energy Agency (IEA), (2019). Access adress: https://www.iea.org/newsroom/news/2019/. Access date: 02.09.2019.

Irfan M, Zhao ZY, Li H, Rehman A (2020) The influence of consumers' intention factors on willingness to pay for renewable energy: a structural equation modeling approach. Environmental Science and Pollution Research, 27: 21747–21761.

Irfan M, Zhao ZY, Rehman A, Oztürk I, Li H (2021) Consumers' intention-based influence factors of renewable energy adoption in Pakistan: a structural equation modeling approach. Environmental Science and Pollution Research, 28:432–445

Kardooni R, Binti Yusoff S, Binti Kari F (2016) Renewable energy technology acceptance in peninsular Malaysia. Energy Policy, 88: 1 -10

López-Navarro MÁ, Llorens-Monzonís J, Tortosa-Edo V (2013) The Effect of Social Trust on Citizens' Health Risk Perception in the Context of a Petrochemical Industrial Complex. International Journal of Environmental Research and Public Health, 10: 399-416

Martins C, Oliveira T, Popovic A (2014) Understanding the Internet banking adoption: a unified theory of acceptance and use of technology and perceived risk application. International Journal of Information Management, 34: 1-13

Ntanos S, Kyriakopoulos G, Chalikias M, Arabatzis G, Skordoulis, M (2019) Public perceptions and willingness to pay for renewable energy: A Case Study from Greece. Sustainability, 10: 687 doi:10.3390/su10030687.

Ockenden CM., Deasy C, Quinton JN, Surridge B, Stoate C (2014) Keeping agricultural soil out of rivers: Evidence of sediment and nutrient accumulation within field wetlands in the UK. Journal of Environmental Management, 135: 54–62

Pidgeon NF, Lorenzoni I, Poortinga W (2008) Climate change or nuclear power—No thanks! A quantitative study of public perceptions and risk framing in Britain. Global Environmental Change, 18: 69–85

Renewables Global Statüs Report -REN21, (2019). Access adress: https://www.ren21.net/reports/global-status-report/. Access date: 10.10.2019

Rezaei R, Ghofranfarid R (2018) Rural households' renewable energy usage intention in Iran: Extending the unified theory of acceptance and use of technology. Renewable Energy, 122: 382-391

S Arslan T, Yilmaz V, Aksoy HK (2012) Structural Equation Model for Environmentally Conscious Purchasing Behavior. Int. J. Environ. Res., 32(1): 323-334. DOI: 10.22059/IJER.2011.498

Siegrist M (1999) A causal model explaining the perception and acceptance of gene technology. Journal of Applied Social Psychology, 29: 2093–2106

Siegrist M (2000) The influence of trust and perceptions of risks and benefits on the acceptance of gene technology. Risk Analysis, 20: 195–203

Siegrist M, Cousin ME, Kastenholz H, Wiek A (2007) Public acceptance of nanotechnology foods and food packaging: the influence of affect and trust. Appetite, 49: 459–466

Spence A, Poortinga, W, Pidgeon N, Lorenzoni I (2010) Public perceptions of energy choices: the influence of beliefs about climate change and the environment. Energy & Environment, 21 (5): 385-407

Tanaka Y (2004) Major psychological factors determining public acceptance of the siting of nuclear facilities. Journal of Applied. Social. Psychology, 34: 1147–1165

Republic of Turkey, Ministry of Energy and Natural Resources, (2019) Access adress: https://www.enerji.gov.tr/tr-TR/Sayfalar/Elektrik. Access date: 01.07.2019

Republic of Turkey, Ministry of Energy and Natural Resources.(2019). Access adress : https://www.enerji.gov.tr/tr-TR/Sayfalar/Jeotermal https://www.enerji.gov.tr/tr-TR/Sayfalar/Gunes. Access date: 02.07.2019

Republic of Turkey, Ministry of Energy and Natural Resources (2019) Access adres: https://www.enerji.gov.tr/tr-TR/Sayfalar/Jeotermal. Access date: 02.07.2019

Ankara Governorship (2017) Access adress: https://ankara.meb.gov.tr/www/turkiyenin-ilk-yenilenebilir-enerji-lisesi-acildi/icerik/1062. Access date: 02.07.2019

Tepebaşı Municipalit (2019) Access address: http://www.tepebasi.bel.tr/hd.asp?hid=8491. Access date: 3.07.2019

Tekirdağ Metropolitan Municipality (2017) The First Solar Power Plant in Thrace was Established in Tekirdağ. Access address: http://www.tekirdag.bel.tr/haber/15400. Access date: 04.07.2019

Woldeyohannes A, Woldemichae DA (2016) Baheta, Sustainable renewable energy resources utilization in rural areas. Renewable and Sustainable Energy Reviews, 66: 1-9

Van der Werff E, Steg L (2015) One model to predict them all: predicting energy behaviours with the norm activation model. Energy Research & Social Science, 6: 8-14

Van Gent HA, Rietveld P (1993) Road transport and the environment in Europe. Science of The Total Environment, 129: 205–218

Visschers VHM., Keller C, Siegrist M (2011) Climate change benefits and energy supply benefits as determinants of acceptance of nuclear power stations: Investigating an explanatory model. Energy Policy, 39: 3621–3629

Yang HY, Chiu HF, Tsai SS, Chang CC, Chuang HY (2002) Increased risk of pretermdelivery in areas with cancer mortality problems from petrochemical complexes. Environ. Res. Section A, 89: 195–200

Declarations

Consent to participate

At the beginning of the questionnaire, the participant was asked if he / she participated in the study voluntarily. The voluntary participation form was marked.

Consent for publication

The article titled "**The effect of environmental concern on renewable energy attitude and usage intention : a case of Turkey**" has not been published in any journal, and all rights of publication belong to Environmental Science and Pollution Research

Ethics Approval

T.C.
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Sorumlu Araştırmacısı olduğunuz ***"Üniversite Öğrencilerinin Yenilenebilir Enerji Kullanma Niyeti : Tutumun Aracılık Rolü"*** başlıklı çalışma hakkında alınan karar ilişikte gönderilmektedir.

Bilgilerinizi ve gereğini saygı ile rica ederim.

Prof. Dr. Eyüp ARTVİNLİ
Kurul Başkanı

BU BELGE ELEKTRONİK İMZALI ASLI İLE AYNIDIR.
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Competing Interest

No competing interest

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Authors Contributions

V YILMAZ: He is analyzed the article. He's an expert in structural eqaution modeling analysis. It is also contributed metot and design of article.

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Highlights

The present study investigated the effects of environmental concerns on the attitudes towards renewable energy.

In the first part of the proposed model, the effect of environmental concerns on the awareness and perceived benefits of RE, and in the second part, the effect of awareness and perceived benefits on the RE usage intention were examined.

Structural Equation Modeling (SEM) was used to test the model.

Figures

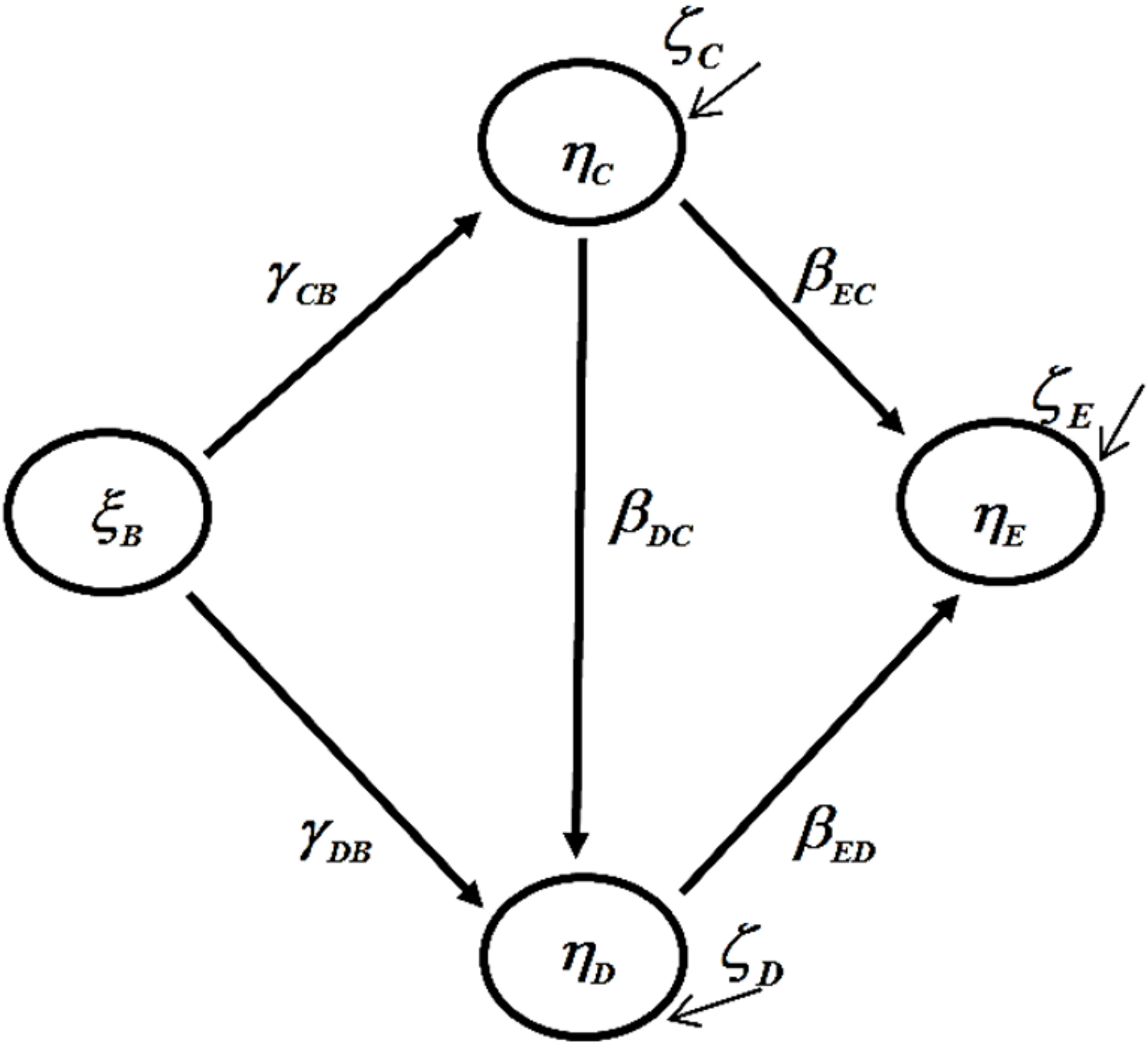

Figure 1

Proposed Research Model. B: Environmental Concern; C: Awareness of renewable energy; D: Perceived Benefit of renewable energy; E: Intention to use of renewable energy

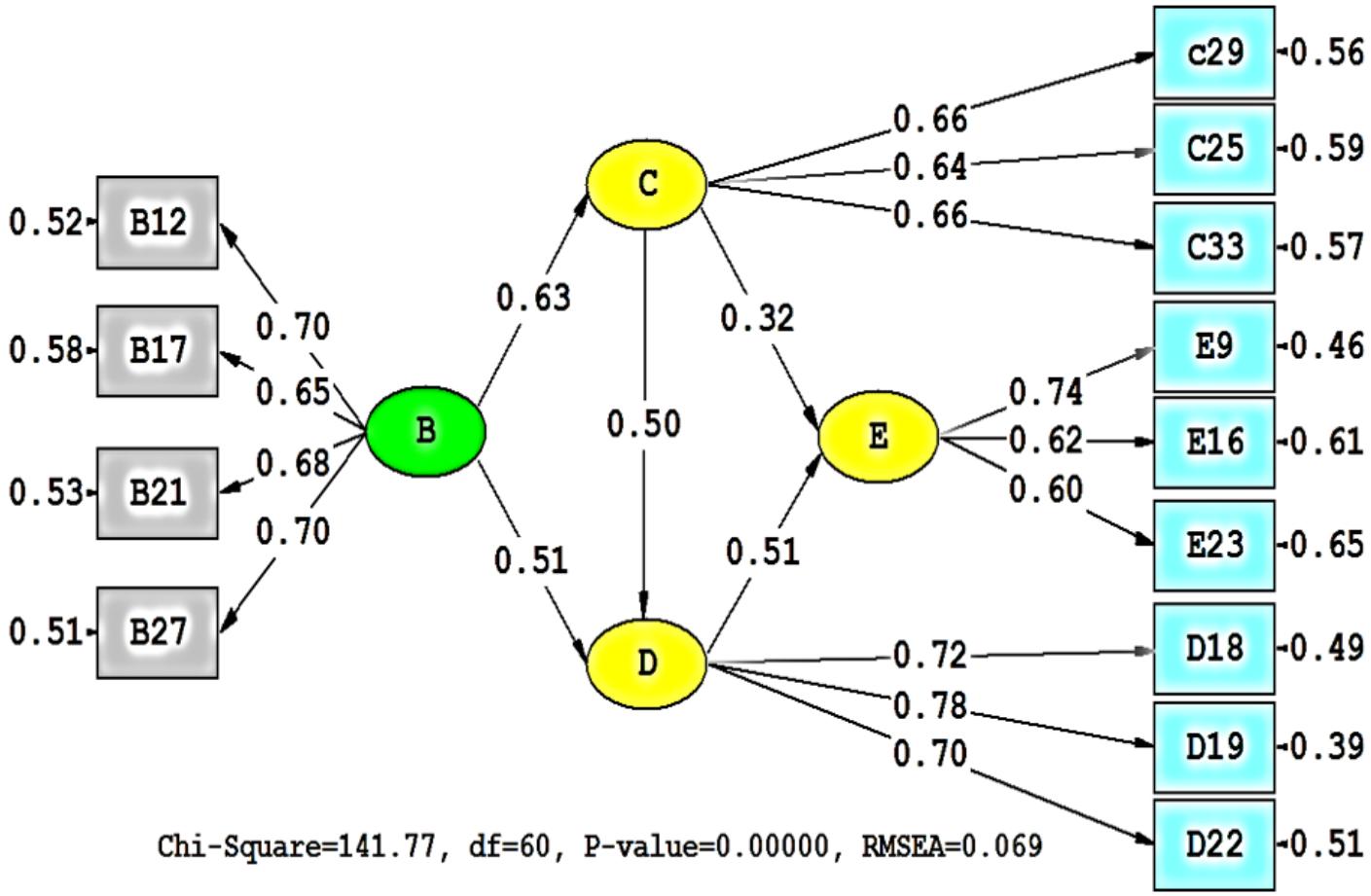

Figure 2

Path Diagram for Renewable Energy Use Model (LISREL8.80 Output) B: Environmental Concern; C: Awareness of renewable energy; D: Perceived Benefit of renewable energy; E: Intention to use of renewable energy