The social acceptance of shale gas development: Evidence from Turkey

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ABSTRACT
Social acceptance can have an important impact on the market penetration of energy technologies and the successful implementation of energy policies. Hence, it is essential to develop quantitative measures of acceptance to be able to manage it. This study adopts a behavioral model to examine the antecedent factors of the social acceptance of shale gas development in Turkey. It utilizes data from a structured questionnaire to estimate a partial least squares model that is based on psychological factors that impact acceptance. This study then explores the influence of the source and content of information on shale gas acceptance. The model results indicate that environmental problem perception and perceived costs do not have a significant effect on the social acceptance of shale gas development. The results have important implications for policymakers as well. The analysis demonstrates that attitudes may be changed through selecting an adequate means of communication between professional actors and society. Effective communication may reduce anxiety about risks associated with shale gas development by allowing individuals to develop a better understanding of the technology. The analysis also suggests that information provision by scientists may prevent the utilization of previous experiences in constructing a knowledge base.

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1. Introduction

Recent developments, particularly conflicts associated with energy technologies, have delineated that decision-makers should be considerate of important realities about human interactions with environmental, economic, and energy systems. While technological, economic, and environmental constraints to implementing low-carbon infrastructure projects will be important in the near term, the social acceptance of alternative solutions and the behavioral aspects of energy system transformations are most likely to be equally challenging. Individuals will need to alter their behavior, both at their residences and workplaces. Attitudes may dictate the ease of implementing policy interventions related to energy technologies [1]. Papadis and Tsatsaronis [2] emphasize that increased public acceptance of alternative solutions must accompany economic and environmental constraints to reach targets because the lack of acceptance may impose very high costs or eliminate very large gains.

Although the general opinion may be positive towards new energy projects, local acceptance may be lacking. Raven et al. [3] refer to this as a ‘social gap’. Despite its importance, quantifying social acceptance is a challenge due to difficulties in collecting data on indicators and quantifying factors that can be directly employed in technical analyses of the energy-economic-environment-society (3 ES) nexus. It is relatively easier to measure and monitor the 3 Es, but difficult to do so for the S dimension. Recent studies took on the challenge and used quantitative methods to study the social acceptance of different energy projects. Nevertheless, no single approach or group of metrics has emerged as best practice. For instance, Savvanidou et al. [4] studied perceptions of biofuels in Greece using data gathered from face-to-face interviews. On the other hand, Musall and Kuik [5] analyzed the influence of a community co-ownership model on the local acceptance of renewable energy in Germany. Another study by Bhowmik et al. [6] explored the determinants of “green energy” acceptance in the Tripura
Alongside behavioral measures of risk perception, and socioeconomic variables such as age, gender, and education level advocated. It follows the behavioral model framework proposed in K. Developments in Denmark. That explained attitudes towards on-land and offshore wind power (i.e., zip code, region, city size, proximity to a wind turbine) in addition to belief-orientated variables in a probit model. Several acceptance studies focused on behavioral factors in explaining attitudes. Montjin-Dorgelo and Midden [8] studied the mediating role of negative affective associations and trust in the risk perception of hydrogen as an energy carrier in transportation. Midden and Huijts [9] included factors such as trust, positive and negative effects, perceived risks, and perceived benefits to explain attitudes towards CO2 storage. Similarly, Bronfman et al. [10] used behavioral factors such as trust, and risk and benefit perception and assessed the acceptance of electricity generation sources, though they did not differentiate between the methods of generation.

Some scholars examined attitudes via a combination of sociodemographic and behavioral factors. In investigating the influence of procedural and outcome fairness on the acceptance of nuclear power plants in Switzerland, Visschers and Siegrist [11] included socioeconomic variables such as age, gender, and education level alongside behavioral measures of risk perception, and benefit perception for the climate and the economy. Similarly, Ladenburg [12] included socioeconomic variables as well as geographical variables (i.e., zip code, region, city size, proximity to a wind turbine) in addition to belief-orientated variables in a probit model that explained attitudes towards on-land and offshore wind power development in Denmark.

This research aims to show how analytical approaches may be used to understand attitudes towards shale gas development and to identify factors that could guide public information. It follows the behavioral model framework proposed in Kanoğlu and Soytas [13] and seeks to understand perceptions that underpin acceptability to provide a more generalizable, effective, and strategic approach to advocacy.

Opinion polls have offered valuable insight into the way people perceive shale gas development, though they have mainly studied attitudes in relation to sociodemographic variables [14,15] or spatial variables and how they interact with factors like economic, social, or environmental risks and benefits [16–18]. The relationship between geographic proximity and the acceptance of energy technologies has received a lot of attention from scholars. Yet, the literature presents mixed results for this relationship. Some studies have referred to the Not in My Backyard (NIMBY) phenomenon [19,20]. Others have argued that the NIMBY concept has become an “insufficient and overly simplistic explanation” for all types of opposition [21] and have provided examples for the “in reverse NIMBY” [22] or “Yes in My Backyard” [23] response. Researchers also noted that social acceptance is a process of aligning a broad spectrum of personal, ideological, social, cultural, physical, contextual, political, and ideological factors, and coordinating solutions [24,25]. In the context of shale gas development, some studies found no relationship between geographic proximity and acceptance [26], while others found evidence supporting the inverse of NIMBY [27]. In fact, individuals who live in close proximity to development are more likely to exhibit more negative attitudes towards the industry when compared to individuals who reside in areas where the industry is less mature [28,29]. They are also more likely to perceive energy resource development as a necessity, and less likely to perceive development as an environmental threat [28]. The literature suggests that attitudes toward natural gas development are highly dependent on environmental attitudes, experience with industry, development, or employment [26,27], and economic opportunities [28,29].

Attitudes have high spatial variance at an individual level; hence researchers have also explored state-level differences [31]. The results of a study on two spatially adjacent states, New York, and Pennsylvania, pointed to the influence of location of the primary residence on the way they weigh the risks and benefits [31]. Research around how different communities view shale gas development is limited, most of which are conducted in the U.K. such as [15,32] and a series of follow up studies in 2013, 2015, and 2017 [33–35] and very recently in China [36]. These studies have, in addition to highlighting spatial differences in attitudes, underscored the dynamic nature of social acceptance by demonstrating that attitudes may vary at different stages of the project implementation [33–35]. They also claimed that the underlying reason for these variations may be knowledge, as sufficient knowledge is necessary for individuals to reach a reasoned judgment [32,33,35].

Several opinion polls tried to understand the relationship between knowledge and perceptions of hydraulic fracturing and most of these surveys have pointed out the lack of familiarity with shale gas development. For instance, Boudet et al. [14] noted that even though a large share of respondents indicated they had some amount of knowledge about the technology, only less than 10% could specify its environmental impacts such as water quality (7%); economic impacts such as employment opportunities and affordable energy (3%); and social impacts such as effects on property and individuals (1%). Studies in the UK [22,33] pointed to a probable relationship between information provision and attitude formation [32]. The University of Nottingham survey noted that the increase in peoples’ familiarity with shale gas development, was associated with a change in the attitude towards the technology [33]. One weakness of the surveys intended at capturing this relationship is that they either noted changes in average responses of favorability metrics over time [33–35] and as exposure to information increases [32] or they reported results, which are based on sociodemographic, geographic [15,32] and familiarity measures [14], rather than establish the causal pathways that lead to changes in the attitude. Therefore, to provide guidance for policymakers to improve social acceptance, this study considers the impact of alternative forms and sources of information. The structured questionnaire is administered in Turkey, where shale gas development has not taken place and has not received a lot of attention from the media, and the results are then analyzed by the partial least squares (PLS) method. The results of the measurement and structural models are then compared and the policy implications of the findings are discussed.

Turkish energy demand relies heavily on fossil fuels (80%). Oil and coal account for 30% each, whereas natural gas meets 20% of energy demand. The IEA 2021 Turkey, Energy Policy Review points out that despite the recently discovered Sakarya reserve in the Black Sea region, and the bilateral agreements on gas pipelines from Russia, and Azerbaijan, Turkey will remain dependent on oil and gas imports. Hence, the country must utilize domestic resources fully to improve its energy security. In that respect, the country is assessing the potential of shale gas, gas hydrates, and coal bed methane in its overall energy mix. Currently, fracking is not restricted in Turkey. However, Energy Market Regulatory Authority may choose not to grant the license or may ask for additional guarantees. This paper contributes to the assessment of this largely unexplored potential by evaluating whether public acceptance can be a hindrance.

While there is no “one size fits all” solution [2,3], by providing an example of how behavioral and social criteria may be quantified such that they can be incorporated in multi-criteria assessments, this paper presents an approach that can be adapted to different types of energy technologies or different spatial settings.

2. Theoretical framework

Ajzen’s theory of planned behavior [37] suggests that attitudes, subjective norms, and perceived behavioral control are critical
dimensions in understanding the intention to exert a particular behavior. Attitudes refer to the extent to which a behavior is favorable, given that the behavior has positive or negative outcomes, while subjective norms refer to the influence of social pressures that urge the individual to perform or refrain from a behavior, and behavioral control refers to the ease of performing the behavior [37]. For this research, the behavior in question is narrowed down to expressing an opinion through responding to a questionnaire anonymously as there are no shale gas developments in Turkey yet. This eliminates any difficulty in performing the behavior and any social pressure that could urge individuals not to perform the behavior. Therefore, social norms and perceived behavioral control are excluded from the model. However, through the inclusion of an indicator for the degree of active promotion desired, attitudes are accounted for in the conceptual model.

Following Tokushige and Tomoda [38], who suggested that independent of the energy technology, the variance in levels of opposition and support could be attributed mainly to perceived risks, benefits and costs, these factors were included in the model. In this respect, development costs, risks such as surface and groundwater contamination and induced seismicity events [39], and benefits such as economic growth and increase in employment opportunities [40] are selected as relevant indicators. Perceived values of these factors influence attitudes towards shale gas development [37,41].

The norm activation model [42] is another theoretical framework that applies to the energy technology acceptance. Personal norms are activated when individuals recognize the negative consequences of not behaving in a socially desired way, and when they feel they may contribute to solving problems (i.e., outcome efficacy) [42]. As shale gas development has not been part of policy discussions in Turkey, and the behavior of interest is the expression of attitudes through responding to a questionnaire, there would be no feeling of moral obligation associated with the action. Hence, personal norms are not included in the model. Nonetheless, its antecedents, perceived benefits, risks and costs, outcome efficacy, and problem perception are considered [42,43]. Problem perception is another factor that could impact the social acceptance of shale gas development significantly [44,45]. The reasoning is that individuals who are more concerned about the prevention of global warming would favor a technology that reduces CO₂ emissions [45]. Outcome efficacy is also considered an important factor in explaining the acceptance of shale gas development [46].

Theories on affect constitute another important dimension of the conceptual model [47]. Peters and Slovic [48], and Montijn-Dorgelo and Midden [8] show that positive affect encompasses feelings like pride, happiness, satisfaction, and negative affect that blankets fear, worries, anger were independent and significant factors in predicting the acceptance of energy technologies. Contrarily, this study proposes evaluating affect through other factors in the model because these feelings are intertwined with environment or health concerns and perceived economic and social benefits associated with the energy technology in question. This is deemed appropriate because the negative affect “worry” resulting from natural gas’ presence in taps [49] could be linked to safety concerns, lack of knowledge about shale gas, a lack of trust in the developers and regulators, or unfortunate experiences. Thus, integrating affective imagery into risk and benefit perception measures would serve to capture the relevance of affect as well.

Trust has a critical role in the conceptual model [50]. Prior research by Huijts et al. [44], concluded that when the public has little knowledge about the technology, and little desire to obtain more information, trust in professional actors becomes more important in explaining attitudes. They state that excessive trust could create more tolerance for uncertainties and a lack of it could diminish cooperation [44]. Following the literature [10,45,51], trust is linked to acceptance through perceived benefits, risks, and costs. In measuring trust, the factors that are commonly suggested by literature: the perceived intentions [10,44,52,53] and competence of professional actors [45,52–54], reliability [45], transparency in planning [5,53], ability to act without private or political pressures and obligations [10], the tendency to disclose information [45] and the degree to which the communicator will be truthful in the information communicated [54] are considered. This research follows the approach of Huijts et al. [44] and Montijn-Dorgelo and Midden [8] and treats trust in the industry and its regulators independently since the roles of these actors in the process of shale gas development are distinct.

The perceived distributive fairness [55,56], and procedural fairness are other crucial determinants [56,57]. In relation to distributive fairness, Schuitema et al. [55] suggest that fairness is based on collective outcomes more strongly influences acceptance than fairness related to personal outcomes. Accordingly, this study focuses on the between-group distributions of benefits, risks, and costs. Procedural fairness is also relevant because it could potentially influence the perceived transparency and thus the trust dynamics of the decision process [58].

The experience factor has two pillars: one that encompasses the impacts associated with the technology directly [59], the other that encompasses the impacts perceived to generate concerns similar to those associated with shale gas development. For the first pillar, experience could serve as a means of accumulating knowledge. For instance, individuals residing in a region where shale gas development activity takes place may weigh the technology’s risks and benefits more accurately [59]. For the latter, it could result in an erroneous evaluation of the risks and could influence acceptance significantly. An example of this could be the experience of an earthquake. Individuals who have previously experienced an earthquake could be more susceptible to oppose the technology if they are informed that the technology bears a seismic risk. The former pillar is not applicable to the case of Turkey because there are no shale projects in the region. Including this dimension where shale gas development has already taken place may be crucial.

Knowledge is also important because it is considered as a means of arriving at a sound judgment [60]. Survey data [14,32,33] underlines the deficiency of knowledge and the lack of a clear understanding of the risks associated with and benefits to be derived from shale gas development. Thus, this research explores the impact of information provision on acceptance. The study concentrates on two channels through which information provision could be influential, the source and content of information. Key actors involved in decision-making processes such as the government, industry, environmental NGOs, and scientists could instill a sense of security in local communities and reduce uncertainties [61]. A recent study by Wang et al. [62] confirmed this hypothesis for nuclear energy in China. Information publicity positively and directly impacts public acceptance and the relationship between them is dependent on the credibility of the information [62]. In terms of the content, certain details of an information package may not appeal to the audience. Based on a survey of Japanese university students, Tokushige et al. [45] discerned that information on natural analogues, and on-field demonstrations incremented the public acceptance of the geological storage of carbon. On the other hand, information concerning the scientific process of carbon storage did not influence attitudes [45]. To explore the validity of this argument, a graphical representation of the scientific process of shale gas development is included in one of the information packages in this study.

A conceptual model is constructed with perceived benefits, risks and costs, procedural and distributive fairness, trust, outcome
efficacy, problem perception, knowledge, and experience constructs (see Fig. 1). For a more detailed discussion, the readers may refer to Kanoglu and Soytas [13].

3. Research method

3.1. Country

Turkey is a country where shale gas development has not started and hence the technology has received little to no attention from the media. The country's natural gas production in 2013 was equivalent to only 1.5% of its consumption [63]. Considering that Turkey has 24 trillion cubic feet of technically recoverable shale gas in the Southeastern and Thrace regions [64], it is possible to assert that the development of shale gas in the country could potentially reduce its foreign natural gas dependency.

3.2. Participant selection

The questionnaire was administered to the students, parents, alumni, faculty, and staff of Middle East Technical University (METU) of Ankara, Turkey. A convenience sampling approach was used. The survey respondents were reached at crowded locations on campus, which included classrooms, study halls, restaurants, libraries, and cafeterias. Their participation in the survey was entirely voluntary.

Whether undergraduate students are appropriate surrogates for non-student populations in consumer and behavioral research in general, is controversial. One argument is that college students systematically differ from nonstudents in that they are more homogeneous [65, 66]. This homogeneity translates into stronger hypothesis tests than if non-student subjects are used, as there is less noise or variation associated with their responses [67]. Peterson [68] explored the validity of this argument and concluded that “the responses of college student subjects were slightly but consistently more homogeneous than those of nonstudent subjects, both within and across scales.” Furthermore, he found nearly half (48%) of the effect sizes obtained from college student respondents were significantly different from those derived from non-student respondents [68]. Mullinix et al. [69] explored how the magnitude of treatment effects produced by convenience samples compared to the effects derived from population samples and suggested that the causal effects are comparable. Hence, one should be cautious when using student samples and recognize the implications of the results, particularly if the research is intended at producing universal principles. Indeed, producing universal principles is not the aim of this research. This study starts with the conception that social acceptance shows spatial and temporal variance and intends to propose a method that is widely applicable. Then, by presenting a case study in Turkey, this study demonstrates the kind of results that may be derived from this generalizable approach.

Another important note is that the focus of this research is attitudes, not behavior. Beltramini [70] claimed that students are representative of adults or non-student samples in consumer research at the attitudinal level but are less appropriate as surrogates in research at the behavioral level. Hence, using a student sample is not expected to be inappropriate for this study. Though the results presented here are not universal, this study provides an approach for future research utilizing more generalizable samples.

3.3. Research approach

This study approached the social acceptance of shale gas development through testing deterministic propositions. In testing such relationships, surveys and case studies emerge as common approaches [71]. As this research intended to trace changes in acceptance and its antecedents as individuals were provided with information of different content from different sources, identifying relevant case studies would have been challenging. The main reason for this is that it would have required testing twelve different hypotheses, which would complicate the formulation of different settings that would allow the scrutiny of changes in all constructs. Consequently, conducting a survey was selected as the appropriate methodology. Responses were collected through paper surveys.

3.4. Survey questions

The questionnaire was designed to trace changes in the social acceptance of shale gas development and its antecedents. The

![Fig. 1. An illustrative representation of the hypothesized relationships for the model of the social acceptance of shale gas development. The ellipses designate latent variables (i.e., perceived benefits, risks and costs, procedural and distributive fairness, trust, outcome efficacy, problem perception, knowledge, experience, and acceptance), and a single-headed arrow represents the direction of causality.](image_url)
questions included represent latent factors in the conceptual model. While most were adapted from previous research, some were peculiar to this research (see Table 1). The item related to seismic risks, for instance, was self-constructed to capture perceptions of the risks that are frequently associated with shale gas development. Apart from the yes/no question for the experience indicator, the items in the questionnaire were measured on a five-point Likert-type scale with values ranging from “1: strongly disagree” to “5: strongly agree.” In addition, a “0: don’t know” option, which was treated as a missing response, was included in the survey so that individuals uninformed about the technology could be identified. All indicators were evaluated as reflective items, meaning that they changed in the same direction as the latent variable they were associated with. The adequacy of the measurement model was assessed initially with respect to the item and construct reliability values and then with respect to convergent and discriminant validities [72].

Table 1
Survey items and their foundations.

| Survey Items                          | Papers Used                                                                 |
|---------------------------------------|----------------------------------------------------------------------------|
| Experience E                         | Self-constructed                                                           |
| Disaster experience (E1)              |                                                                             |
| Knowledge (K)                        | Self-constructed                                                           |
| Sufficiency of climate change knowledge (K1) | Self-constructed                                                           |
| Sufficiency of shale gas knowledge (K2) |                                                                             |
| Trust (T)                             |                                                                             |
| Reliability (regulators) (T1)         | Tokushige et al. (2007)                                                     |
| Reliability (operators) (T2)          | Tokushige et al. (2007)                                                     |
| Disclosure of information about shale gas (regulators) (T3) | Frewer et al. (1996), Tokushige et al. (2007)     |
| Disclosure of information about shale gas (operators) (T4) | Frewer et al. (1996), Tokushige et al. (2007)     |
| Disclosure of information about alternatives to shale gas (regulators) (T5) | Self-constructed                                                           |
| Disclosure of information about alternatives to shale gas (operators) (T6) | Self-constructed                                                           |
| Intentions (regulators) (T7)          | Bronfman et al. (2012), Huijts et al. (2007), Johnson (1999), Peters et al. (1997) |
| Intentions (operators) (T8)           | Bronfman et al. (2012), Huijts et al. (2007), Johnson (1999), Peters et al. (1997) |
| Competence in assessment (regulators) (T9) | Self-constructed                                                           |
| Competence in assessment (operators) (T10) | Self-constructed                                                           |
| Ability to interfere when a problem arises (regulators) (T11) | Self-constructed following the approach of Tokushige et al. (2007) |
| Ability to solve problems (operators) (T12) | Self-constructed following the approach of Tokushige et al. (2007) |
| Safety concern (regulators) (T13)     | Tokushige et al. (2007)                                                     |
| Safety concerns (operators) (T14)     | Tokushige et al. (2007)                                                     |
| Transparency in planning (T15)        | Musalli and Kuik (2011), Peters et al. (1997)                              |
| Political independence (operators) (T16) | Self-constructed following the approach of Tokushige et al. (2007) |
| Perceived Risks (R)                   | Self-constructed following the approach of Huijts et al. (2007) and Tokushige et al. (2007) |
| Personal risk (R1)                    | Huijts (2012)                                                               |
| Social risk (R2)                      | Huijts (2012)                                                               |
| Environmental risk (R3)               | Huijts (2012)                                                               |
| Risk to future generations (R4)       | Huijts (2012)                                                               |
| Seismic risk (R5)                     | Huijts (2012)                                                               |
| Severity of consequences when a problem occurs (R6) | Tokushige et al. (2007) |
| Scientific knowledge about risks (R7) | Tokushige et al. (2007)                                                     |
| Perceived Benefits (R)                | Tokushige et al. (2007)                                                     |
| Personal benefit (B1)                 | Tokushige et al. (2007)                                                     |
| Social benefit (B2)                   | Tokushige et al. (2007)                                                     |
| Environmental benefit (B3)            | Bronfman et al. (2012), Huijts et al. (2007)                               |
| Benefit to future generations (B4)    | Tokushige et al. (2007)                                                     |
| Economic benefit (B5)                 | Tokushige et al. (2007)                                                     |
| Development necessity (B6)            | Huijts (2012)                                                               |
| Perceived Costs (C)                   | Huijts (2012)                                                               |
| Development costs (C1)                | Huijts (2012)                                                               |
| Procedural Fairness (PF)              | Huijts (2012)                                                               |
| Inclusion in decision making (PF1)     | Huijts (2012)                                                               |
| Distributive Fairness (DF)            | Tokushige et al. (2007)                                                     |
| Fair distribution of risks and benefits (DF1) | Tokushige et al. (2007)                                                    |
| Need for preventing global warming (PP1) | Tokushige et al. (2007)                                                    |
| Global warming as a concept against nature’s laws (PP2) | Tokushige et al. (2007)                                                    |
| Global warming as a negative legacy from the development of civilization (PP3) | Tokushige et al. (2007)                                                    |
| Outcome Efficacy (OE)                 | Huijts (2012)                                                               |
| Consideration of opinions (OE1)       | Huijts (2012)                                                               |
| Acceptance (A)                        | Tokushige et al. (2007)                                                     |
| Personal acceptance (A1)              | Tokushige et al. (2007)                                                     |
| Social acceptance (A2)                | Tokushige et al. (2007)                                                     |
| Acceptance of future generations (A3) | Tokushige et al. (2007)                                                     |
| Environmental acceptance (A4)         | Bronfman et al. (2012)                                                      |
| Not in my back yard (NIMBY) (A5)      | Tokushige et al. (2007)                                                     |
3.5. Information provision

Data is collected from a control group that responded to the questionnaires without any information and a treatment group where participants were randomly provided with an information package that included either a summary of current discourses of key actors involved in the process of shale gas development, as in Huijts et al. [44] or a visual representation of the scientific process of shale gas development through hydraulic fracturing. The government, the industry, environmental NGOs, and scientists were identified as actors that could influence acceptance because they are involved in policymaking, the implementation of projects, the provision of information on environmental issues, and in the formulation of a shared fact base for the technology.

4. Data analysis

4.1. General information

Overall, 302 respondents completed the questionnaire for the control group, and 315 completed the survey for the information group. The gender distribution was balanced for both groups (145 females and 139 males for the control group; 144 females and 154 males for the information group). The respondents were relatively young with approximately 66 and 82% of respondents within the age range of 18–24 for the information and control groups, respectively. The participants were from engineering, economic, and administrative sciences disciplines.

4.2. Data screening: normality and outliers analysis

Responses for which more than 75% of the indicator values were missing, were removed from the data set. As the trust factor had many indicators, it was treated separately for the data screening process. Responses having more than 25% missing values were removed. The examination of histograms revealed no outliers. The normality of the distributions was analyzed to determine whether parametric or non-parametric tests should be used. Both Kolmogorov-Smirnov and Shapiro-Wilk tests indicated that all variables showed significant non-normality. Therefore, the data were analyzed using a non-parametric method called the partial least squares (PLS) technique [73].

4.3. Group-wise comparison

A comparison of the acceptance indicators of the information and the control groups was made to see whether there were significant differences in attitudes towards shale gas development. The mean acceptance values represented in Table 2 for the control (\(H_{\text{control}} = 3.2\)) and information (\(H_{\text{information}} = 2.9\)) group were on different ends of the acceptance spectrum. While on average, the control group displayed a favorable attitude towards shale gas development, the information group had a slightly negative attitude towards the technology.

A one-way ANOVA test identified differences between the means of the acceptance levels of different information groups. The post hoc Tukey and Bonferroni test results presented in Table 3 suggested that the means of acceptance of shale gas development close to one’s house was significantly different for the control group and the group that received information from scientists. Additionally, the validity of the homogeneity of variances assumption was explored using the Levene statistic. The significance values suggested that the homogeneity of variance did not hold for the “development close to one’s house” indicator. Yet, further analysis of the Kruskal Wallis test results suggested
that the homogeneity of variance assumption held asymptotically. The ANOVA result indicates a significant difference between the acceptance levels close to one’s house among the control group and the group that received information from scientists was valid. The verified difference between the two groups implies that information of proper content from certain actors could help overcome the “not-in-my-back-yard” syndrome.

4.4. Structural equation modeling (SEM) and the partial least squares (PLS) method

Structural equation modeling (SEM) is a statistical technique that simultaneously estimates interdependent relationships between latent variables. Latent variables are not directly observed but inferred through their manifestations [74]. The latent variables (see Fig. 1) are perceived benefits, risks, and costs, procedural and distributive fairness, trust, outcome efficacy, problem perception, knowledge, experience, and acceptance. As a variance-based SEM method, PLS, which represents latent variables as a weighted composite score of their indicators, was used. This method places minimal restrictions on the sample size [75]. The nonparametric bootstrap method employed by PLS allows testing with smaller samples by randomly generating subsamples from the original data set. Furthermore, unlike the covariance-based SEM techniques, PLS does not result in negative variance estimates when the normality assumption is violated [75].

4.5. Measurement model results

The results for the control group presented in Fig. 2 and Table A.1 indicated that several items had loadings significantly lower than the accepted threshold of 0.7 [72,73]. However, it should be noted here that for more complex models 0.6 can be considered as the sufficient level [72].

Following this suggestion, the indicators “sufficiency of shale gas knowledge, transparency in planning, and political independence” were removed from the control group measurement model. Similarly, the following indicators were removed from the information group measurement model:

- Disclosure of information about shale gas (regulators)
- Disclosure of information about shale gas (operators)
- Disclosure of information about alternatives to shale gas (regulators)
- Disclosure of information about alternatives to shale gas (operators)
- Scientific knowledge about risks
- Economic benefit
- Global warming as a concept against nature’s laws

Were commonly removed from the constructs. The final loadings are presented in Table A.2.

4.6. Scale reliability and validity for the control group

Before testing hypotheses, the scale reliability and validity of each group were assessed. Reliability analysis scrutinizes the degree to which the measurement in a singular unidimensional construct is dependable [76]. According to the results presented in Table A.2, all modified constructs except one had a Cronbach’s alpha value greater than the recommended minimum of 0.7 [77]. The alpha for problem perception was substantially below the minimum. As the loadings of the indicators were not significantly different, and no other indicator reflective of problem perception was identified, no changes were made to the construct.

All composite reliabilities were greater than 0.811, which is significantly above the recommended minimum of 0.707. Moreover, the average variance extracted (AVE) was evaluated to compare the amount of variance that a latent variable captures from its indicators to the variance that is an aftermath of measurement error [75]. Apart from the value for the more complex construct of trust, the AVEs for all constructs were at least 0.656, which is higher than the suggested minimum of 0.5 [73,75]. On the other hand, the value of AVE for trust was 0.476, which is still close to the suggested minimum. As trust was measured by several distinguishable items with comparable loadings, no modulations were made to the construct. Convergent validity was interpreted through an inspection of the square root of AVEs represented in the diagonal elements of Table 4. The results showed that apart from that for the trust factor, for which the value was 0.69 still close to the threshold, convergent validity values were all greater than 0.707. This corresponds to high internal consistency.

Finally, the discriminant validity of constructs was examined. In doing this analysis, the notion was to make sure that each construct shares more variance with their own measures than they share with the remaining constructs in the model [72]. The discriminant validity assessments were made by comparing the square root of AVEs given in the diagonal of Table 4, and the correlations of the latent variable with different constructs. Results suggested that all

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Table 3
Intergroup comparison of acceptance levels. Significance code: 0.01 * 0.05.

| Dependent Variable (I) | Type       | Type             | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval |
|------------------------|------------|------------------|-----------------------|------------|-----|-------------------------|
| Not in my back yard    | Tukey HSD  | Control Group    | Information from the government | 0.446      | 0.171 | 0.097                   | -0.04 | 0.93                     |
|                        |            |                  | Information from the industry | 0.217      | 0.182 | 0.842                   | -0.31 | 0.74                     |
|                        |            |                  | Information from NGOs      | 0.414      | 0.186 | 0.229                   | -0.12 | 0.95                     |
|                        |            |                  | Scientific Information     | 0.144      | 0.203 | 0.981                   | -0.44 | 0.73                     |
|                        |            |                  | Information from scientists| 0.508*     | 0.168 | 0.032                   | 0.03  | 0.99                     |
| Bonferroni             | Control Group |                 | Information from the government | 0.446      | 0.171 | 0.141                   | -0.06 | 0.95                     |
|                        |            |                  | Information from the industry | 0.217      | 0.182 | 1.000                   | -0.32 | 0.76                     |
|                        |            |                  | Information from NGOs      | 0.414      | 0.186 | 0.401                   | -0.14 | 0.96                     |
|                        |            |                  | Scientific Information     | 0.144      | 0.203 | 1.000                   | -0.46 | 0.74                     |
|                        |            |                  | Information from scientists| 0.508*     | 0.168 | 0.040                   | 0.01  | 1.00                     |

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square roots of AVEs were higher than the correlations between the focal construct and the remaining constructs [78]. Hence, the validity measures were quite acceptable.

4.7. Scale reliability and validity for the information group

In terms of scale reliability, all constructs in the information group except one had a Cronbach’s alpha value greater than the recommended minimum of 0.7 (see Table A.2) [77]. The problem perception construct had an alpha of 0.487. Nevertheless, as the construct consisted of only two items, removing any item would resolve the issue with the low alpha value, so no changes were made to the construct. All composite reliabilities were greater than 0.792, which is above the recommended minimum of 0.707. Apart from the value for the more complex construct of trust, the AVEs for all constructs were at least 0.655, greater than the advised minimum [73,75]. For trust, the AVE value was found to be 0.477, which is acceptable given the complexity of the model being tested. For convergent validity, the results indicated that apart from that for the trust factor, for which the value (0.691) was still close to the threshold, convergent validity values were all greater than 0.707. A comparison of the square root of AVEs given in the diagonal of Fig. 2.

Table 4

Discriminant validity and convergent validity of the constructs of the control group. Abbreviations are listed as follows: A: Acceptance, B: Perceived Benefits, C: Perceived Costs, DF: Distributive Fairness, E: Experience, K: Knowledge, OE: Outcome Efficacy, PF: Procedural Fairness, PP: Problem Perception, R: Perceived Risks, T: Trust.

|     | A    | B    | C    | DF   | E    | K    | OE   | PF   | PP   | R    | T    |
|-----|------|------|------|------|------|------|------|------|------|------|------|
| A   | 0.810|      |      |      |      |      |      |      |      |      |      |
| B   | 0.704| 0.877|      |      |      |      |      |      |      |      |      |
| C   | -0.030| 0.056| 1.000|      |      |      |      |      |      |      |      |
| DF  | 0.320| 0.251| -0.072| 1.000|      |      |      |      |      |      |      |
| E   | 0.007| 0.033| -0.064| -0.031| 1.000|      |      |      |      |      |      |
| K   | 0.034| 0.098| -0.009| 0.016| 0.175| 1.000|      |      |      |      |      |
| OE  | 0.169| 0.120| -0.017| 0.236| -0.062| 0.049| 1.000|      |      |      |      |
| PF  | 0.051| 0.045| -0.046| 0.168| 0.043| 0.083| 0.405| 1.000|      |      |      |
| PP  | -0.116| -0.052| -0.101| 0.008| -0.108| -0.044| -0.188| -0.147| 0.828|      |      |
| R   | -0.385| -0.279| 0.399| -0.099| 0.045| -0.048| 0.006| 0.065| 0.019| 0.831|      |
| T   | 0.494| 0.424| -0.066| 0.448| -0.043| -0.033| 0.384| 0.277| -0.106| -0.239| 0.690|

Fig. 2. Measurement model results: a) Trust, b) Perceived Benefits, c) Perceived Risks for the control group and d) Trust, e) Perceived Benefits and c) Perceived Risks for the information group. The rectangles represent observed variables, i.e., the response to each question in the survey, and the ellipses represent latent variables. A single-headed arrow portrays the nature of the construct (reflective or formative) and the number on each arrow designates the standardized regression coefficient. Please note that although T9 appears to have a high loading in this figure, upon removal of other items from the construct, its loading remained below the recommended minimum of 0.6. This figure is for comparison of the initial measurement model only.
Table 5, and the correlations of the latent variable with different constructs suggested that discriminant validity was attained, as well [78].

4.8. Structural model results

To test the significance of the paths in the structural model, the bootstrap resampling method was used. The resampling size was chosen as 500 [75]. A tabular representation of the initial model results can be found in Table A.1 and visual delineation of the structural model results upon removal of items with low loadings can be found in Fig. 3 and Table A.2.

The structural model results suggested that many of the hypothesized relationships were supported. Table B.1 and Fig. 3 represent the causal effects and their significance. The following were not confirmed in both the information and control group:

- The cultivation of knowledge is positively associated with the establishment of trust
- If more trust is placed in actors that have a role in shale gas development or in those responsible for supervising shale gas development, the perceived costs associated with the technology will decrease
- An increase in environmental problem perception is associated with an increase in the acceptance of shale gas development
- An increase in perceived costs is associated with a decrease in the social acceptance of shale gas development
- Outcome efficacy is positively associated with the acceptance of shale gas development

The following hypothesized relationships were confirmed for the control group but not for the information group:

- Experience is positively associated with knowledge
- Distributive fairness has a significant positive impact on the social acceptance of shale gas development

The predictive power of the models for the control and information groups was assessed by the explained variance (R²) values in Table 2. The literature on explained variance suggests that the values of 0.67, 0.33, and 0.19 represented a substantial, moderate, and weak fit, respectively [73]. Provided this, the results in Table 6 implied that the explanatory power for the endogenous variables ranged between the weak and moderate levels for the control group. For the end goal of acceptance, the model had satisfactory results. The analysis results indicated that 56% of the total variance of the acceptance of shale gas in the control group was attributed to trust, perceived risks, and benefits, experience, procedural and distributive fairness. The values were slightly different for the information group and highly satisfactory results were achieved for the acceptance construct. The analysis results indicated that 65% of the total variance of the acceptance of shale gas development in the information group was attributed to trust, perceived risks, perceived benefits, and procedural fairness. For model fit, the goodness-of-fit formula of Tenenhaus et al. was used [79]. This measure is derived upon taking the square root of the product of the average R² value of endogenous variables (i.e., acceptance, perceived benefits, risks and costs, knowledge, and trust) and the average AVE value. For the control group, the computed value was 0.342 (see Table 6). Unfortunately, this was slightly below the theoretical cut-off of 0.36 [78]. The goodness of fit value for the information group was 0.371 (see Table 6), which is above the cut-off [78].

To execute a robustness check, a multigroup analysis (MGA) was conducted with 5000 subsamples using a model which included indicators common to the reduced form model of both the information and control groups. The results in Table 7 revealed no significant differences among the path coefficients of both groups. Even though there were numerical differences in the inner relationships between factors that impact acceptance, information provision did not alter the relationships among psychological factors that impact the acceptance of shale gas development significantly. In other words, while information provision produced changes in the signs of the latent variables and influenced the extent to which they impacted attitudes to a certain degree, it did not necessarily produce significant differences in each factor's contribution to the formation of a stance towards shale gas development. As the mean knowledge values presented in Table 2 for the control (µcontrol = 3.46) and information groups (µinformation = 3.52) underline, participants did not consider themselves to be very knowledgeable about shale gas development even after having received information. The lack of sufficient knowledge about the technology could possibly explain why the inner relationships did not change substantially. It should however be noted here that exploring how the amount of information provided impacts attitude formation is not the intention of this research. This research rather focuses on the impact of the source and content of information in explaining attitudes towards the technology. Future research might explore whether the amount of information provided, and the frequency of communication may create meaningful differences in the inner relationships between factors that impact acceptance such that it results in significant changes in attitudes.

5. Discussion and policy implications

There are several takeaways for policymakers and researchers from both the measurement and structural model results that are
discussed in the following sub-sections.

5.1. Measurement model discussion

The first important result was that information provision could address some major concerns of the public. Seismic risk was not an important factor when individuals were provided with information. This suggests that the high factor loading for the control group may be representative of the development of attitudes based on intuitive feelings. Given that the Thrace Basin in Turkey, where a significant portion of the shale resources is found, is a region deformed by the North Anatolian fault system [80], the survey respondents may have been anxious about induced seismicity events. Nevertheless, respondents in the information group were relieved, likely because they developed a better understanding of the technology. This finding is closely aligned with the results of studies in the U.K. [32,33,35], suggesting that policymakers should be cognizant of the dynamic nature of social acceptance, educate
people about the potential risks and benefits associated with resource development and continuously monitor how the acceptance measures in our model change. It is also critical to understand acceptance in countries with similar geological characteristics. The Marcellus play in the U.S., for instance, is surrounded by northeast-trending folds in the Valley and Ridge province [81,82]. Information provision could be key to building trust and reducing risk perception in this region.

Second, individuals who became more knowledgeable desired more transparency. This was confirmed numerically by tracing the loadings of the “transparency” indicator for the control and information groups. The low loading for the control group compared to the high loading in the information group (Table A.2) suggests that as exposure to information increases, communities may be disturbed by not being informed about the decision-making process. Prior research underlined the importance of this factor [5,53]. However, it had not traced changes in the significance of transparency as the technology and its potential impacts became part of the public discourse. This could be an interesting point for future research. Comparing the relative importance of the transparency indicator in regions or other countries where shale gas development is already taking place could make a valuable contribution. Overall, the major policy implication would be that authorities should explore effective communication options with the public at the very early stages of the technology’s adoption so that information disclosure does not constitute a barrier at the later stages of project implementation.

The final result was the low item loading of “economic benefit” for both the information and control group (see Table A.2). Given that previous research in the U.S. concluded that mineral rights ownership is associated with the public perception of the natural gas industry [28,30], it is likely that this result is peculiar to Turkey or other civil law countries that have similar mineral rights ownership structures. In Turkey, the economic benefits derived from resource development do not directly transfer to the individual landowners. The state exclusively and imprescriptibly owns the mineral rights [83]. While mineral rights owners in the United States have obtained substantial gains from royalty payments [39], individuals in Turkey do not feel that there would be any economic benefit associated with the development. Hence, policymakers should recognize the spatial differences in economic motives and reflect on how these differences may impact the way individuals form opinions on energy technologies before they develop business models for different countries.

5.2. Structural model discussion

The first important result of the structural model assessment was that environmental problem perception did not have a significant direct effect on the acceptance of shale gas development. In other words, the extent to which individuals felt that climate change constituted a threat did not impact their attitudes towards shale gas development significantly. This is an interesting finding, particularly because environmental problem perception had previously been identified as an important factor in explaining attitudes towards renewable energy development [20,46,47,61]. In designing the theoretical framework, we had hypothesized that individuals who were more concerned about the prevention of global warming would favor a technology that reduces CO2 emissions, whether this is a cleaner fossil fuel resource or a renewable energy source. However, not only did we find the factor of problem perception to be unimportant in explaining attitudes towards shale gas development, but we also discerned that the environmental interference perception for global warming exerted a negative influence on the social acceptance of shale gas development. This is where we believe fossil fuel acceptance models may differ from renewable energy technology acceptance models. Our analysis prompts us to believe that individuals do not associate shale gas development with a reduction of greenhouse gas emissions, an observation that has indeed been made in the U.K [33–35]. Not having made this association, a citizen concerned about humanity’s impact on the environment, becomes more supportive of renewable energy technologies rather than shale gas development, which is perceived as a dirty energy source (hence the negative association). Therefore, emphasizing the idea that shale gas has a cleaner environmental footprint will only be marginally beneficial. Instead, focusing efforts on addressing the technology-specific risks by setting stricter restrictions on flaring, supporting research efforts on wastewater disposal, or establishing a more equal distribution of benefits could influence attitudes more substantially.

The second important result was that while the experience factor was a direct determinant of knowledge for the control group, it was not a significant factor that explained acceptance for the information group. This suggests that when individuals are provided with information, they tend to rely on the knowledge acquired through that excerpt. When there is no such information though, experience may come into play. This is important for policy design because it undermines the setting of realistic and meaningful communication of information to the public. It is likely that authorities could prevent previous experiences from becoming a deterrent. Particularly, in regions where previous natural disaster experiences unrelated to shale gas development may shape opinions, policymakers should try to engage stakeholders as early as possible and disseminate information about the risks and benefits associated with the technology. This will ensure that individuals use factual information in arriving at a judgment and that they bring up more legitimate concerns.

The third important result relates to the perceived costs factor. The analysis showed that the hypothesized relationship between trust and perceived costs, and perceived costs and acceptance were both insignificant. Hence, the cost factor was revisited. One may claim that individuals either do not place importance on financial factors that they are not knowledgeable about or they do not believe financial factors impact them significantly. This is in line with our finding that economic benefit is not an important factor. This is most likely because they do not realize the extent to which development costs influence the prices that consumers face. If that is the case, then the shale gas discourse should focus on aspects that individuals are more familiar with and that have a more direct impact on local communities. These aspects could include issues such as water contamination and induced seismicity, which have been identified as relevant factors in explaining attitudes towards shale gas development [33–35].

6. Conclusions

There are at least three high-level benefits of the integration of social acceptance into energy resource policy discussions. First, it serves to get the science of societal risk evaluation right. Analytical models based on a set of simple assumptions such as the rational economic choice model with complete information have been criticized for not incorporating conclusions derived from empirical analysis of real-world phenomena into their structure. Although they are highly attractive from an intellectual standpoint, they remain unlikely to provide the level of understanding necessary to transition to sustainable systems within desired time frames. Moreover, while empirical models have been utilized broadly to study the societal impacts of oil and gas development, no single approach or group of metrics has emerged as best practice. The underlying reasons for this include the fact that the evidence
utilized in analysis comes from various sources including but not limited to local knowledge, scientific research, or a combination of the two, and that problems and interventions are context-specific. For this reason, key actors involved in decision-making processes have not been able to develop a common understanding of the current situation and key areas of improvement. On the other hand, the method employed in this research may provide a universal tool for population assessments and screening the relative impact various factors have on the opinions, evaluations, and behavioral intentions of the public.

Second, the framework employed here provides an opportunity to scale up localized solutions. Many sustainable solutions depend on very specific aspects of their ecosystems. For instance, differences in geological characteristics, regulatory environment, and market structure, and technical aspects require most of the interventions to be individualized. While research has been successful in identifying key barriers and opportunities on a case-by-case basis, empirical assessments of human interactions with environmental systems have not yielded universal laws. The model in this paper is promising in that it could apply to several different social and spatial contexts. Even though the analysis results would vary by country or region, the indicator development process used in this paper could be followed to evaluate the social acceptance of different resource extraction projects. Once the sensitivities of multiple communities are better understood, policymakers could compare these responses to identify the common traits and differences. To that end, we recommend targeting research at more locations to ensure that decision-makers focus on aspects that may achieve the greatest impact.

Third, this approach could be utilized for the continual improvement of policy designs. Developing practices that are responsive to public values, interests, and concerns through time is critical to developing sustainable solutions. This requires the metric to be a longitudinal measure, rather than an instantaneous measure of an attribute that may not be relevant in the future. Models that are based on psychological theories, can easily be used for adaptive management of natural resource policy. As technological and scientific advancements continue to inform decision-makers, they may identify novel indicators that are relevant to public acceptance and easily integrate them into the model while preserving the core latent construct structure.

Credit author statement

Dilge Kanoglu: Conceptualization, Methodology, survey design, Software, Validation, Formal analysis, Investigation, Data curation, writing, editing, Visualization. Ugur Soytas: Conceptualization, Supervision, survey design, Investigation, writing, review and editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A

| Construct      | Item Indicator | Item Loading (Control Group) | Item Loading (Information Group) | T Statistics (Control Group) | T Statistics (Information Group) | Cronbach’s Alpha (Control Group) | Cronbach’s Alpha (Information Group) | Composite Reliability (Control Group) | Composite Reliability (Information Group) | Communality (AVE) (Control Group) | Communality (AVE) (Information Group) |
|----------------|----------------|------------------------------|----------------------------------|------------------------------|----------------------------------|-----------------------------------|-------------------------------------|----------------------------------------|----------------------------------------|-----------------------------------|-----------------------------------|
| Experience     | E1             | 1.000                        | 1.000                            | 0.000                        | 0.000                            | 1.000                             | 1.000                               | 1.000                                  | 1.000                                  | 1.000                             | 1.000                             |
| Knowledge      | K1             | 0.962                        | 0.507                            | 2.790                        | 1.249                            | 0.500                             | 0.511                               | 0.497                                  | 0.741                                  | 0.465                             | 0.612                             |
|                | K2             | 0.065                        | 0.984                            | 0.164                        | 3.056                            | 0.065                             | 0.984                               | 0.164                                  | 3.056                                  | 0.065                             | 0.984                             |
| Trust          | T1             | 0.688                        | 0.654                            | 14.850                       | 13.361                           | 0.826                             | 0.838                               | 0.841                                  | 0.850                                  | 0.323                             | 0.308                             |
|                | T2             | 0.746                        | 0.508                            | 21.755                       | 16.834                           | 0.746                             | 0.508                               | 21.755                                 | 16.834                                 | 0.746                             | 0.508                             |
|                | T3             | –0.135                       | 0.565                            | 0.935                        | 0.398                            | 0.005                             | 0.984                               | 2.790                                  | 1.249                                  | 0.507                             | 2.790                             |
|                | T4             | –0.054                       | 0.523                            | 0.372                        | 0.740                            | 0.054                             | 0.523                               | 0.372                                  | 0.740                                  | 0.054                             | 0.523                             |
|                | T5             | –0.071                       | 0.712                            | 0.515                        | 0.675                            | 0.064                             | 0.722                               | 0.515                                  | 0.675                                  | 0.064                             | 0.722                             |
|                | T6             | 0.064                        | 0.722                            | 0.570                        | 1.397                            | 0.660                             | 0.658                               | 13.146                                 | 12.528                                 | 0.660                             | 0.658                             |
|                | T7             | 0.621                        | 0.600                            | 12.855                       | 13.089                           | 0.621                             | 0.600                               | 12.855                                 | 13.089                                 | 0.621                             | 0.600                             |
|                | T8             | 0.689                        | 0.715                            | 15.712                       | 9.122                            | 0.689                             | 0.715                               | 15.712                                 | 9.122                                  | 0.689                             | 0.715                             |
|                | T9             | 0.710                        | –0.051                           | 14.489                       | 6.315                            | 0.640                             | 0.096                               | 11.270                                 | 7.464                                  | 0.640                             | 0.096                             |
|                | T10            | 0.694                        | 0.089                            | 15.756                       | 6.644                            | 0.739                             | 0.175                               | 18.224                                 | 16.282                                 | 0.739                             | 0.175                             |
|                | T11            | 0.618                        | 0.665                            | 11.271                       | 16.891                           | 0.248                             | 0.672                               | 5.373                                  | 12.367                                 | 0.248                             | 0.672                             |
|                | T12            | 0.545                        | 0.611                            | 9.211                        | 10.876                           | 0.428                             | 0.672                               | 5.373                                  | 12.367                                 | 0.428                             | 0.672                             |
| Perceived Risks| R1             | 0.842                        | 0.876                            | 26.321                       | 42.462                           | 0.842                             | 0.876                               | 26.321                                 | 42.462                                 | 0.842                             | 0.876                             |
|                | R2             | 0.907                        | 0.903                            | 50.795                       | 54.003                           | 0.907                             | 0.903                               | 50.795                                 | 54.003                                 | 0.907                             | 0.903                             |
|                | R3             | 0.875                        | 0.894                            | 40.631                       | 52.190                           | 0.875                             | 0.894                               | 40.631                                 | 52.190                                 | 0.875                             | 0.894                             |
|                | R4             | 0.883                        | 0.850                            | 46.424                       | 32.328                           | 0.883                             | 0.850                               | 46.424                                 | 32.328                                 | 0.883                             | 0.850                             |
|                | R5             | 0.742                        | 0.561                            | 13.753                       | 6.515                            | 0.742                             | 0.561                               | 13.753                                 | 6.515                                  | 0.742                             | 0.561                             |
|                | R6             | 0.720                        | 0.650                            | 12.866                       | 10.892                           | 0.720                             | 0.650                               | 12.866                                 | 10.892                                 | 0.720                             | 0.650                             |
|                | R7             | 0.212                        | 0.107                            | 1.871                        | 0.956                            | 0.212                             | 0.107                               | 1.871                                  | 0.956                                  | 0.212                             | 0.107                             |
### Table A.1 (continued)

| Construct Item | Item Indicator (Control Group) | Item Loading (Control Group) | Item Loading (Information Group) | T Statistics (Control Group) | T Statistics (Information Group) | Cronbach's Alpha (Control Group) | Cronbach's Alpha (Information Group) | Composite Reliability (Control Group) | Composite Reliability (Information Group) | Communality (AVE) (Control Group) | Communality (AVE) (Information Group) |
|----------------|-------------------------------|-------------------------------|----------------------------------|-----------------------------|----------------------|-------------------------------|-------------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
| Perceived Benefits | B1 0.873 0.902 | 42.972 46.474 | 0.905 0.888 | 0.928 0.918 | 0.688 0.658 | 0.924 0.916 | 0.943 0.938 | 0.769 0.751 |
| Perceived Costs | C1 1.000 1.000 | 1.000 1.000 | 0.000 0.000 | 0.867 0.865 | 0.905 0.904 | 0.656 0.655 | 0.909 0.894 | 0.930 0.924 | 0.691 0.711 |
| Procedural Fairness | PF1 1.000 1.000 | 1.000 1.000 | 0.000 0.000 | 0.856 0.865 | 0.907 0.904 | 0.656 0.655 | 0.909 0.894 | 0.930 0.924 | 0.691 0.711 |
| Distributive Fairness | DF1 1.000 1.000 | 1.000 1.000 | 0.000 0.000 | 0.856 0.865 | 0.907 0.904 | 0.656 0.655 | 0.909 0.894 | 0.930 0.924 | 0.691 0.711 |
| Problem Perception | PP1 0.849 0.695 | 2.051 1.726 | 0.589 0.437 | 0.461 0.413 | 0.362 0.373 | 0.856 0.865 | 0.907 0.904 | 0.656 0.655 | 0.909 0.894 | 0.930 0.924 | 0.691 0.711 |
| Outcome Efficacy | OE1 1.000 1.000 | 1.000 1.000 | 0.000 0.000 | 0.856 0.865 | 0.907 0.904 | 0.656 0.655 | 0.909 0.894 | 0.930 0.924 | 0.691 0.711 |
| Acceptance | A1 0.875 0.852 | 43.541 29.920 | 1.000 1.000 | 1.000 1.000 | 1.000 1.000 | 1.000 1.000 | 1.000 1.000 | 1.000 1.000 | 1.000 1.000 | 1.000 1.000 | 1.000 1.000 |

### Table A.2

Measurement properties of the final constructs.

| Construct Item | Item Indicator (Control Group) | Item Loading (Control Group) | Item Loading (Information Group) | T Statistics (Control Group) | T Statistics (Information Group) | Cronbach's Alpha (Control Group) | Cronbach's Alpha (Information Group) | Composite Reliability (Control Group) | Composite Reliability (Information Group) | Communality (AVE) (Control Group) | Communality (AVE) (Information Group) |
|----------------|-------------------------------|-------------------------------|----------------------------------|-----------------------------|----------------------|-------------------------------|-------------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
| Experience | E1 1.000 1.000 | 1.000 1.000 | 0.000 0.000 | 0.856 0.865 | 0.907 0.904 | 0.656 0.655 | 0.909 0.894 | 0.930 0.924 | 0.691 0.711 |
| Knowledge | K1 1.000 | 1.000 1.000 | 0.000 0.000 | 0.856 0.865 | 0.907 0.904 | 0.656 0.655 | 0.909 0.894 | 0.930 0.924 | 0.691 0.711 |
| Trust | T1 0.698 0.715 | 14.955 17.151 | 0.888 0.844 | 0.907 0.904 | 0.656 0.655 | 0.909 0.894 | 0.930 0.924 | 0.691 0.711 |
| | T2 0.758 0.764 | 21.869 22.170 | | | | | | | |
| Perceived Risks | R1 0.842 0.876 | 25.939 43.052 | 0.909 0.894 | 0.930 0.924 | 0.691 0.711 | 0.909 0.894 | 0.930 0.924 | 0.691 0.711 | 0.909 0.894 | 0.930 0.924 | 0.691 0.711 |
| Perceived Benefits | B1 0.871 0.909 | 39.108 47.779 | | | | | | | | (continued on next page)
Table A.2 (continued)

| Construct | Indicator (Control Group) | Indicator (Information Group) | T Statistics (Control Group) | T Statistics (Information Group) | Cronbach’s Alpha (Control Group) | Cronbach’s Alpha (Information Group) | Composite Reliability (Control Group) | Composite Reliability (Information Group) | Community Reliability (Control Group) | Community Reliability (Information Group) |
|-----------|---------------------------|-------------------------------|-----------------------------|---------------------------------|----------------------------------|-------------------------------------|----------------------------------------|----------------------------------------|----------------------------------------|----------------------------------------|
| Perceived Costs | B2 0.889 0.888 | 42.866 41.375 | 1.000 1.000 | 1.000 1.000 | 0.000 0.000 | 0.000 0.000 | 0.000 0.000 | 0.000 0.000 | 0.000 0.000 | 0.000 0.000 |
| Procedural Fairness | C1 1.000 1.000 | 1.000 1.000 | 1.000 1.000 | 1.000 1.000 | 1.000 1.000 | 1.000 1.000 | 1.000 1.000 | 1.000 1.000 | 1.000 1.000 | 1.000 1.000 |
| Distributive Fairness | DF1 1.000 1.000 | 1.000 1.000 | 1.000 1.000 | 1.000 1.000 | 1.000 1.000 | 1.000 1.000 | 1.000 1.000 | 1.000 1.000 | 1.000 1.000 | 1.000 1.000 |
| Problem Perception | PP1 0.922 0.750 | 4.095 2.258 | 0.567 0.487 | 0.811 0.792 | 0.685 0.657 | 0.657 0.657 |
| Outcome Efficacy | OE1 1.000 1.000 | 1.000 1.000 | 1.000 1.000 | 1.000 1.000 | 1.000 1.000 | 1.000 1.000 |

Appendix B

Table B.1

Structural estimates with hypothesized relationships. Abbreviations are listed as follows: E: Experience, K: Knowledge, T: Trust, PF: Procedural Fairness, R: Perceived Risks, B: Perceived Benefits, C: Perceived Costs, PP: Problem Perception, A: Acceptance, DF: Distributive Fairness, OE: Outcome Efficacy.

| Construct | Direct Effect (Control Group) | Direct Effect (Information Group) | T Statistics (Control Group) | T Statistics (Information Group) | P Values (Control Group) | P Values (Information Group) | Hypothesis Supported? (Control Group) | Hypothesis Supported? (Information Group) |
|-----------|-------------------------------|-----------------------------------|-----------------------------|---------------------------------|--------------------------|-----------------------------|----------------------------------------|----------------------------------------|
| H1 E → K | 0.175 0.006 | 2.499 0.094 | 0.013 0.925 | Yes (5% level) | No |
| H2 K → T | –0.056 –0.021 | 0.776 0.307 | 0.438 0.759 | No | No |
| H3 PF → T | 0.282 0.429 | 4.177 7.249 | 0.000 0.000 | Yes (0.1% level) | Yes (0.1% level) |
| H4 T → R | –0.239 –0.264 | 2.865 3.677 | 0.004 0.000 | Yes (1% level) | Yes (0.1% level) |
| H5 T → B | 0.424 0.416 | 6.190 6.951 | 0.000 0.000 | Yes (0.1% level) | Yes (0.1% level) |
| H6 T → C | –0.066 0.050 | 0.804 0.617 | 0.422 0.537 | No | No |
| H7 PP → A | –0.070 –0.046 | 1.156 0.900 | 0.248 0.369 | No | No |
| H8 R → A | –0.213 –0.215 | 3.371 4.230 | 0.001 0.000 | Yes (1% level) | Yes (1% level) |
| H9 B → A | 0.598 0.655 | 9.294 13.034 | 0.000 0.000 | Yes (0.1% level) | Yes (0.1% level) |
| H10 C → A | 0.025 0.031 | 0.500 0.786 | 0.617 0.42 | No | No |
| H11 DF → A | 0.138 0.069 | 2.261 1.687 | 0.024 0.052 | Yes (5% level) | No |
| H12 OE → A | 0.053 –0.012 | 1.118 0.294 | 0.264 0.769 | No | No |

Appendix C. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.energy.2021.122150.

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