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An Investigation on The Social Acceptance of Nuclear Energy: A Case Study on University Students

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Abstract

In this study, the causal relationships between the factors related to nuclear energy acceptance and the sensitivity of young generations to nuclear energy are examined with structural equation model. The data obtained by the questionnaire applied to 521 students studying at the faculties of the Kütahya Dumlupınar University were analyzed. The students were asked the questions related to the latent variables which are perceived benefits of energy supply, perceived environmental benefits, risk perception, trust and acceptance. While risk perception has a statistically significant and negative effect on acceptance, the effects of other latent variables in the model have found to be positive.

Keywords: Structural Equation Modeling, Nuclear Energy, Social Acceptance.

Jel Classification Codes: C4, P48.

Nükleer Enerjinin Sosyal Kabulüne Yönelik Bir İnceleme: Üniversite Öğrencileri Üzerine Bir Alan Çalışması

Özet

Bu çalışmada nükleer enerjinin kabulü ile ilgili faktörler ve genç kuşakların nükleer enerjiye olan duyarlılıkları arasındaki nedensel ilişkiler yapısal eşitlik modeli ile incelenmiştir. Kütahya Dumlupınar Üniversitesi fakültelerinde öğrenim görmekte olan 521 öğrenciye uygulanan anketin verileri analiz edilmiştir. Öğrencilere enerji arzının algılanan faydaları, algılanan çevresel faydalar, risk algısı, güven ve kabul gizil değişkenleri ile ilgili sorular sorulmuştur. Nükleer enerji kabul düzeyi üzerinde risk algısının istatistiksel olarak anlamlı ve negatif etkisi saptanmış, modeldeki diğer gizil değişkenlerin kabul düzeyine etkisinin istatistiksel olarak anlamlı ve pozitif olduğu tespit edilmiştir.

Anahtar kelimeler: Yapısal Eşitlik Modellemesi, Nükleer Enerji, Sosyal Kabul.

Jel Sınıflandırma Kodları: C4, P48.

1. INTRODUCTION

Energy, which has become the main source of economic growth, industrialization and urbanization, is considered an important input for production and consumption activities (Paul & Bhattacharya, 2004: 977). A safe and accessible source of energy that is inevitable for human life is of utmost importance for the sustainability of modern societies. Throughout history, with the development of civilizations, the demand for energy has been constantly increased. It is estimated that the increase in global energy demand will increase rapidly with the increase of human population, urbanization and modernization tendencies in the coming years (Asif & Muneer, 2007: 1388-1389).

Today, nuclear energy is regarded as a useful strategy for becoming an environmentally friendly energy source with extremely low carbon dioxide emissions to meet the world's rapidly rising energy demand (Wang & Li,

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2016: 165). Nuclear energy in combating climate change can be seen as a possible strategy to reduce climate change; because harmful carbon emissions are very low in the use of such energy sources (Visschers et al., 2011: 3621). However, coal, one of the most polluting sources of energy left in nature by the depletion of oil and natural gas reserves in the near future, will greatly increase the trend of global warming (Comby, 2006: 2). In addition, alternative energy sources, such as solar energy and wind energy are quite expensive and still do not produce enough energy to meet the current needs of the world (Visschers et al., 2011: 3621).

With regard to nuclear energy, the public perception of it in many countries is a critical factor in determining whether nuclear energy is used to generate electricity in a country (Goodfellow et al., 2011: 6199). Although public acceptance of nuclear power plants has increased over the years, the public opinion seems unstable in many countries (European Commission, 2008; Pidgeon et al., 2008, Corner et al., 2011). In this regards, it is crucial to examine the acceptance of the people and the determinants of this acceptance in terms of the formation of nuclear power politics. For this reason, policy makers need to consult the public for their views on nuclear energy to develop nuclear energy policies.

The aim of the study is to examine the causal relationships between the younger generations' awareness of nuclear energy and the factors affecting their acceptance levels with a structural model In this context, considering the theoretical framework, factors related to nuclear energy acceptance, which is a latent variable, have been revealed. Trust, perceived energy supply benefit, perceived environmental benefit and risk perception have been tested for the effects of university students on nuclear power acceptance.

2. CONTEXT

2.1. Nuclear Power

Every living things needs an internal energy to survive and countries are no exception. Countries that do not have enough energy do not have the dynamism and power. Countries that can not supply their own sources of energy will have to import energy. Since such countries are dependent on external factors to survive, countries that want to remain strong and healthy must first make every effort to produce and use their own energy resources (Kasapoğlu, 1996: 1).

With the depletion of insufficient fossil fuel reserves in the world, other cheap energy sources will be needed to fill this gap (Roth et al., 2009: 413). Carbon dioxide, sulfur dioxide or nitrous oxide gases produced by the burning of fossil fuels are not produced by the use of nuclear energy. One gram of uranium produces as much energy as a ton of coal or oil. Accordingly, the nuclear waste is about a million times smaller than the fossil fuel waste. Most fossil fuel wastes cause global warming, acid rain, smoke and other atmospheric pollutants (Comby, 2006: 2-3). In nuclear power plants,1 tonne of uranium fuel generates as much energy as thousands of tonnes of coal. For these reasons, it is thought that the uranium present on the earth will meet the energy demand for many years and the continuity in the energy production will be ensured (Furuncu, 2016: 201).

Due to the rapid growth of the world's population and economic growth, countries have been searching for new sources of energy in order to meet their increasing energy need. The fact that fossil fuels are going to be consumed in the near future and that countries are looking for an energy source that produces low carbon emissions has laid the groundwork for the emergence of nuclear energy. Nuclear power plants, which provide cleaner and cheaper electricity generation today, are an important alternative to many energy-intensive developed countries. Approximately 11% of electricity demand in the world is covered by nuclear energy (International Energy Agency, 2016: 26). Table 1 shows the ratios of the number of nuclear power plants in some countries and in active electricity generation.

Table 1. Number of Nuclear Power Plants and Rates In Electricity Generation of Some Countries

Country	Number of Nuclear Power Plants	Electricity Generation Rates (%)
USA	99	20.4
France	58	76.3
Japan	42	0.4
Russia	35	18.6
Korea	24	31.5
Canada	19	15.9
Britain	15	17.4
Sweden	10	34.3
Spain	8	20.3
Germany	8	14.1
Belgium	7	38.5

Source: http://www.oecd-nea.org/ndd/ pubs/ 2016/7300-ned-2016.pdf.

When the share of nuclear energy in the electricity production of the countries is taken into account, France is the first country with 76%. The number of nuclear power plants that have become widespread since the 1960s in the world reached 450 by November 2016 (Euronuclear, 2017). The United States, France, Japan and Russia are the countries with the largest number of nuclear power plants in the world and 234 of the 450 power plants are located in these countries. Albania, Portugal, Ireland, Croatia, Serbia, Belarus, Latvia, Norway, Poland, Estonia and Turkey are among the countries that are considering to meet the high electricity demand from the nuclear power plant in the near future (Locatelli et al., 2013: 2)

2.2. Nuclear Power Development in Turkey

Turkey has been the country with the fastest increase in energy demand in the Organization for Economic Co-operation and Development (OECD) since last 10 years. Turkey has experienced a rapid growth in demand in every part of the energy sector in this period. Nevertheless, Turkey has been in second place after China in terms of natural gas and electricity demand growth since 2002. The trend of energy demand growth is expected to continue in the long run (Ministry of Foreign Affairs, 2017). As a result of the development of energy production and consumption in Turkey with different tendencies, 76% of the production in 1970 met the consumption with the rate dropping to 35% in 2000 and to 28% in 2004. According to the estimates of the Ministry of Energy, it is expected that this decline will continue at a rapid pace and that in 2020 domestic energy production will meet 24% of the total primary energy demand (Hepbaşlı, 2005: 316). For this reason, it is inevitable for the country to increase its external dependency on energy. Turkey, which consumed 80 million tons of petroleum energy in the last year of the last century, reached 120 million tons of energy consumption in 2013 with a 50% increase after 13 years, but the increase in energy production did not reach this level in the same period. At the moment, Turkey is among the countries with the highest level of external dependence on energy in the world. In order to stabilize the growth of the Turkish economy and to reduce external dependence, all possible domestic resources need to be assessed for energy production (Tamzok, 2014: 1-2).

As Turkey's domestic energy resources are limited, this creates dependency on energy imports, especially oil and natural gas. Along with the increased energy demand in Turkey, approximately 25% of total energy demand is met by domestic sources while the rest is met by diversified import sources.

In Turkey, nuclear power plant studies have been continuing for many years to reduce energetic external dependence. In this sense, first of all, between USA and Turkey, in May 1955, the first agreement on the use of atomic energy in peaceful ways was signed (Fischer, 1997: 29). In 1956, the Atomic Energy Commission was established in Turkey to direct radiation and nuclear energy policies. With this development, nuclear energy studies have been started. In 1957, Turkey became a member of the International Atomic Energy Agency (IAEA). In 1962, the test reactor TR-1 was run at the Çekmece Nuclear Research and Training Center. In the 1970s, feasibility studies for the construction of nuclear power plants started in Turkey (Ruan, 2008: 1070).

Turkey, which has the world's second richest reservoir of energy and has an energy bottleneck, accelerated its attempts to establish a nuclear power plant in Sinop and Akkuyu in order to provide a sustainable and stable development process and reduce foreign dependency on energy. Turkey is among the countries that are planning to benefit from nuclear power plants in order to meet the increasing energy demand every year. For this purpose, various agreements have been signed with Russia and Japan for the nuclear power plants to be built in Mersin and Sinop provinces.

Turkey should increase the share of renewable energy resources in order to reduce energy dependence, maximize the use of domestic resources, and combat climate change. Turkey should also continue its efforts to exploit nuclear energy to reduce its dependence on imported fossil fuels. By 2023, Turkey plans to meet 10% of its total electricity needs from two nuclear power plants to be built in Mersin/Akkuyu and Sinop (Ministry of Foreign Affairs, 2017).

Public support in nuclear power plant projects is more important than others. In the 1960s and 1970s, nuclear energy was regarded as a cheap source of energy that had no significant negative impact. Nonetheless, the public opinion on nuclear energy emerged as an opposition in many countries after the Three Mile Island (TMI) accident in 1979 and the Chernobyl accident in 1986. As a result, nuclear power plant projects have been delayed and even canceled. However, acceptance of the public in waste management is an indispensable issue and the support of the people is coming out to be negative because of nuclear waste problems. For these reasons, the government should initiate training strategies at the earliest stages of the project, taking into account the public's thoughts on nuclear safety and waste management, in order to take public support and identify problems with public acceptance. (Sirin, 2010). However, the public's attitude toward nuclear power plants has become one of the most talked-about and debated topics in the public opinion. In Europe, people's support for energy production through nuclear power plants has increased over the last few years and the number of Europeans who have developed nuclear energy opposition has decreased. Measures to be taken in the fight against climate change are a continuing issue in public debate in the European Union. The role of nuclear energy in reducing CO_2 emissions compared to other energy sources is undeniable and therefore affects the public's nuclear view on the positive side (Visschers et al., 2011: 3622; European comissions, 2008: 5).

Organizing workshops, meetings, seminars and conferences to encourage public awareness and acceptance of the peaceful use of nuclear energy in Turkey are among the policies applied to the development of the nuclear energy industry (Atiyas, 2015: 7-8). Citizens' preferences play an increasingly important role in the decisions about energy investments that can be made in regions or countries where people live for different energy sources, even sometimes in neighboring countries (Pidgeon et al., 2008). The general public opposition to nuclear energy in Turkey argues that the government cannot cope with the risk of an accident or suggest a suitable plan for the elimination of waste (Jewell and Ateş, 2015: 278). It is well known that as soon as the nuclear accidents took place, these reports became stronger in public and the negative thoughts on nuclear energy were exacerbated at that time. For example, rapid public resistance after the recent Fukushima accident means that governments in some developed countries can no longer act freely in the selection of nuclear energy (Ertör et al., 2012: 310). However, those who accept nuclear energy seem to have increased in Europe in recent years, while the number of Europeans who are showing an attitude towards nuclear energy has declined (Visschers et al., 2011: 3622).

Regarding nuclear energy, public perception in many countries is an important factor in determining whether nuclear energy can be used to generate electricity in a country. Decisions about nuclear power plants are strongly influenced by public opinion and political will. To improve the technical understanding of nuclear weaponry and to compare them with other risks is the key to improving the nuclear energy support of the people (Erdoğdu, 2007: 30). Furthermore, it is of great importance to examine the factors that determine public acceptance, in order to create nuclear power politics. For this reason, policymakers need to consult the public for their views on nuclear energy. In this study, Dumlupınar University students' opinions about nuclear energy were taken.

2.3. Previous Studies Regarding The Acceptance of Nuclear Power Stations

Social acceptance is necessary for the development of energy technology. In the last decade, there have been countless investigations of public concerns about energy technologies, including nuclear power plants, one of the most controversial topics on the world today (Romanach et al., 2015: 1144).

In China People's Republic, a causal model explaining university students' acceptance of nuclear power by structural equation model was developed. It is predicted that the perceived energy supply benefits, perceived environmental benefits and risks are the determinants of Chinese university students' acceptance of nuclear energy in the model. It is also assumed that the confidence in the nuclear energy in the model affects the perceived energy supply benefits, perceived environmental benefits and risk perception. When the results obtained from the data collected from 506 students by questionnaire are examined, it is observed that the acceptance of nuclear energy is a meaningful and positive effect of perceived energy supply benefits and environmental benefits; risk perception has a meaningful and negative effect. Trust also has an indirect impact on acceptance, affecting perceived energy supply benefits, perceived environmental benefits and perceived risk (Wang and Li, 2016).

Bird et al. (2014) conducted a nationwide survey in 2010 to investigate the Australian public's attitudes toward nuclear energy in relation to climate change and other energy alternatives. The majority of respondents (42%) indicated that nuclear energy is ready to accept climate change as mitigation. Australians, however, believe that nuclear energy offers a cleaner, more efficient alternative to coal, which dominates domestic energy production. The most positive opinion of Australian public about the selection of energy sources (71%) is to promote the use of renewable energy resources.

In Switzerland, a large model based on impact and confidence explaining people's perception of nuclear power plant risk and benefit has been tested by using SEM. There are two types of benefit perception in the model for relieving perceived benefit and climate change for a secure energy supply. Furthermore, the perception of trust and its effects were investigated in relation to risk. The acceptance of nuclear power plants has been influenced by people's perception of a safe energy supply, mitigation of climate change and risk perception (Visschers et al., 2011).

Previous research has documented the public's concerns about nuclear energy risks, and it is mentioned that the opposition to nuclear energy is particularly linked to the environmental problem. Concerns about both general environmental concerns and climate change have led to a positive assessment of renewable energy sources and a negative assessment of nuclear energy. Despite the policy that nuclear energy is a low-carbon electricity source, it has come to the conclusion that most people concerned about climate change and the environment perceive it as nuclear negative (Spence et al., 2010).

The risk perception for nuclear energy has been shown to negatively affect the acceptability of nuclear energy in many studies in the literature (Greenberg, 2009; Tanaka, 2004). A national study in the United States has developed a model that advocates that attitudes toward nuclear energy are a perceived risk function and that risk perception and attitude is a characteristic, belief, and trust function. As a result of the research, it has been revealed that the increase of confidence in the management institutions leads to the decrease of perceived nuclear energy risk, while the high confidence and low risk perceptions cause the individuals to exhibit positive attitudes towards nuclear energy. While individuals with traditional values were in a positive attitude, those with self-sacrificing values showed an opposition to nuclear energy (Whitfield et al. 2009).

Questionnaire study was applied to 1491 person was conducted to explore the UK people's views on nuclear energy and climate change, and to explore attitudes towards perceived risks, benefits, acceptability and nuclear energy restructuring of nuclear energy. When the results of the British public opinion are examined; it has emerged that the environmental benefit of nuclear energy is an alternative solution to climate change and that people have a positive influence on nuclear energy adoption. Participants expressed "reluctant acceptance" of nuclear energy as a "solution" to climate change because they saw it as problematic in terms of nuclear energy risks (Pidgeon et al., 2008). The research shows that people prefer nuclear power plants to the consequences of climate change if nuclear power is clearly shown to mitigate climate change and when it is required to choose between nuclear power plants or climate change (Bickerstaff, 2008).

2.4. The Hypothesized Model and Research Aims

In the study, a causal model explaining university students' acceptance of nuclear power is being tested. The studies in the literature have revealed the factors affecting nuclear energy acceptance. In the application part of this study, students' opinions on the acceptance of nuclear energy were obtained through a questionnaire developed by Wang and Li (2016). In the stage of adapting the statements in the Wang and Li's (2016) scale to Turkish, care has been taken to use a simple and comprehensible language. The trust in nuclear energy in the model indirectly affects the acceptance of nuclear energy. Perceived energy supply benefits, perceived environmental benefits and risks are predicted to be decisive factors on the level of students' acceptance of nuclear energy. In other words, it has been explored that the effects of nuclear energy acceptance by taking into account the perceived benefits of energy supply, perceived environmental benefits, risk perception and trust variables. In addition, the effects of these latent variables on each other are revealed. The causal relationship between variables is explained by structural equation modeling. Considering the scale used by Visschers et al (2011), 2 questions were added to the scale by taking advantage of relevant theoretical and field studies. Therefore, the number of observed variables of the latent variable related to the energy supply benefit in the model is increased to 3, and the number of observed variables related to the environmental benefit is increased to 4. The findings obtained from the analysis of the data with SEM were reported.

All of the research hypotheses related to the model and causal relationships are presented graphically in Figure 1.

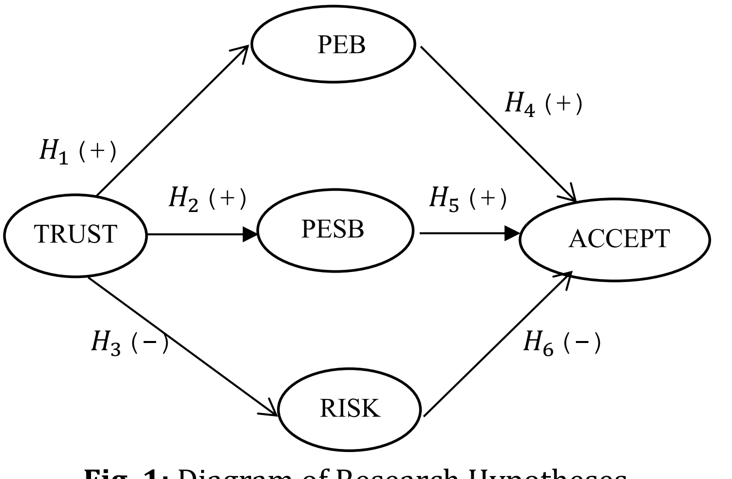

Fig. 1: Diagram of Research Hypotheses

To examine the relationship between the factors influencing the level of students' acceptance of nuclear power plants, the hypotheses within the model are addressed as follows:

Research Hypotheses

- H_1: Students' perceptions of trust regarding nuclear energy have a positive influence on the beliefs of the nuclear energy about the environmental benefits.
- H_2:Students' perceptions of trust regarding nuclear energy have a positive influence on their belief in the benefit of energy.
- H_3:Students' perceptions of trust regarding nuclear energy have a negative effect on nuclear energy risk perceptions.

Numerous studies in the literature have tested the relationship between benefit perception, risk perception, trust and acceptance. In addition to direct effects on acceptance, trust indirectly affects acceptance by influencing trust, benefit and risk perception towards nuclear energy. Previous research has shown that trust is an important influence on perceived benefit and risk perception (Chen and Li, 2007; Siegrist and Cvetkovich, 2000).

For these reasons, those who trust more in the institutions related to technology see more benefits and perceive low level of risk. In particular, past research has extensively examined the relationship between trust and risk perceptions (Pidgeon et al., 1992; Renn and Levine, 1991; Slovic, 1993).

- H_4: Students' beliefs about the environmental benefits of nuclear energy have a positive impact on the level of accepting nuclear energy.

Benefit perception affects nuclear acceptance positively (Liu et al., 2008). In addition, the relationship between perceived environmental benefit and public acceptance for climate change has been examined (Spence et al., 2010, Bickerstaff et al., 2008).

- H_5: Students' belief in the benefit of energy supply has a positive effect on the level of acceptance of nuclear energy.

Visschers et al. (2011) and Wang and Li (2016) found that the increased belief in the perceived energy supply benefits of nuclear energy led the public to demonstrate a positive attitude toward nuclear energy acceptance.

- H_6: Students' perceptions of nuclear energy risk have a negative influence on the level of accepting nuclear energy.

Confidence and risk perceptions of people to government and energy companies are related to the acceptability of nuclear power plants. (Ansolabahare and Konisky, 2009: 567). The most important research flow to opposing power plants concerns the individual's risk attitudes. Persons who are less likely to take risks are more reluctant to accept potentially hazardous technologies (Slovic, 1987: 283). In particular, risk perception has been observed to reduce the acceptance of nuclear energy from past research (Song et al., 2013: 56).

3. METHODS

3.1. Sample and Questionnaire

Dumlupınar University, is located in the west of Turkiye and in Kütahya province, is a state university and was founded in 1992. 26567 undergraduate students at the faculties located at the Kütahya Dumlupınar University Evliya Çelebi Campus during the 2015-2016 academic year constitute the population. 521 students selected by stratified sampling method were determined as the sample of the researcher. Proportional distribution of students in faculties; 22 faculties of education, faculty of engineering, 5 medical faculties, and 27 applied sciences profession high school students. Since 26 questionnaire are missing, faded, and incorrectly filled, they have not been evaluated.

The questionnaire consists of two parts. In the first part, there are questions about the socio demographic characteristics of the participants. In the second part, 20 observed variables representing 5 latent variables used in the research model are included. Participants were asked to rate their views and opinions on nuclear power plants with a five-point Likert scale (1: strongly disagree; 5: strongly agree).

When the descriptive statistics on the socio demographic characteristics of the students were examined, it was determined that 56% of the students were female and 44% were male. When the age and marital status are examined, it is seen that most of the participants are composed of students between 18-22 years (73.5%) and single students (98.1%). 38.8% of the students are in the Faculty of Economics and Administrative Sciences and 22.3% of them are studying in the engineering faculties. 203 students participating in the survey together with being 3rd year students constitute 39% of the sample. 40.7% of the participants live in the Marmara region and 20.7% live in the Aegean region. When the educational status of the parents of the students participating in the survey is examined; 256 (49.1%) primary school graduates and 237 mothers with secondary education (45.5%). 42.4% of the students defined the family as conservative, while 38.2% defined themselves as nationalist. 338 students declared that they had knowledge of nuclear energy.

3.2. Data Analysis

According to Hox and Bechger (1998), SEM is not only a commonly used method in behavioral sciences but also related to theoretical constructs represented by latent variables. Relations between the theoretical constructs are shown by regression and path coefficients, and it is investigated whether the estimated covariance matrix fits the covariance matrix of the observed data by this method. Two of the most fundamental features of SEM are the causal processes in the theoretical model can be represented by structural equations (regression equations) and that they can be modeled visually for a more clear conceptualization of the theory underlying structural relations. The default model is then statistically tested to prove that hypotheses are correct and to show that the data represent a consistent representation of the data (Byrne, 2010: 3).

In YEM, there are two basic models as measurement model and structural model. The main aim of the measurement model, which is a part of SEM, to explain how the observed variables represent latent variables as a means of measuring and to establish the relationship between the variables. The test of the measurement model often uses confirmatory factor analysis (CFA) (Khine, 2013: 6; Jöreskog and Sörbom, 1993: 15). While the measurement model evaluates the unobserved variables as the linear functions of the observed variables, the direction and the power of the relations between the unobserved (latent) variables in the structural model are shown. A typical structural equation model is shown as follows (Joreskog and Sorbom, 1996):

$$\eta = B_{\eta} + \Gamma\xi + \zeta \tag{1}$$

Here, η is the column vector of *m* endogenous variables, ξ is the column vector of the exogenous variables, and B is a matrix of the coefficients related to the direct effects of the endogenous variable on the other endogenous variable. Γ is a matrix (m × n) of coefficients related to the direct effects of the exogenous variable on another endogenous variable, and ζ is a column vector of error terms associated with the endogenous variables. Φ represents the covariance matrix (n × n) of the exogenous variable ξ.

Measurement equations that relate latent variables to measurement variables are shown by the following equation;

$$y = \Lambda_y \eta + \epsilon \tag{2}$$

$$x = \Lambda_x \xi + \delta \tag{3}$$

p is the measured endogenous variable, and q is the external measured column vector, respectively, as $y_{(p\times1)}$ and $x_{(q\times1)}$. Λ_y and Λ_x, are the corresponding factor loading λ_{ij} matrices. ε and δ are error terms related to measured variables and are uncorrelated.

ML and GLS estimation methods used in SEM require a multivariate normality assumption. WLS or Robust ML estimation methods can be used in cases where normality is not provided in the data set. Since WLS method does not give statistically good results with a small number of data, it requires at least 1000 units of sampling even for 10 observed variables (Muthen, 1989: 25). Since the sampling volume within the scope of the study was not as wide as required by the WLS, and the assumption of a multivariate normality in the data set was not achieved, the robust ML method was chosen as the estimation method in the analysis phase. The model fit is evaluated by the Satorra Bentler corrected χ^2 test statistic, which yields more reliable results in this method used in cases where the distributional hypothesis is violated, and asymptotic covariance matrix is used (Byrne & Stewart, 2006: 303; Çelik & Yılmaz; 2013: 27). SPSS 22 and LISREL 8.51 statistical package programs were used in the analysis of the data.

Table 2: Multivariate Normality Test Results for Continuous Variables.

Skewness			Kurtosis			Skewness and Kurtosis	
Value	**Z-value**	**P- value**	**Value**	**Z- value**	**P- value**	χ^2	**P-value**
33.485	19.655	0.000	512.105	16.602	0.000	661.952	0.000

Mardia's normalized multivariable kurtosis coefficient was calculated as 512.105. The critical value is calculated using the p (p + 2) equation that Raykov and Marcoulides (2008) presented to represent the observed number of "p" variables. Since the number of observed variables included in the study is 20, the critical value is calculated as 420. It is determined that the dataset does not provide a multivariate normality assumption because the kurtosis coefficient obtained from the analysis is larger than the critical value. This result is also supported since the p-values of the skewness and kurtosis coefficients are smaller than 0.05 as shown Table 2.

In the study, 202 students at the Faculties of Economics and Administrative Sciences were surveyed in the framework of the pilot study in order to reveal the structural validity of the research model. Kaiser-Meyer-Olkin (KMO) and Bartlett test values were examined to determine the suitability of such data for factor analysis before applying the exploratory factor analysis (EFA) to the obtained data. From these tests, KMO is useful in determining whether sample size is sufficient to perform factor analysis. Kaiser emphasizes that this value is excellent as it approaches 1 and that it is not within acceptable limits below 0.50 (Kaiser, 1974: 35). The KMO value of 0.799 indicates that sufficient sample size has been reached to implement factor analysis. Since the significance level of the Bartlett test is calculated as 0.00, it is concluded that the null hypothesis of '' Correlation matrix unit matrix'' is rejected and the data set is suitable for factor analysis.

After assessing the suitability of the obtained data for factor analysis, EFA were applied to 20 observed variables in the data set to reveal the factors (latent variables) of the observed variables and the number of these factors. In other words, it is aimed to test the structural validity of the model. In the EFA result using Varimax Rotation Technique and Principal Component Analysis, trust5 was removed from the analysis as it disrupted the questionnaire factor structure. The factor load for each observed variable and the eigenvalue and variance explanatory rates for latent variables are shown in Table 3.

Table 3: Result of Exploratory Factor Analysis

Component	Eigen-values	% of Variance	Cumulative %
ACCEPT	4,930	25,949	25,949
RISK	2,461	12,952	38,901
PEB	1,645	8,657	47,558
PESB	1,368	7,199	54,757
TRUST	1.090	5,735	60,492

As a result of the analysis without the number of factors being determined in advance, 19 observed variables in the data set were collected under five factors according to the theoretical model. These factors, which are greater than the eigenvalue 1, are called Acceptance, Risk, Perceived Environmental Benefit, Perceived Energy Supply Benefit and Trust. As shown in Table 3, the five-factor structure obtained accounts for 60.492% of the total variance. The first factor (Accept) explains 25.49% of the total variance. Other factors, Risk, Peb, Pesb and Trust explain 12,952%, 8,657%, 7,199% and 5,735% of the total variance, respectively. The reliability of the subscales ranged from 0.62 to 0.79. The reliability coefficient of all observed variables in the measurement model is 0.812. Therefore, it can be understood from the Table 4 that the scale has a sufficient reliability level.

CFA is a statistical technique that assumes the relationship model as a priori and is used to verify the factor structure of the observation set.

Table 4: Reliability Analysis Results

Latent Variables	Reliability Coefficient (α)
TRUST	0.626
PEB	0.684
PESB	0.703
RISK	0.707
ACCEPT	0.799

It allows the investigator to test the hypothesis that there is an association between observed variables and underlying latent structures (Suhr, 2006: 1). Figure 2 shows the results of the CFA for the measurement model that reveals the latent variables and the observed variables that are related to these latent variables with the standardized path coefficients. When examining Figure 2, it is seen that the path changed between 0.46-0.63 for the Trust latent variable. The other factors' path coefficients changed between for Peb, Pesb, Risk and Accept 0.48-0.68, 0.56-0.73, 0.49-0.66, 0.53-0.86, respectively.

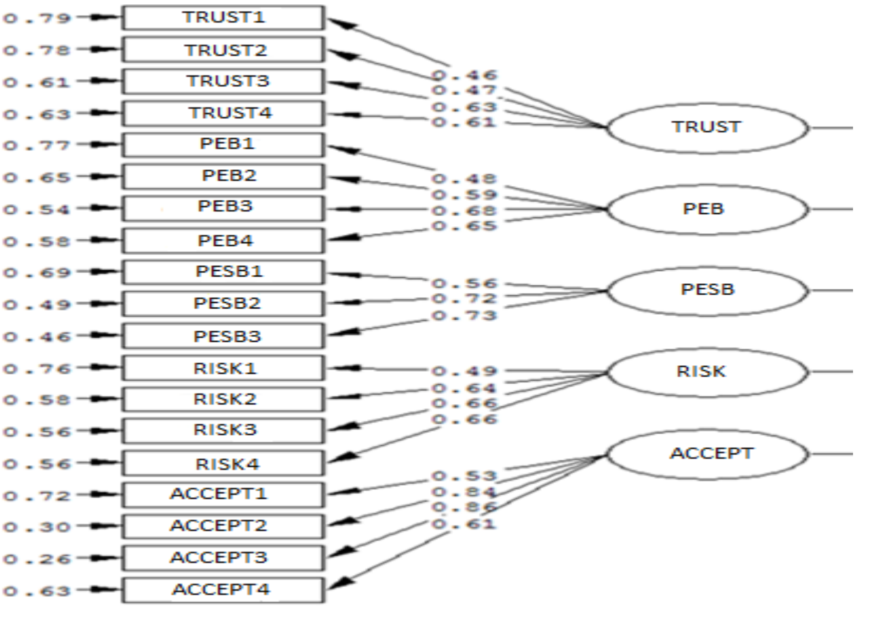

Fig. 2: CFA Result of The Measurement Tool

Before going to SEM analysis, the validity of the model used must be measured. When the values of the goodness of fit calculated for the measurement model are examined, it is determined that χ^2/df is 2.15 and it is decided that the variance-covariance matrix estimated by the population variance covariance matrix is harmonized. Other fit indices are within good fit and acceptable limits, as RMSEA = 0.047, SRMR = 0.05 and GFI = 0.93.

3.6. Analysis Result of Structural Equation Model (SEM)

At this stage of the study, the analysis process of the structural equation model, which reveals the relationship between latent variables and each other and observed variables, has been introduced. As mentioned earlier, since the assumption of multivariate normality is not provided in the data set, the robust ML estimation method is used in analyzing the SEM. In this context, the Satorra-Bentler χ^2 value was used during the analysis. The output of the LISREL program resulting from the analysis of the research model is shown in Fig. 3.

Signs for all connections in the model have emerged in accordance with theoretical expectations. When examined more specifically, students' perceptions of the perceived energy supply benefit and environmental benefits of nuclear energy affect positively the level of nuclear power acceptance; and risk perceptions negatively affect the acceptance level.

When the values of the goodness of fit obtained from the analysis of the values of goodness of fit used in evaluating the statistical fitness of the SEM were examined, it was decided that the data set was within the acceptable limits since the value of χ^2/df was calculated to be 2.38. the RMSEA value, based on the difference between the sample covariance matrix and the estimated covariance matrix appears to be within acceptable values of 0.052. When the other criteria are examined, the SRMR value (0.055) and the GFI value (0.92), which is considered to be the reciprocal of R^2 in the regression analysis of SEM, reflects acceptable fit indices. It is observed that the value of AGFI calculated as 0.90 is in good fit level. The result of the fit indices was found to be statistically meaningful and appropriate.

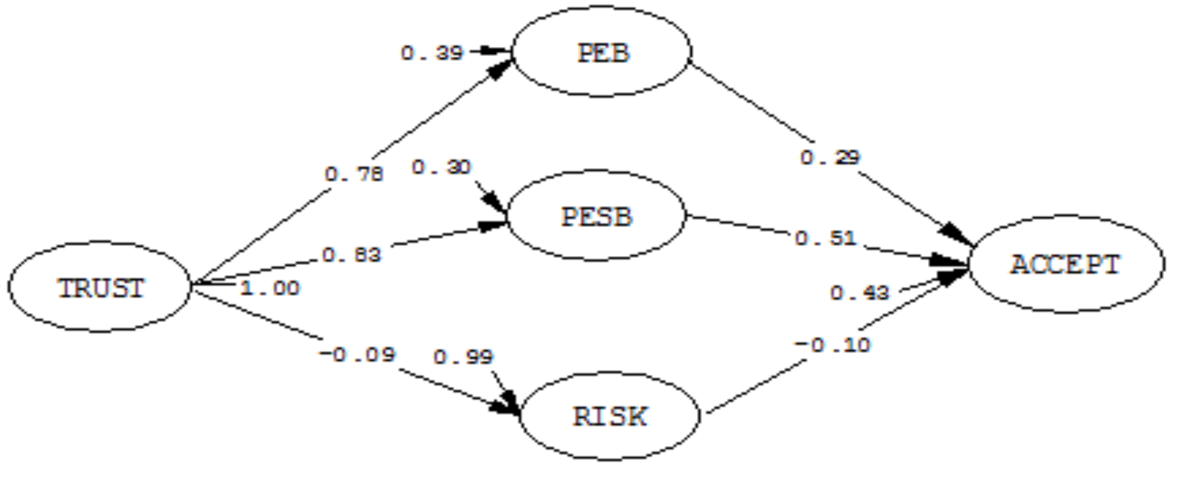

Fig. 3: Path Diyagram, TRUST: Trust, PEB: Perceived Environmental Benefit. PESB: Perceived Energy Supply Benefit, RISK: Risk, ACCEPT: Acceptance

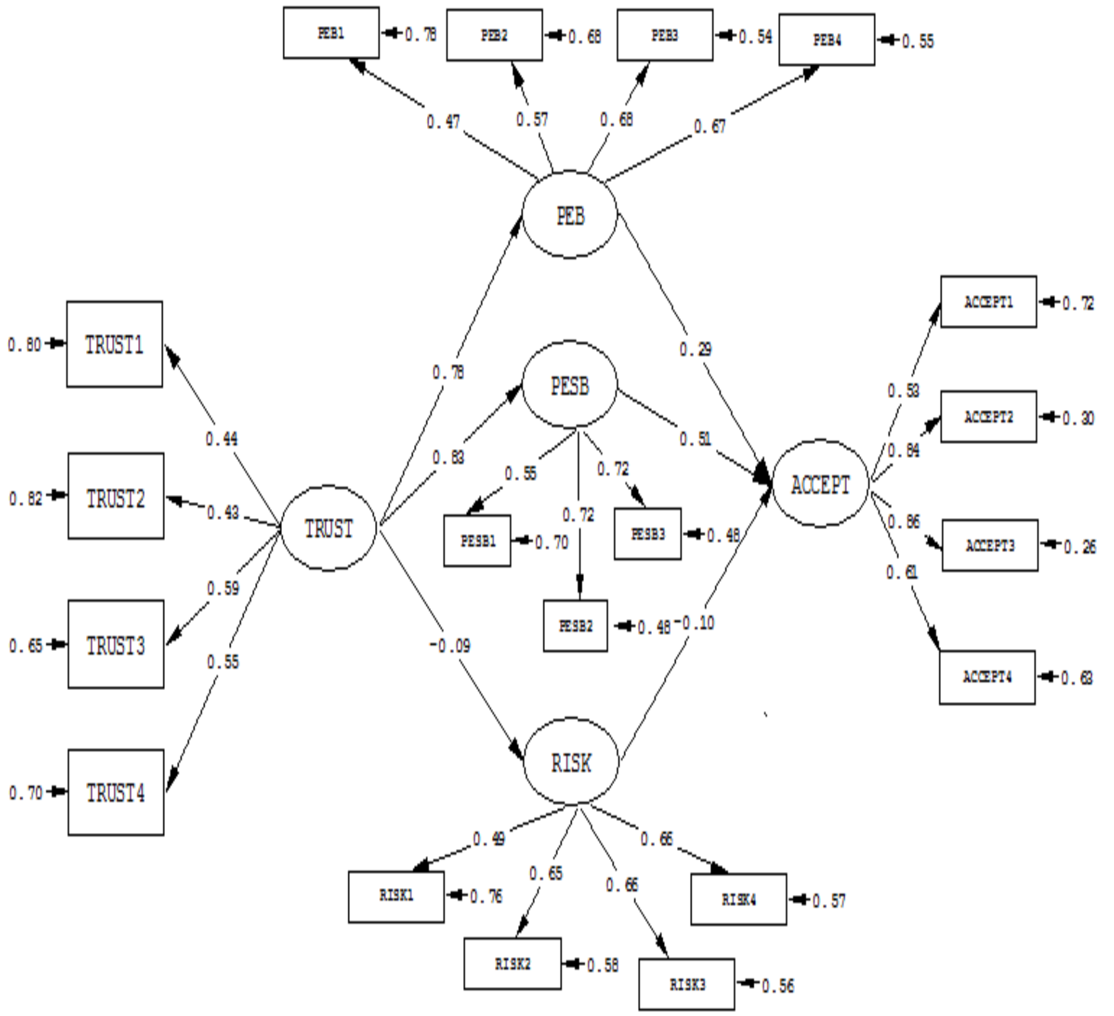

Fig. 4: Structural Equation Model

The results of the analysis of the SEM in which the measurement model and the structural model are combined, the t values and the multiple coefficient of determination R^2 values, expressed as the measure of the change explained by the dependent variable independent variable are given Table 5.

Table 5: Structural Equation Model Results

Latent Variables	Standard Loadings	t Values	R^2
TRUST			
1.The nuclear power plants constructed by nuclear power enterprises maintain high quality.	0.44	8.25	0.20
2.Nuclear experts' evaluation about nuclear accidents is scientific and reasonable.	0.43	8.27	0.18
3.Siting selection of nuclear power plants made by government is scientific.	0.59	13.13	0.35
4.Nuclear power plant workers can operate professionally.	0.55	11.13	0.30

Latent Variables	Standard Loadings	t Values	R^2
PERCEIVED ENVIRONMENTAL BENEFITS			
1.Developing nuclear power can effectively reduce greenhouse gas emissions.	0.47	-	0.22
2.Nuclear power development can prevent the destruction of forest areas by preventing hydroelectric power plants from establishing on fertile soils.	0.57	8.00	0.32
3.Developing nuclear power can substantially reduce dust from burning coal.	0.68	8.32	0.46
4.Developing nuclear power can effectively solve environmental damage produced by fossil fuel mining.	0.67	8.20	0.45
PERCEIVED ENERGY SUPPLY BENEFITS			
1.Developing nuclear power can reduce our dependence on international energy market.	0.55	-	0.30
2.Nuclear power plants will increase the standard of living in Turkey.	0.72	10.54	0.52
3.Developing nuclear power can optimize Turkey's energy supply structure.	0.72	10.20	0.52
RISK			
1.Nuclear accident risk caused by natural disasters is big.	0.49	-	0.24
2.Nuclear accident risk caused by operational error of nuclear power plant workers is big.	0.65	8.05	0.42
3.People living near nuclear power stations have huge psychological stress.	0.66	8.16	0.44
4.People living near nuclear power stations will suffer from radiation.	0.66	8.01	0.44
ACCEPTANCE			
1.I think it is a wise choice for Turkey to develop nuclear power.	0.53	-	0.28
2.I think the Turkish government should put more investment in nuclear power development.	0.84	9.35	0.70
3.I think the share of nuclear power should be increased in Turkey's total electricity generating capacity.	0.86	9.56	0.74
4.Compared to traditional thermal power, I think nuclear power is better.	0.61	8.73	0.37

Structural Relations	Standardized Loadings	t values	Hypothesize Results
TRUST → PEB	0.78	7.75	Supported
TRUST → PESB	0.83	9.71	Supported
TRUST → RISK	-0.09	-1.34	NotSupported
PEB → ACCEPT	0.29	2.91	Supported
PESB → ACCEPT	0.51	4.65	Supported
RISK → ACCEPT	-0.10	-2.25	Supported

When analysis results are examined, it is seen that all parameter estimates are meaningful (t> 1.96). It is understood that the highest coefficient of trust latent variable belongs to trust3 with 0.59 among the four items (observed variable). Therefore, as the level of students' confidence in nuclear power plants increases, so does the belief that the choice of location for the construction of the nuclear power plant by the government will be scientific. The variance of the trust latent variable appears to be mostly explained in the trust3 observed variable. In other words, this item (observed variable) best describes the variance of the trust latent variable (R^2= 0.35).

The expression that best explains the variance of the peb latent variable is peb3 (R^2= 0.46). The path coefficient for this item is calculated as 0.68. As students increase their belief in the environmental benefits of nuclear energy, it will also increase their view that nuclear energy development will reduce the amount of dust produced by burning coal to a considerable extent.

The observed variables pesb2 and pesb3, which are expressed as "Nuclear power plants will increase the standard of living in Turkey" and "Nuclear energy development can improve the energy supply structure of Turkey", have equally significance in describing the variance of the pesb latent variable (R^2 = 0.52). However, it is seen that the path coefficients related to the items are calculated as 0.72 in Table 5.

One unit increase in the risk latent variable leads to an increase of 0.66 units in the risk3 and risk4 observed variables. Participants' perceptions of the risks of nuclear energy and the perceptions of people living in places close to nuclear power plants are under great psychological stress and are suffering from radiation damage. The R^2 value of the variables that best describe the variance of the risk latent variable is 0.44.

Accept3 which is expressed "The share of nuclear energy in Turkey's total electricity generation should be increased" is the most important factor explaining the level of acceptance of nuclear power plants with 0.86 path coefficient. The R^2 value of the observed accept3 variable describing the accept variable was 0.74.

Table 6: Structural Equation Model Results

PEB = 0.78 x TRUST (0.10) 7.75	R^2 = 0.61
PESB = 0.83 x TRUST (0.086) 9.71	R^2 = 0.70
RISK = - 0.09 x TRUST (0.065) -1.34	R^2 = 0.0076
ACCEPT = 0.29 x PEB + 0.51 x PESB - 0.010 x RISK (0.10) (0.11) (0.043) 2.91 4.65 -2.25	R^2 =0.57
ACCEPT = 0.67 x TRUST (0.07) 8.71	R^2 = 0.45

A unit increase in the trust external latent variable leads to a 0.78 increase in the internal latent variable peb or vice versa. It has been found that there is a positive and statistically significant relationship between the two latent variables. Multiple determination coefficients (R^2) calculated as a result of the structural equation generated using the trust and peb latent variables was 0.61.

It was determined that there was a statistically significant and positive relationship between the trust external latent variable and the pesb internal variable. The path coefficient calculated as 0.83 indicates that a unit increase in trust will result in an increase of 0.83 units in the pesb. The external latent variable trust describes 70% of the internal latent variable pesb (R^2= 0.70).

The path coefficient between the trust external latent variable and the risk internal latent variable is -0.09. This coefficient indicates that a unit increase in trust will cause a decrease of 0.09 units in RISK. The expected negative relationship between the latent variables was not statistically significant (t=-1.34). The external latent variable trust describes 0.0076 of the internal latent variable risk.

A statistically significant positive correlation was found between the accept internal latent variable and the PEB internal latent variable (0.29). This coefficient value indicates that a one point increase in peb will cause an increase of 0.29 units in accept. The value of the path coefficient between the pesb latency variable and accept is 0.51. There was a statistically significant and positive relationship between these two latent variables. The relationship between risk and accept internal latent variables was also statistically significant and the path coefficient was calculated as -0.10. The multiple coefficient of determination of the structural equation obtained by using the corresponding coefficients of the peb, pesb and rısk internal latent variables assumed to explain the accept internal latent variable was calculated to be 0.57. This was determined at a significance level of 0.05, which explained 57% of the latent variables.

In addition to the direct effects of these three latent variables, there is an indirect effect of the trust external variable on the accept internal variable. The indirect effect between trust and accept which is statistically significant is calculated as 0.67. As a result of the obtained structural equation, it was found that trust explained 45% of the accept latent variable.

The H_1 hypothesis positively proved that the students' trust perceptions of nuclear energy (trust) positively influenced their beliefs about the environmental benefit of nuclear energy (peb) statistically, and the relationship between these two latent variables was found to be significant (ϒ = 0.78, t = 7.75).

It was statistically determined that the students had a positive effect on the nuclear energy reliability (trust) and energy supply benefit perceptions (pesb), and the H_2 hypothesis was accepted (ϒ = 0.83, t = 9.71).

The H_3 hypothesis was not statistically verified (γ=-0.09, t=-1.34). Participants' trust perceptions of nuclear energy (trust) were found to have a negative effect on the risk perceptions of nuclear energy (risk), but this relationship was found to be weak and statistically insignificant.

The H_4 hypothesis (β = 0.29, t = 2.91), which was expressed as having a positive effect on the environmental benefit (peb) on acceptance level (accept) of the nuclear energy was accepted.

It is seen that students' trust are positively influencing their beliefs in benefit of energy supply (PESB), in other words increasing their level of accepting nuclear energy (ACCEPT). This relationship formulated with the hypothesis was statistically confirmed and significant (β = 0.51, t = 4.65).

Students' perceptions of nuclear energy risk (risk) have a negative effect on nuclear energy acceptance levels (accept). Finally, the hypothesis was also statistically evaluated and verified. It has been found that the increase in perception level of risk of nuclear energy (risk) has a negative effect on students' acceptance of nuclear energy (accept) (β = -0.010, t = -2.25).

In the analysis of the data, the difference between the means was tested by t test and ANOVA. The socio-demographic characteristics of the students who participated in the survey are shown in Table 7 shows the difference between the mean score of acceptance regarding nuclear energy. The mean score of acceptance differ statistically by sex. There is a difference between the acceptance scores of male and female students ($p < 0.05$). There was a statistically significant difference ($p < 0.05$) between the 338 students who declared that they were knowledge based on nuclear energy and the acceptance mean scores of 113 students who did not have any information about the subject. Participants with nuclear knowledge have been found to have higher acceptance mean scores.

Table 7: T Test and Anova Results of Nuclear Energy Acceptance By Demographic Variables

		N		**s**	**t**	**p**
Sex	Female	292	3,32	,807	-5,00	0,00
	Male	229	3,70	,890		
Nuclear Knowledge	Yes	338	3,85	,912	2,455	0,014
	No	113	3,36	,754		
		Sum of Squares	**SD**	**Mean Square**	**F**	**p**
Faculty	Betweengroups	17,658	8	2,207	3,047	0,001
	Withingroups	370,870	512	,724		
	Total	388,528	520			
Family Political View	Betweengroups	12,406	3	4,135	5,684	0,001
	Withingroups	376,122	517	,728		
	Total	388,528	520			
Own Political View	Betweengroups	10,672	3	3,557	4,867	0,002
	Withingroups	377,856	517	,731		
	Total	388,528	520			

When the results of the ANOVA regarding the difference of the acceptance mean scores according to the faculty members in which the students were educated were examined, it is seen that this difference is statistically significant ($p < 0.05$). According to the Tukey test, which shows the difference between the meanings, the acceptance mean scores of the students studying at the faculties of engineering and theology were 0.690 and 0.873 units more respectively than the students enrolled at the health high school. Therefore, it can be said that the students studying at the faculty of engineering and theology have a warmer view of nuclear power plants.

It is understood that the nuclear acceptance mean scores differ according to the political opinion supported by the family ($p<0.05$). According to the Tukey test; it is observed that this difference emerged in the children of families with conservative, social democratic and nationalist views. The mean score acceptance of nuclear energy in children of conservative families is 0.364 and 0.243 units more than in social democratic and nationalist families, respectively.

When we look at the political opinion supported by the participants themselves; it is observed that there is a statistically significant difference in acceptance averages of the students ($p<0.05$). According to the Tukey test; students who defined themselves as conservatives have a higher acceptance level than those who define them as social democrats.

4. DISCUSSION AND CONCLUSION

In the study, the causal relationships among the factors affecting the nuclear energy acceptance levels of the students were analyzed by SEM with the questionnaire applied to 521 undergraduate students at the faculties located at the Kütahya Dumlupınar University Evliya Çelebi Campus in 2015-2016 education year. In this context, considering the theoretical framework, nuclear power acceptance factors, which are latent variables, have been put forward and the effects of trust, perceived energy supply benefit, perceived environmental benefit and risk perception on the nuclear power acceptance of university students have been tested. Nevertheless, as we have seen in the literature, perceived benefits for the environment, perceived benefit for energy supply, risk perception and trust-based causal model, which explain the nuclear power acceptance of university students in Turkey, have not yet been investigated. Since the empirical work on the acceptance of technologies that Turkish people think is dangerous in the context of nuclear power is very limited, it is thought that this work contributes to the literature on the relation between perception of benefit, perception of risk, trust and acceptance of nuclear energy.

In the conceptual model containing 5 latent variables and 19 observed variables, it was determined that the most important variable affecting nuclear power acceptance is the perceived energy supply benefit. As a result of the analysis, it has been determined that students' beliefs in the benefit of nuclear energy supply have a positive effect on nuclear energy acceptance levels ($\beta = 0.51$, $t = 4.65$). The relationship between these two variables in the literature is proved by Li et al. (2015) and Visschers et al. (2011). In the study of Ateş and Saraçoğlu (2013) applied to science teachers, reached the conclusion that students thought that nuclear energy could be an effective factor in closing the energy gap in the country. The reason for this is that the supply of energy is directly related to the daily lives of people. For example, people need electricity every day and demand winter heat supply (Visschers et al., 2011: 3626). In addition, it is expected that Turkey's energy needs will have 200% by 2020 and world's energy needs have 60%. Therefore, Turkey should invest in increasing energy investments by three times the world average (ITO, 2007: 12). Energy demands in countries are increasing with population growth and economic growth. Turkey is inadequate about energy resources in terms of population and per capita energy consumption. In this regard, creating energy policy for the future is a necessity for Turkey. For this reason, nuclear power generation capacity can meet the growing energy demand of Turkey in the long run. As a result of this research, it can be said that Turkish university students have realized the situation of the energy supply in Turkey and regard the benefit of energy supply as an important factor.

While risk perception negatively affects nuclear acceptance, perceived environmental benefit has a positive effect on acceptance. The studies in the literature support the findings obtained by analysis result. In the study of Wang and Li (2016) which is based on the establishment of the research model, the hypothesis that the students have a positive effect on the nuclear energy acceptance level of the environmental benefits of nuclear energy is statistically verified ($\beta = 0.29$ $t = 2.91$). Pidgeon et al. (2008) emphasized that the environmental benefit of nuclear energy is an alternative solution to climate change, and that people have a positive influence on nuclear energy adoption. Bickerstaff et al. (2008) and Spence et al. (2010) have shown that perceived environmental benefits play a decisive role in nuclear energy adoption. Bird et al. (2014) conducted a nationwide survey in 2010 to investigate Australian attitudes toward nuclear energy as climate change. The majority of respondents (42%) indicated that nuclear energy is ready to accept climate change as mitigation. With the increasing energy demand per capita and young population, rapidly increasing urbanization and economic development, Turkey has been one of the world's fast-growing energy markets for the last two decades. Turkey is heavily dependent on expensive imported energy resources, which are a major burden on the economy. Air pollution, which is associated with increased industrialization, creates a great environmental concern in the country (Bilgen vd., 2008: 393). The use of nuclear energy does not produce carbon dioxide, sulfur dioxide, or nitrous oxide gases, such as fossil fuels. One gram of uranium produces as much energy as a ton of coal or oil. Accordingly, nuclear waste is about a million times smaller than fossil fuel waste. Most fossil fuels cause global warming, acid rain, smoke and other atmospheric pollutants (Comby, 2006: 2-3). Nuclear energy, which produces almost no air pollution, has a lower carbon emission level compared to fossil fuels and plays an active role in mitigating climate change (Adamantiades and Kessides, 2009: 5150). For this reason, the benefits of nuclear energy for the environment have emerged as an important factor affecting nuclear acceptance for the students.

Nevertheless, it has been found that students have a lower and negative influence on nuclear acceptance compared to nuclear power risk perceptions, perceived environmental benefit and perceived energy supply benefit latent variables. Visschers et al. (2011), Wang and Li (2016), Li et al. (2015) and Whitfield et al. (2009) also showed a consistent result for this statistically valid relationship (β = -0.10, t =-2.25). Finally, the TRUST sense has been identified as an indirect influence of nuclear energy acceptance. This finding may be related to the absence of any nuclear accidents in Turkey and the sense of security of the students to government.

In the research model, the H_1 hypothesis, which expresses the positive relationship between the statistically significant TRUST and PEB latent variables, is confirmed in parallel with the studies of Wang and Li (2016) (Υ = 0.78, t = 7.75). In addition, the H_2 hypothesis, indicating that students had a positive influence on the beliefs about the energy supply benefit of trust perceptions of nuclear energy, was found to be statistically significant, Similar to the study, Visschers et al. (2011) suggested that there is a positive and meaningful relationship between these two latent variables in research models. The analytical results obtained statistically confirm the authors' allegations (Υ = 0.83, t = 9.71). This can be cited as the policies and strategies of the Turkish government to secure nuclear energy supply security. Among these policies is the reduction of the environmental impacts, along with the adoption of policies that take measures to meet the country's energy needs with safe, continuous, lowest cost and least environmental destruction (MENR, 2011).

In the research model, it is stated that students have a negative influence on the perceptions of trust regarding nuclear energy (trust) and risk (risk). This relationship, which is stated in the H_3 hypothesis, was rejected statistically (Υ=-0.09, t = -1.34).

In terms of demographic variables, it was determined that the students' mean scores of nuclear energy acceptance level differs according to gender, faculty, nuclear knowledge, family and the political opinions of the individual himself. These results are in line with the findings of Özdemir and Çobanoğlu (2008). Considering that girls are more sensitive to the environment and that nuclear energy may have developed a hesitant attitude towards the environment, it can be considered as a reason why male students' nuclear energy perspectives are more positive than female students. The high level of acceptance of the students studying at the faculty of engineering is the result of the lessons that students have taken in the undergraduate program. It can be considered that the high level of acceptance of the family and the students who regard themselves as conservative may be related to the adoption of a close opinion of the ruler.

Nuclear energy studies could be conducted in different regions and cities in Turkey where nuclear power plants like Mersin-Akkuyu, Sinop-İnceburun are planned in order to reveal the thoughts of wider masses of society.

The limitation of the study is that the study does not include all relevant factors affecting nuclear power acceptance and that the individuals participating in the survey are selected only from university students. Information on individual beliefs, personal norms and moral values may be added as a determinant of nuclear energy acceptance in future research. Nevertheless, 521 students may not be sufficient for university students to demonstrate the level of nuclear power acceptance of the entire country. As the diversity of participants is limited, future researchers may take into account the views of the general population of Turkey and local citizens, especially those living near nuclear power plants, in order to determine the acceptance of nuclear energy. Relevant efforts could be made to reduce the level of anxiety of the people about nuclear energy. In addition, since the importance of mass media in community life cannot be denied, a wide range of people can be informed on this issue.

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