THE IMPACT OF INFORMATION PROVISION ON THE SOCIAL ACCEPTANCE OF SHALE GAS DEVELOPMENT

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

DİLGE GÜLDEHEN KÂNOĞLU

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SCIENCE
IN
EARTH SYSTEM SCIENCE

JULY 2018

Approval of the thesis:

THE IMPACT OF INFORMATION PROVISION ON THE SOCIAL ACCEPTANCE OF SHALE GAS DEVELOPMENT

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ABSTRACT

THE IMPACT OF INFORMATION PROVISION ON THE SOCIAL ACCEPTANCE OF SHALE GAS DEVELOPMENT

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July 2018, 101 pages

Social acceptance is critical to the market penetration of new products and technologies as well as the successful implementation of policies, including those concerning energy demand. The hydraulic fracturing technique employed in the development of shale gas has been followed by controversy and this has resulted in the emergence of heterogeneity in attitudes towards the process. This thesis proposes a model for understanding the acceptance of shale gas development. The proposed model encompasses the factors: perceived benefits, risks and costs, procedural and distributional fairness, trust, outcome efficacy, problem perception, knowledge and experience. The study then explores the impact of information provision from different sources (the government, the industry, environmental NGOs and scientists) and of different content (scientific and non-scientific) on acceptance. A one-way ANOVA suggests that a significant difference between the means of the acceptance of shale gas development close to one's house exists among the control group and the group that received information from scientists. However, an overall evaluation of the model through the partial least squares technique reveals that apart from that between experience and

knowledge, information provision does not alter the relationships among the factors that impact the acceptance of shale gas development significantly. For the experience factor, the results indicate that experience has a strong positive impact on knowledge for the control group only. This is crucial in that it underlines that selecting an adequate means of communication between relevant actors and the society could break the utilization of previous experience to construct a knowledge base.

Keywords: Social acceptance, Shale gas, Trust, Risk, Information

ÖZ

KAYA GAZININ TOPLUMSAL KABULÜNE BİLGİNİN ETKİSİ

Kânoğlu, Dilge Güldehen
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Temmuz 2018 , 101 sayfa

Toplumsal kabul yeni üruünlerin ve teknolojilerin piyasaya girmesi ve enerji talebini ilgilendirenler dahil olmak üzere politikaların etkin bir biçimde hayata geçirilmesi noktasında önemli bir rol oynamaktadır. Kaya gazının çıkarılması sürecinde kullanılan hidrolik çatlatma teknolojisi tartışma konusu olmuş ve bu durum teknolojiye karşı yaklaşımlarda farklılıkları beraberinde getirmiştir. Bu tez kaya gazının toplumsal kabulünü etkileyen faktörleri anlamamızı sağlayan bir model önermektedir. Önerilen model risk, fayda, maliyet algıları, prosedürel ve dağılımsal adalet, güven, sonuç etkinliği, sorun algısı, bilgi ve deneyim etmenlerini içermektedir. Çalışma daha sonra farklı kaynaklardan (hükümet, endüstri, çevre sivil toplum kuruluşları ve bilim insanları) farklı içerikte (bilimsel ve bilimsel olmayan) bilginin kabul üzerine etkisini araştırmaktadır. Tek yönlü ANOVA sonuçları kontrol grubu ile bilim insanlarından bilgi alan grubun kendi evlerine yakın kaya gazı çıkarılması noktasında ortalama olarak anlamlı bir farkı olduğunu önermektedir, ancak kısmi en küçük kareler tekniği ile yapılan değerlendirmeler bilgi aktarımının deneyim ve bilgi ilişkisi haricinde toplumsal kabulü etkileyen etmenler arasındaki ilişkiyi anlamlı bir ölçüde değiştirmediğini ortaya koymaktadır. Sonuçlar deneyim etmeninin yalnızca kontrol grubu için bilgi

üzerinde güçlü olumlu bir etkisi olduğunu belirtmektedir. Bu durum ilgili aktörler ile toplum arasında uygun iletişim yönteminin seçilmesi durumunda toplumun önceki deneyimlerini bilgi temelini oluşturmak için kullanma eğilimini kırabileceğinin altını çizdiği için önemli bir sonuçtur.

Anahtar Kelimeler: Toplumsal kabul, Kaya gazı, Güven, Risk, Bilgi

To my family...

ACKNOWLEDGMENTS

This thesis is the embodiment of my journey of M.S. which was like diving into the deep blue ocean, full of hardship, advancement and wonder. When I rose to the surface experiencing the sensation of accomplishment, I recognized that although it is solely my name that appears on the cover of this thesis, a number of individuals that include my family, friends, colleagues; and some institutions have supported me through this adventure.

First of all, I am greatly indebted to my advisor, my mentor Professor Uğur Soytaş, for not only being a great influence, but for being a great person, as well. This thesis would not have been possible without his encouragement, guidance, constant support and understanding. I will always cherish the memory of our long walks that turned out to be perfect opportunities for brainstorming. A special thanks should go to Professor Ramazan Sarı for his appreciation and counsel through the course of my studies. He has widened my horizons and has always reminded me that "we cannot think of being acceptable to others until we have first proven acceptable to ourselves." I will always be grateful for the motivational speeches he has given me. An additional note of thanks must go to Professor Ayşen Yılmaz for supporting me in adjusting to a new environment at Middle East Technical University. Instead of going over my tasks directly, she would always start our conversations by asking me about how I was doing. I really appreciate everything she has done for me.

I gratefully acknowledge the project Nature4Cities – Nature Based Solutions for re-naturing cities: knowledge diffusion and decision support platform through new collaborative models (EU Project ID: 730468) for providing me with an exceptional research opportunity and for partially funding this research.

Finally, I appreciate and acknowledge my family and friends. I am thankful to my dearest friends İdil Yıldırım, Ilgım Bakkaloğlu, Murat Can Sarıhan, Selin Kızılgün, Lila Özkazanç, Çağla Deniz Bahadır, Ahmet Taygun Namlı, Tayfun Acar, Kök-

sal Temel, Barış Oruç, Tuna Akyıldız, Melih Sevinç, Kıvılcım Şebnem Elibüyük, Gülayça Özcebe, İrem Yaprak Utku, Elif Topçu, Gül Beyaz Genç, Çağrı Yalçın, Ayhan Epik and Kemal Çağlar Göğebakan for always being there for me. I am thankful to Özlem Güran, Pınar Ucuzal and Akif Koca for their kindness and thoughtfulness. I sincerely thank Deborah Senior, Ilge Splane, Birsen Ulupınar, Pervin Uslu and Samira Salem for reminding me how little distance means when someone means so much. It is my fortune to have had the miraculous support of my grandparents Gülender Şeref and Ferhunde Kânoğlu, my aunts Sibel Kancaoğlu, Emine Kavaklıoğlu, Nadiye Baydar, Fatma Murat, my uncles Osman Şeref, Mehmet Murat, Mustafa Murat, Ömer Murat, and other members of my extended family. I would also like to thank my mother in law, Fehime Özkan, and father in law, Savaş Özkan, for their love and moral support. Another thanks goes to my brother in law, Ömer Ege Özkan, for the hugs and kisses and his everlasting energy that inspires me. My heart felt regard goes to my parents. All that I am and ever hope to be I owe to them. I am so grateful to my dear mother, Neşe Kânoğlu, for knowing me better than I know myself. I know she would have been so proud of me. I feel her with me through every heartbeat, every thought and every step. My angel, you are loved beyond words and missed beyond measure. My hero, my dad, Utku Kânoğlu, you have taught me much more than how to ride a bike and how to drive. You have taught me about perseverance, patience and love. I know that your embrace could make all the trouble in the world go away. I realize it took me some time to follow your advice, but thanks to you I feel like I have found where I belong and am looking forward to working on a paper together. Many thanks goes to my brother, my best friend, Doruhan Kânoğlu, for his constant love and unconditional support. If it hadn't been for the time we spent together, I wouldn't have learned this much about the geologic time scale, which turned out very useful during my studies. I also owe special thanks to a very special person, my husband, Alican Özkan, for his continued love, never failing encouragement, understanding and patience. You have helped me keep things together at moments I thought impossible. My father once said that his best choice in life was marrying my mother, and that he wished that I feel the same way for the rest of my life. I consider myself the luckiest person in the world to have met you and I feel that our best days are yet to come. I will owlways love you.

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CHAPTER 1

INTRODUCTION

While technologies such as the use of climate-friendly alternatives to ozone-depleting hydrofluorocarbons (HFCs) and hydrochlorofluorocarbons (HCFCs), and energy efficient lighting have been embraced by society, others like nuclear power plants, wind turbines, and carbon capture and storage have encountered substantial amounts of resistance [1]. This resistance has stemmed from the prevalence of societal concern either due to the environmental, social or health impacts associated with the technology or from the impression that common resources could have been utilized in a different manner.

Recent advances in the precision and efficiency of the horizontal drilling and hydraulic fracturing techniques employed in the development of shale gas have resulted in the experience of an energy renaissance in the United States. Regions that have previously endured extended periods of economic decline have revitalized, energy security has been ensured at the national level, and a transition towards less carbon-intensive electricity generation has taken place [2, 3, 4]. These developments have been followed by controversy. Presently, more individuals oppose the expansion of shale gas development than support it [5, 6]. Therefore, it is crucial for planners to provide incentives for research, and to adopt necessary measures to diminish, if not eliminate, the adverse impacts of shale gas development. This will ensure that social consensus is reached while extensive amounts of resources are made available.

It is social acceptance that provides us with a measure of the extent to which people are "willing and prepared to adopt the applications in their own contexts when

presented with an opportunity" [7]. In scrutinizing the social acceptance of shale gas, one may refer to Pennsylvania, Illinois, and New York, which are three states that have adopted legislative measures regarding unconventional gas development in recent years. They are comparable socioeconomically and have substantial opportunity to achieve economic development. The act in Pennsylvania endorsed a confined system of disclosure of chemicals involved in the process, did not necessitate water testing prior to drilling and did not account for seismic events linked to drilling [8]. On the other hand, policymakers in Illinois favored a more flexible system that allowed public health authorities and family members to access chemical information, required that drilling commence following the completion of tests for water surrounding the site of drilling by an independent third party and safeguarded individuals from seismic events through expanding monitoring and mitigation requirements "when they (seismic events) are of sufficient intensity to result in a concern for public health and safety" [8]. New York has portrayed a more conservative approach towards shale gas development. The New York Department of Health advocated for a ban on hydraulic fracturing in March 2015, due to its potential to result in the emission of methane and volatile organic compounds to the air, its impact on water management, its potential public health threats, and of primary consideration, its impacts on communities that encompass noise and encumbered resources [9]. This ban was to prevail until scientific assessments provided sufficient background to determine the level of risk to public health and when the risks could be adequately managed [9]. This particular heterogeneity in new and expansive legislation emphasizes the significance of social acceptance in terms of the successful implementation of energy policy: even if a proposal is put forward, if society does not intend to support it, an advancement may be delayed, may have to be modulated or may not take place at all. Hence, it is of substance to follow how people form opinions on energy technologies, and to understand the underlying reasons of distinguished responses to the same impulse so that we identify adequate means of modulating these responses.

National and state-level opinion polls have offered valuable insight into the way people perceive shale gas development, but they have mainly concentrated on either the significance of sociodemographic factors [10], on a limited set of factors that include

the economic benefits or social or environmental risks singularly [11, 12, 13], or on the balance of risks and benefits [14, 15, 12, 16].

One study that is crucial to this thesis is the University of Nottingham survey that has scrutinized the public's attitude towards shale gas development in the United Kingdom. The survey has traced changes in knowledge of shale gas, what the public perceived to be the environmental impacts of development, and the technology's acceptability since 2012 [17, 18, 19, 6]. One of the most important contributions of this survey has been to record how the responses evolved through numerous notable events that include the highly publicized Balcombe protests against a proposed test drilling by Cuadrilla for oil in August 2013, and the election of a majority conservative government in May 2015 [17, 18, 19, 6].

The information gathered as part of this survey suggests that the media coverage of shale gas development has been increasing since 2011 [17], and that the increment in peoples' reception to information about shale gas development, particularly relating to its potential deleterious impact on drinking water, has been accompanied by a change in the way the technology is perceived. While concerns about the contamination of water supplies due to shale gas development had been declining prior to the Balcombe protests, the trend reversed between July 2013 and September 2015 [18]. This change points to a probable relationship between information provision and attitude formation. Yet, to date very little work has explored the validity of this relationship in the context of shale gas development. Whitmarsh et al. [20] studied this relationship by presenting participants with texts concentrating on economic or environmental factors, and for each factor the information was either framed in loss or gain terms [21]. However, as noted by the authors, there is considerable scope to analyze changes in acceptance by changing the media, source and framing of information related to shale gas. In line with this recommendation, building upon the sustainable energy technology acceptance framework of Huijts et al. [1], this thesis presents a model suitable for the social acceptance of shale gas development. It specifies relationships among factors that explain the social acceptance of shale gas development. The proposed model for understanding acceptance encompasses the factors: perceived benefits, risks and costs, procedural and distributional fairness, trust, outcome efficacy, problem perception, knowledge and experience. The main

contribution of this thesis to the literature is to provide a framework that will allow stakeholders to evaluate the social acceptance of shale gas development in different countries, through time. As research in the United Kingdom has shown [17, 19, 18, 6], social acceptance is a continuous process. Once the concerns of the public are identified, projects or policies could be adjusted to account for the opinions and evaluations of the public. Therefore, the thesis proceeds by presenting considerations regarding the amelioration of communication between professional actors and citizens. In this sense, the source and content of information, and the means of its provision are important aspects. This thesis concentrates on the former two and accounts for the interaction between the technology, professional actors and features of the technology's application in order to understand how the provision of information may impact the social acceptance of shale gas development.

CHAPTER 2

BACKGROUND

2.1 Shale Gas Development Basics

Natural gas has constituted an important component of the global energy mix and unconventional natural gas reserves, that include shale gas reservoirs, have recently been regarded as alternative natural gas sources [22]. Shale gas reservoirs are defined as organic-rich and very fine grained sedimentary rocks [22]. They consist of matrix and natural fracture systems. Shale gas then refers to natural gas stored in pore spaces of the shale matrix and natural fractures [23]. The characteristic that differentiates shale gas from conventional gas is that it does not naturally flow into a well. This is because it has extremely low permeability [24] and low porosity values [25]. Shale gas can be forced to flow by artificially incrementing its permeability through fracturing the system containing gas. This is accomplished by the technique hydraulic fracturing [26]. The process serves to reactivate and reconnect natural fractures in shale, that are generally closed as a result of overburden pressure [25].

To have a better understanding of the risks and benefits associated with shale gas development one may have a closer look at the process of producing natural gas in shale formations. The process begins with drilling. Drilling initially follows a vertical path, which may then be gradually curved so as to reach a ninety degrees angle. Entitled horizontal drilling, this process enables access to the horizontal strata of the reservoir [27]. During the drilling stage a steel pipe is placed into the hole, and cement casing is utilized to keep the structure of the wellbore intact and to isolate it from contact with fresh water aquifers. Following this, the completion phase that

allows the well to produce natural gas begins. Hydraulic fracturing occurs during this stage. Through pumping a mixture composed of water, proppant (generally sand), and chemicals along and across the drilled formation, subsequent fractures are propagated in the rock layer [28]. While the role of sand is to prevent fractures from closing, chemicals preserve the well and ameliorate its operation. The final stage production comes next. The top of the well is outfitted with a collection of valves and gas flow is connected to a distribution network. Once the well reaches its economic limit, all pipes are removed from it, it is filled with cement and abandoned [29].

2.2 Shale Gas Risks and Benefits

Shale gas development has been associated with a number of benefits. The most commonly cited benefit relates to economic development. This encompasses employment opportunities, infrastructure, revenues, and taxes shale gas development promises [26]. House [30] notes that production in Texas at the Barnett Shale created 100,000 jobs and generated annual output of $11.1 billion in 2011. Similar results were observed in Pennsylvania [31], and in the Marcellus Shale that goes across West Virginia and Pennsylvania [32]. It is reasonable to envision that this impact will continue since an assessment of 48 basins around the world in 32 countries by the United States Energy Information Administration suggests that the estimated recoverable shale gas potential is almost equivalent to conventional natural gas [33]. This result was also confirmed by the business-information firm IHS, that postulated that the potential could amount to 42 trillion cubic meters, a value almost 65 times the current annual consumption of the United States [34]. The abundance of shale gas, combined with its 50-66% approximate lower production cost when compared to conventional gas development implies that continuing shale gas operations bears the potential of depressing global prices of natural gas and breaking longstanding monopolies through facilitating global competition [35].

One of the most debated aspects of shale gas development has been the greenhouse gas emissions related to it and hence, its global warming potential. Several studies have estimated figures in this respect [28, 36, 37, 3, 38, 39, 40, 41, 42, 4, 43]. The

most commonly disputed work is that of Howarth et al. [44] that concluded that the global warming potential of shale gas is higher than that of coal. To the contrary, other authors have claimed that shale gas has driven out the "dirtier" fuel, namely coal, from the electricity sector [45, 46]. Moreover, future scenarios in Jacoby et al. that compared emissions from the sector with and without accelerated utilization of shale gas discerned that shale gas reduces the US national emissions 17% when compared to the business as usual scenario. For a detailed criticism of Howarth et al. [37], and a discussion of the impacts of shale gas development on climate change readers are directed to [28, 36, 3, 40, 41]. What is of consequence here is that the suggested impacts vary significantly depending upon assumptions of authors. When the impact of supply increase on energy consumption and fuel substitution is accounted for, the figures change [47]. When the impacts are analyzed for different end uses such as heating and electricity [42, 3] the results change again. Therefore, more comprehensive studies should be conducted in relation to this matter.

There are also a number of concerns raised about shale gas development. The first concern relates to leakage and accidents. As the production process of shale gas consists of numerous steps, malfunctions are difficult to detect. This results in instances of natural gas escaping into the atmosphere as reported in the Uinta Basin in Utah [48], in the Denver-Julesburg Basin [49], and in the Barnett Shale region [46]. Another important study related to such events is that of Holzman [50], where he notes that 50% of the inspected novel natural gas wells in Quebec leaked methane. Water availability and quality are notable concerns, too [4]. As clarified in the previous section, shale gas operations are substantially water intensive. That is to say, in an environment where "the groundwater resources and ecosystems are under threat" [51], proper water treatment and disposal measures should be taken. The hydraulic fracturing technique employed in the development of shale gas can also contribute to seismic events. Still, one should note that these are of the scale of insignificant disturbances, rather than disastrous instances [26]. Nevertheless, other factors such as the deep well injection of wastewater have been shown to have caused earthquakes [52, 53]. Kerr [52] states that the injection of wastewater from shale gas development under the Dallas/Fort Worth International Airport generated more than 180 earthquakes be-

tween 2008 and 2009, each ranging up to the magnitude 3.3 on the Richter scale. The causality was evident as the earthquakes stopped once injections were ceased. Similar observations have been made in the Guy-Greenbrier region, as well [52].

Researchers often underline the potential of shale gas to displace cleaner forms of energy, including renewable energy sources [54]. Logan et al. [46] suggest that the drop in natural gas prices achieved through shale gas development has been followed by the resurgence of the hunt for oil liberated through the improved technology of hydraulic fracturing. Howarth and Ingraffea [37] support this standpoint by claiming that: "shale gas competes for investment with green energy technologies, slowing their development and distracting politicians and the public from developing a long-term sustainable energy policy." Furthermore, the profitability of shale gas production is also questionable. This is a result of a combination of factors: the hardship of measuring reserves, low profit margins of current fields, the economic impacts on traditional natural gas producers, and the cost of externalities [26]. In terms of low depletion and recovery rates, it is important to note that while conventional wells can maintain production at an increasing rate up to 40 years [54], the output of shale gas drops 80-95% within the first three years [55]. In terms of impacts on traditional natural gas producers, the repercussions in the liquefied natural gas (LNG) market are already observable. Wright [56] states that increased shale gas production has resulted in the stagnation or decline of traditional LNG production in all but 3 major countries, namely Australia, Nigeria and Russia.

CHAPTER 3

THEORETICAL MODEL

3.1 Motives or Goals that Impact Acceptance

Lindenberg and Steg [57], categorize three motives or goals in terms of the channel of their impact on behavior: gain, normative, and hedonic goals.

3.1.1 Gain Motives and Acceptance

The theory of planned behavior [58] suggests that the intention to exert a particular behavior is based on attitudes, subjective norms and perceived behavioral control. While attitudes correspond to the degree of agreeableness of the behavior in question, subjective norms correspond to the social hardship or ease to perform the behavior, and perceived behavioral control to the facility to perform the behavior [58].

In this study, we are not exploring acceptance in the context of numerous actions, but only in expressing an opinion on shale gas development through answering a questionnaire. Concentrating on the single deed of answering a questionnaire anonymously ensures that there is no difficulty in performing the behavior. Similarly, there is no social pressure that urges individuals not to perform the behavior. Finally, in terms of the degree of agreeableness of the action, in line with [59], we suggest capturing this through the inclusion of an indicator for "deployment promotion" among the indicators of acceptance. This indicator will measure the degree of active promotion of the technology the respondent finds suitable. Overall, none of the identified

variables, namely attitudes, subjective norms or perceived behavioral control remain in our model.

While we remove these three factors from our model we account for outcomes that influence attitudes. These outcomes can be divided into benefits, risks and costs, see Figure 3.1. When gain goal is focal, individuals weigh the values of these outcomes and select alternatives that provide them with the maximum gain, or the minimum risks or costs. Regardless of the type of the energy technology, the variance in the levels of opposition or support both at the individual and social level, can mainly be attributed to two factors: perceived risks and benefits [60, 61, 62, 63].

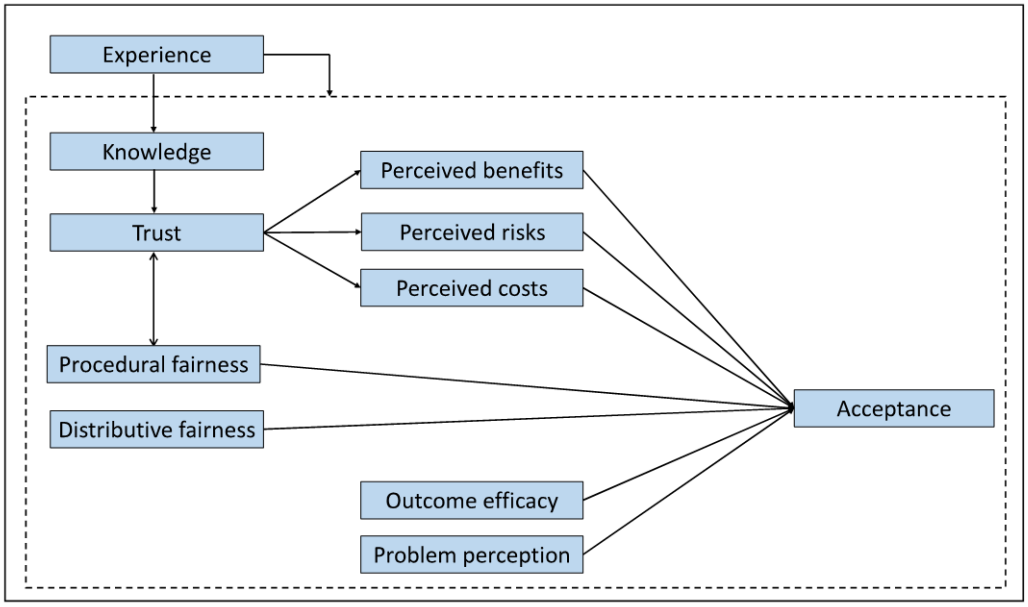

Figure 3.1: An illustrative representation of the model for the social acceptance of shale gas development.

For shale gas development, costs could include monetary costs to the society such as subsidies required to guarantee the cost-effectiveness of investments or non-monetary costs such as the exertion to apprehend the technology. Risks could include rapid industrialization, community conflict, social-psychological stress and disruption [64], surface and groundwater contamination, deterioration of air quality and induced seismic events [4]. Benefits of the technology could relate to collective benefits such as

the reduction of natural gas prices, contribution to economic growth, the diminution of the energy intensity, and the solution of energy security problems [26]. One should however state that only perceived and salient benefits, risks and costs, that materialize through intuitive judgments would influence attitudes towards shale gas development at a specific moment [58, 65].

3.1.2 Normative Motives and Acceptance

When normative goals are central to decision making, individuals base their choices on their moral evaluations, that is, on the extent they feel they are morally obliged to act in a peculiar manner or refrain from doing so [66]. Labeled as personal norms, these moral evaluations are stimulated when individuals sense that there will be ramifications to their not behaving in the socially desired way, and when they acknowledge their ability to contribute to the mitigation of problems. In our analysis, we are only concentrating on the action of clarifying a stance towards shale gas development through responding to an anonymous questionnaire. In line with this reasoning, personal norms will not be present as a factor in our model, but in cases where differential actions should be accounted for, readers may refer to [1].

While we have excluded personal norms from our model, we account for its antecedents. In the context of energy technology acceptance personal norms are influenced by perceived benefits, risks and costs, outcome efficacy and problem perception [67, 66], see Figure 3.1. Since we have clarified the impact of perceived benefits, risks and costs in the gain motives section, we will elaborate on the remaining factors here.

Related to the social acceptance of shale gas development, awareness of adverse consequences of human interference with the environment could be influential. This concept referred to as problem perception encompasses climate change, pollution, loss of biodiversity, and resource depletion [68, 59]. The impact of problem perception could be through the following mechanism: the more one thinks we should actively prevent global warming, the more he or she might favor a technology that reduces

CO_2 emissions [59].

Outcome efficacy represents the degree of assistance one can provide in effectively solving problems [69]. Two aspects of outcome efficacy are of consequence in the technology acceptance framework. The first one pertains to the potency of the technology to resolve perceived problems. The other one is related to the extent to which one believes that his or her attitude would impact the application of the technology. As to the former, Engelder [34] asserts that shale gas development has a cleaner environmental footprint when compared to coal, so it may be viewed as an effective way of contributing to the mitigation of the impacts of climate change. As to the latter, in communities such as New York where social agreement upon the dominance of risks of shale gas development over its benefits could possibly result in a ban of the technology, individuals may exert behavior in favor or against a technology much easily. If this action is one against the technology, an advancement may be delayed, may incur higher costs, or not take place at all [70].

3.1.3 Hedonic Motives and Acceptance

When hedonic goals are central to decision making, feelings govern behavior [57]. Theories on affect concentrate on the role of anticipated feelings associated with a technology [71], or on feelings that result from the aftermath of decisions [72] in explaining goals that influence attitudes towards energy technologies. Peters and Slovic [73], and Montijn-Dorgelo and Midden [74] showed that positive affect that encompasses feelings like pride, happiness, satisfaction and negative affect that blankets fear, worries, anger are independent and significant factors in predicting the acceptance of energy technologies. Additionally, Lavine et al. [75] argued that the direction of cognitions and affect were crucial in determining the impact on acceptance. As explained in Huijts et al. [68] they elaborated on the matter by claiming that "when cognitions and affect point in the same direction (e.g., are both positive or both negative), they equally contribute to attitude, but when they contradict, then feelings tend to dominate over cognitions in the formation of attitudes." However, we propose considering affect in relation with other factors in our model such as risks and benefits,

experience, knowledge, and trust in relevant actors associated with the development of energy technologies. This is because in the context of shale gas development these feelings are intertwined with environment or health concerns and with perceived economic benefits. For example, the negative affect of apprehension linked to the prevalence of natural gas in taps [76] could be accounted for through the inclusion of an indicator for safety concern within the perceived risk factor in our model. Moreover, it is probable that this worry be a consequence of a lack of knowledge about the technology, a lack of trust in the people responsible of development, experience of the technology due to proximity to the source, or all enlisted. Thus, our approach of integrating affective imagery with risk and benefit perception will serve useful in capturing these relationships altogether.

3.2 Perceived Context that Impacts Acceptance

3.2.1 Trust and Acceptance

Trust can be defined as the extent to acknowledge susceptibleness on one's part, that is founded upon a positive anticipation of the intention or behavior of the another [77]. This susceptibleness has been identified as a factor that impacts acceptance directly in some studies [78, 79], indirectly through the channel of perceived benefits, risks and costs in others [59, 74, 71, 80, 81, 78] and both directly and indirectly in the study of Soland et al. [82]. Following the most frequently modeled relationships, we link trust and acceptance through perceived benefits, risks and costs, see Figure 3.1.

Relying on government organizations, the industry, environmental organizations, scientists and the ideas that they convey to us through media could be perceived as a substitute to acting upon full knowledge [83, 79, 84] (Figure 3.1). Since it is challenging for individuals to select, comprehend and evaluate all information available to them, and they may not have the experience that would allow them to form an objective standpoint, trust provides a foundation for one's opinion [79, 84, 71]. When trust is excessive, people may tolerate uncertainties or insufficiency of information, and be more overt to accept novel technologies. Contrarily, a lack of trust in actors

implementing or regulating projects, may create prejudice and diminish cooperation [1].

The substance of trust brings into question how trust in professional actors is cultivated. Some authors have concentrated on two key factors, the perceived intentions and competence of professional actors [85, 86, 68], and have suggested that the belief that the actor is concerned about and capable of safeguarding the interests of the citizens and the environment increments the individual's willingness to conform. In addition to these aspects, numerous characteristics have been suggested in relation to trust. These include the reliability, predictability, transparency, ability to act without private or political pressures and obligations, tendency to disclose information about alternatives to the technology [87, 88, 59, 89]. The factor trust in our model accounts for all listed aspects.

The implementation of an energy technology is generally a multi-actor process. Therefore, while trying to formulate a model for the social acceptance of shale gas development it is crucial that we clarify whether trust should be considered as a composition of trust in the participating actors, or as separate entities with respect to the specific roles of each actor in the process. Huijts et al. [68] adhered to the latter approach and found that trust in actors who are responsible for the planning and implementation of carbon capture and storage (the government and the industry) resulted in more positive and less negative affects. This in turn altered the perception of risks and benefits towards the energy technology such that acceptance increased [68]. On the other hand, if actors other than those in charge of the technology (namely non-governmental organizations (NGOs)) were trusted, their negative stance against the technology decreased acceptance [68]. In this sense, trust becomes important in evaluating which source of information has more considerable impact on shale gas acceptance.

In our model for shale gas development we utilize a similar approach to Huijts et al. [68] and treat trust in each actor independently since the roles of each actor is distinct in the process, as well. In terms of concern for safety for example, while trust in the

industry is related to the intention and capability to take necessary precautions to limit associated risks, trust in the government is linked to the propensity to interfere when a problem arises during shale gas development.

3.2.2 Fairness and Acceptance

Neoclassical economics assumes that choices are founded on monetary gains and consumption [90], but experimental games have delineated the opposite, and have underlined the significance of fairness in decision-making. Kahneman et al. [91], for example, showed that the perception of fairness of a firm's short-run price decisions impacted consumer behavior and thus precluded firms from exerting full monopoly power.

Attitudes towards energy technologies are similarly impacted by the perceived fairness of the distribution of benefits, risks and costs: distributive fairness, and the fairness in contribution to the decision process that results in the actualization of the technology: procedural fairness [92, 93, 94]. This relationship is depicted in Figure 3.1.

Fairness of procedures is related to the consideration of opinions. When individuals from different groups all feel that their opinions are sufficiently regarded in the planning and implementation of projects, procedures are considered to be fairer [95]. In the framework of environmental risk management, Earle and Siegrist [96] suggest that fairness can instill a sense of trust when it is the primary consideration or when there is an absence of information relating to trust. They further elaborate on the matter by stating that the relationship is generally the exact opposite, trust leads to perceived fairness [96].

In terms of distributive fairness, research has shown that "fairness based on collective outcomes," that is to say fairness relating to the distribution of benefits and drawbacks

between groups, is the predominant antecedent of acceptance of travel demand management strategies [97]. In the context of shale gas development, the distribution of economic benefits has not been as broad as promised. Hardy and Kelsey [98] found that while activity in the Marcellus Shale resulted in an increase in the lease and royalty income of Pennsylvania residents, the revenue distribution was concentrated among a miniscule section of the population.

3.3 Knowledge and Experience that Impacts Acceptance

3.3.1 Knowledge and Acceptance

De Best-Waldhober and Daamen [99] claim that reaching a reasoned judgment requires a sufficient amount of knowledge. The main issue regarding knowledge is that its exigency encourages people to base their intention to accept on intuitive feelings. This underlines the importance of the subjective component of knowledge, as noted by House et al. [100]. Thus, we concentrate on self-rated knowledge in the following sections.

A survey conducted to analyze Americans' indicated familiarity with and perceptions of hydraulic fracturing concluded that among the sample of 1061 respondents "13% did not know how much they had heard about the technology; 39% had heard nothing at all; 16% heard a little; 22% heard some; and 9% heard a lot" [10]. Although there was a total of 47% that possessed some amount of knowledge about shale gas development, only few of them could specify its impacts on water quality (7%); economic or energy supply that encompass "job creation" and "cheap energy" (3%); and social impacts that include "effects on property and people" (1%) [10].

The lack of familiarity with shale gas development raises the question whether we can develop awareness and modulate attitudes towards this energy technology. The first issue to account for in this sense is the credibility of the source of information. Craig

and McCann [101] showed that when the letterheads of distributed letters that provided advice on energy conservation changed while the content remained the same, the letter from the local energy commission had a higher impact on behavior when compared to the letter from the local utility. We will not elaborate more on the substance of this change in this part of the paper as it has been discussed in detail in the trust section.

The second characteristic of information that is significant in explaining differences in social acceptance is its content. How the type of information impacts social acceptance was discussed by Tokushige et al. [59]. A survey conducted among 423 Japanese university students on the perception of geological storage of carbon dioxide revealed that information concerning the scientific process did not necessarily influence attitudes. On the other hand, information on natural analogues incremented the level of public acceptance through diminishing the perceived risks. Similarly, on field demonstrations increased public acceptance through enhancing visions of human interference with the environment in the process of implementation [59]. This is also an important consideration for shale gas development. Individuals may not be susceptible to change their attitude towards shale gas development through the provision of scientific information. If that is the case, going on about the level of isolation that the casing of the drilled hole provides will be counterproductive. Hence, understanding which content would modulate acceptance should be an imperative consideration for policymakers.

An important note here is that the studies mentioned above concentrate only on the impact of a single change regarding information, ceteris paribus. However, it is often too difficult to differentiate the source and the content since each actor has a different approach towards the technology in question and presents this attitude in the information they disseminate through diverse means of communication. In line with this reasoning, Huijts et al. [68] chose to interview members of the government, industry and environmental NGOs to discern their approach towards carbon capture and storage. The results of surveys conducted before and after individuals were provided with realistic information from these actors showed that NGOs were trusted the most,

and the industry least by respondents.

In the context of shale gas development, we identified the government, the industry, environmental NGOs and scientists as actors that could influence acceptance because they are involved in policymaking, the implementation of projects, the provision of information on environment-related issues, and in the formulation of a shared fact base for the technology. We may elaborate on the perceptions of these actors to elucidate the ways through which these actors could influence acceptance.

The representatives of the United States government see shale gas development as an economic opportunity that generates government revenue via taxes, creates new jobs and contributes to the Gross Domestic Product [102]. They claim that the energy released during hydraulic fracturing is generally not likely to initiate a seismic event, but that groundwater contamination remains a risk mainly because of the human factor. These spokespersons underline that requirements from numerous laws apply to shale gas development, and that this ensures that the process is highly engineered, controlled and monitored [102]. The significance of this viewpoint is that it attempts to instill a sense of security to individuals about the environmental risks linked to shale gas development. This may in turn reduce the level of risk perception or increment the level of benefit perception, see Figure 3.1.

Energy companies consider shale gas as an opportunity that has stimulated economic activity through lowering power and materials costs [103]. Representatives of the industry claim to take earthquakes that may be related to shale gas development seriously, and regarding groundwater contamination they state that “there have been no such confirmed cases in the at least 2 million wells fracked over the past 68 years” [103]. They further assert that existing standards, regulations protect communities from adverse impacts of the process, and that on field experience and industry practices have allowed methane emissions from hydraulically fractured natural gas wells to fall by nearly 65% between 2012 and 2015 [103]. The approach of industry representatives is therefore such that it reinforces their intentions and capabilities. This

may serve to formulate trust in the actors. If such trust is established, it is probable that people undermine the risks associated with the technology, see Figure 3.1.

Environmental NGOs have grave concerns about shale gas development because they consider it as a temporary fix. While shale gas is presented as means of reducing greenhouse gas emissions since natural gas emits 50% less carbon dioxide when compared to burning coal [34], environmental NGOs suggest that relying on this source will be at the expense of long-term solutions to the issue that should build upon the transition to renewable energy sources [104]. Additionally, they underline the possibility of surface and groundwater contamination particularly that of drinking water, through leaks of toxic chemicals in fracking fluids. Therefore, they advocate for holding off shale gas activities "until all these problems are adequately addressed" [104]. If NGOs are perceived to have been trustworthy, the definitive language presented here may impact social acceptance through incrementing the risk perception. To represent this relationship, we have formulated a direct association from knowledge to trust and through trust to perceived risks in our model (Figure 3.1).

Scientists that assessed the overall impact of shale gas development noted that 1.5% of the gas produced in the Barnett Shale region is emitted to the atmosphere prior to being transmitted to the power plant [46]. Radioactive pollutants could persist in this produced gas traveling through pipelines, enter households and eventually lead to lung cancer. Similarly, spills and leaks and the disposal of inadequately treated wastewater or hydraulic fracturing fluids can result in the contamination of both surface and groundwater [4]. Moreover, the benefits to be derived from shale gas development remain uncertain. The net effect on greenhouse gas emissions should account both for direct emissions and for the economic aftermath of fuel substitution due to diminished natural gas prices [4]. Again, the economic benefits predicted to be derived from shale gas development should account for the negative externalities on traditional natural gas producers [26]. According to scientists, these synergies may "amplify risks and produce cumulative effects" [4] and since the understanding of these amplification mechanisms is limited more weight should be placed on doing a thorough life-cycle assessment. Overall, scientists are skeptical about the impact of

shale gas development. What this implies for this research is that information from scientists can reduce bias (both in favor and against) towards the technology (Figure 3.1).

The method of information provision is also effective in modulating the social acceptance of an energy technology. It consists of the medium of communication, frequency and content of the provided information, and the language used in this process.

Thaler and Sunstein [105] claim that the accuracy of information is secondary to the method of explanation. Visual cues and vivid descriptions emerge as more effective means of communication when compared to verbal representations. The authors founded their argument upon an experiment that showed that customers of an energy company who were provided with an "Ambient Orb" that generated a salient red-light signal when energy consumption was high, diminished their peak energy demand by 40% [105]. Henceforth, technological advancements that provide us with novice ways of conveying ideas will become consequential in managing social acceptance through the knowledge channel.

According to Heberlein and Baugartner [106] how one explains a particular incentive influences its effectiveness . Stern [107] supports this position through discerning that consumers who received an enhanced information package with frequent reminders about time-of-use rates, and recommendations on the means to regulate home energy use, diminished their peak-period electricity consumption to a level 16% below that attained when one message that explained the rates was utilized. The implication of this in terms of shale gas development is that it accentuates the necessity to adjust strategies such that desired changes be achieved.

The word choice is crucial in communicating ideas that could impact acceptance. Evensen et al. [108] found that using the phrase "shale gas development" instead of "fracking" in a questionnaire produced significantly distinctive results in terms of the attitude of respondents. "Fracking" appeared to have more negative connotations and

respondents were three times more inclined to resort to positive expressions while describing "shale gas development" when compared to "fracking." Nonetheless, in analyzing the impact of changing the source of information, it is usually difficult to control the language employed, particularly in the case of shale gas development. This is because actors adopt a language that strengthens their argument. NGOs for instance, prefer to utilize the phrase "fracking" in their statements [104] most probably, because it carries negative connotations [108]. Alternatively, regulators use the phrase "shale gas development" [102], possibly in order to avoid bias [108].

Whether the cultivation of knowledge brings about more positive acceptance or not is uncertain. Yet, research suggests that it can result in the formulation of more stable opinions [109]. Thus, we strongly encourage policymakers to gather information about how the public perceives the technology starting from the very early stages of the process, and to analyze the impact of information provision through time so that policies are as effective as possible.

3.3.2 Experience and Acceptance

Experience has two pillars in our model of shale gas development. First of all, it encompasses the impacts associated with the technology directly. This experience may stem from proximity to the source, or from substantial media coverage. In either way, experience serves as a means of accumulating knowledge and this may influence how people weigh benefits, risks and costs and develop a stance about the development process (Figure 3.1). An example that would clarify this approach relates to nuclear energy technologies. A study conducted in Switzerland five months prior to and immediately after the Fukushima incident showed that both the public's acceptance of nuclear power and the trust society places in reactor operatives were more negative following the accident [63]. Again, opinion polling in Pennsylvania, a state where shale gas development actively takes place, showed that 48% of the respondents followed news pertaining to drilling activities in the Marcellus Shale either "somewhat" or "very" closely [14]. This reinforces the idea that experience influences knowledge

and raises the question whether experience can constitute a barrier for further activities in the region.

The second pillar is personal experience unrelated to the particular energy technology. In the case of shale gas development this may be the experience of a natural disaster, more specifically the experience of an earthquake. Individuals who have previously experienced an earthquake unrelated to shale gas development may be more susceptible to oppose the technology if they are informed that it bears a seismic risk.

We depicted the large-scale effect of experience by two arrows: one that points at knowledge and another that points at all variables in our model, see Figure 3.1. We have not internalized experience as in the case of knowledge, because neither can we limit peoples' exposure to the technology nor can we establish full security from external impacts.

3.4 Conceptual Model

Drawing upon the literature review presented in the previous chapters a conceptual model had been formulated to scrutinize the impact of information provision on the social acceptance of shale gas development. Taking into account the argument of Dul and Hak that states that policymakers and managers often ignore the probabilistic nature of reality and hence omit exceptions, and that they act as if a state of complete determinism prevails [110], this thesis follows a deterministic approach in testing the conceptual construct.

For the conceptual model twelve hypotheses have been developed with six exogenous (experience, knowledge, procedural fairness, distributional fairness, problem perception and outcome efficacy) and five endogenous variables (trust, perceived benefits, perceived risks, perceived costs and acceptance). The hypotheses are provided below:

Hypothesis 1: If there is more experience related to shale gas development or to a technology that is perceived to generate concerns similar to those associated with shale gas development, society will become more knowledgeable about the technology.

Hypothesis 2: An increase in the level of knowledge impacts the level of trust significantly.

Hypothesis 3: If the fairness of procedures related to shale gas development increases, society will place more ample trust in relevant actors.

Hypothesis 4: If more trust is placed in actors that have a role in shale gas development or in those responsible of supervising shale gas operations, the perceived risks of the technology will diminish.

Hypothesis 5: If more trust is placed in actors that have a role in shale gas development or in those responsible of supervising shale gas operations, the perceived benefits of the technology will increase.

Hypothesis 6: If more trust is placed in actors that have a role in shale gas development or in those responsible of supervising shale gas operations, the perceived costs of the technology will increase.

Hypothesis 7: The more individuals perceive global warming as a threat, the more they would be inclined to support the development of shale gas.

Hypothesis 8: A higher risk perception results in a decrease in the acceptance of shale gas development.

Hypothesis 9: A higher benefit perception results in an increase in the acceptance of shale gas development.

Hypothesis 10: A higher cost perception results in a decrease in the social acceptance of shale gas development.

Hypothesis 11: If the fairness in the distribution of benefits, risks and costs associated with shale gas development increase, the acceptance of the technology will increase as well.

Hypothesis 12: If the belief that one's opinions are effective in shaping policies related to shale gas development is fostered, the technology's acceptance will increase.

The combination of the above hypotheses results in the development of the model presented in Figure 3.2.

As previous research has shown, in addition to the factors presented in Figure 3.2, other factors such as sociodemographic variables or situational factors that include the location and scale of projects can impact social acceptance. Yet, it is reasonable to assert that these factors are likely to influence acceptance through the psychological factors in our model. Moreover, this research intends to propose a framework that would allow for cross-sectional comparisons in addition to longitudinal comparisons. In this case, the incorporation of sociodemographic and situational variables to our model may preclude us from making multigroup comparisons as the contents of items relating to institutional structures for instance, could be divergent.

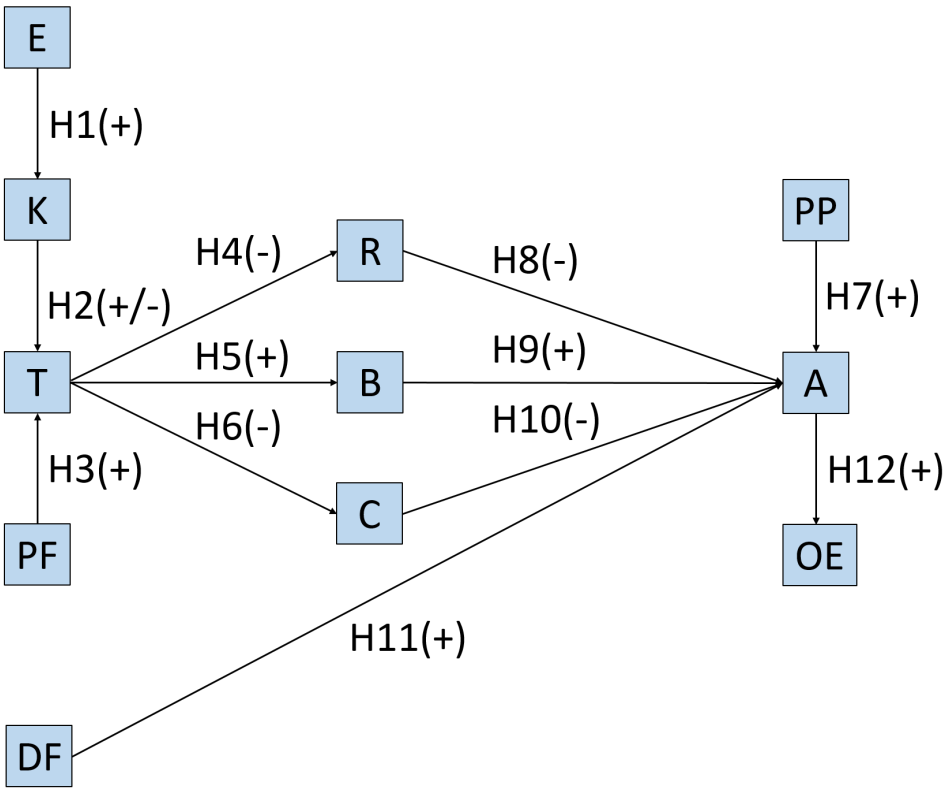

Figure 3.2: An illustrative representation of the hypothesized relationships for the model of the social acceptance of shale gas development. Abbreviations are listed as follows: E: Experience, K: Knowledge, T: Trust, PF: Procedural Fairness, DF: Distributional Fairness, R: Perceived Risks, B: Perceived Benefits, C: Perceived Costs, PP: Problem Perception, A: Acceptance, OE: Outcome Efficacy.

CHAPTER 4

RESEARCH METHOD

In this chapter, we initially elaborate on the research methodology employed in analyzing the impact of information provision on the acceptance of shale gas development. Following this, we clarify the design of sampling. Finally, we discuss the structure and elements of the survey utilized in measuring the factors in our model.

4.1 Research Approach

This thesis approaches the social acceptance of shale gas development through testing deterministic propositions. In testing such relationships, Dul and Hak [110] suggest utilizing either an experiment or a case study. However, as this research intends to trace changes in acceptance and its antecedents as individuals are provided with information of different content from different sources, experimentation would not have been possible. The main reason of this is that it would have required testing actions that are related to shale gas development. Moreover, this research is founded upon twelve different hypothesis, which would complicate formulating different settings that would allow the analysis of all constructs. Thus, conducting a survey was selected as the appropriate methodology.

4.2 Research Design

In this section of this research, the country and participant selection mechanisms and their theoretical foundations are provided.

4.2.1 Country Selection

Taking into account that the aim of the survey was to analyze the impact of information provision on the social acceptance of shale gas development, it was reasonable to the conduct the study in a country where no shale gas development operations have been instigated, and hence one where the technology has received little attention from the media. In line with this reasoning, the questionnaires were administered to individuals in Turkey. Turkey was also relevant to this research in that its natural gas production in 2013 was equivalent to only 1.5% of its consumption [22]. Considering that Turkey has 24 trillion cubic feet of technically recoverable shale gas in the Southeastern and Thrace regions [111], it is possible to assert that the development of shale gas in the country could reduce its foreign natural gas dependency. Therefore, this thesis could serve as a foundation for further research in understanding society's approach towards the technology in the upstream context.

4.2.2 Participant Selection

The questionnaire was administered to the students, parents, alumni, faculty or staff of Middle East Technical University (METU) of Ankara, Turkey. A convenience sample of surveys was used rather than a random investigation due to difficulties in obtaining high quality data about a complicated model. Moreover, due to the use of several technical terms in the information section, the questionnaire was in English and thus conducting the survey in an institution where the language of instruction is English made sense. The respondents were reached in crowded locations on campus, that include classrooms, study halls, restaurants, the library and the cafeteria. Their participation to the survey was entirely voluntary.

4.3 Survey Design

In this section of this research we elaborate on the items in our questionnaire and the literature utilized in preparing the final version of it. Following this, the format of the survey, its pre-testing and implementation is explained.

4.3.1 Survey Questions

The questionnaire (see Appendix A) was designed to trace changes in the social acceptance of shale gas development and its antecedents. The questions included were formulated to represent factors elaborated on in the theoretical model section. While most of the questions were adapted from previous research, some were peculiar to the scope of this thesis. 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.

The questionnaire consisted of six parts. The first part consisted of two multiple choice questions about demographics, one yes/no question about disaster experience, and one open-ended question about the faculty the respondent was enrolled in. The second part encompassed questions about the subjective knowledge level of participants. The third part consisted of questions related to the extent to which individuals believe global warming constitutes a threat to the present and future generations. The fourth section included questions related to the approaches of the "organizations and people operating shale gas development" and to that of their "regulators." While the perceived risks, benefits and costs were assessed in section five, acceptance was measured in the final part of the questionnaire. In all sections except the first one, the items were measured by a five-point Likert-type scale with values ranging from "1: strongly disagree" to "5: strongly agree." However, a "0: don't know" option was also included in the survey so that individuals uninformed about the technology, or its implementation could be identified.

All constructs in the proposed model were analyzed based on reflective scales. In the succeeding paragraphs we briefly discuss how the items in each construct were formulated. Following this, we present a table that indicates the papers utilized in preparing the survey questions.

As no shale gas development facilities were operating in Turkey at the time of this

study, experience was measured as that of a natural disaster. One may claim that such an experience, particularly the experience of an earthquake, may create prejudice towards shale gas development since individuals can come across information associating the two processes.

The knowledge factor in our model was measured as a combination of subjective levels of climate change and shale gas knowledge. The inclusion of climate change knowledge as an indicator was important in that it introduced an environmental perspective into the stance formation framework. As the debate on the prioritization of shale gas operations over renewables gets heated, climate change knowledge could become more prominent in shaping perspectives towards the technology.

The factor of trust composed of trust in two groups one that is responsible of the development of shale gas and the other that supervises the operations. Trust in these actors blanketed their intentions, reliability and competence, their inclination to disclose information and the transparency in planning.

Procedural fairness was measured as the extent to which all social groups are represented in decision making. Distributive fairness was measured as the fair distribution of risks and benefits among members of the society.

Both perceived risks and benefits encompassed personal, social, environmental, and intergenerational considerations. Perceived risks also included a seismic risk indicator that was particular to the case of shale gas development. The construct accounted for the severity of all risks, as well. On the other hand, the perceived benefits factor included an economic benefits indicator in addition to the previously listed ones with the intention of capturing monetary benefits and employment opportunities associated with shale gas development. Perceived costs were measured as the cost of development of natural gas from shale formations.

Outcome efficacy was measured as the extent to which one perceives his or her actions impact policy making in the context of shale gas development. Problem perception was measured as the perceived significance of global warming and the perceived necessity to take action against it.

Finally, acceptance was measured with the personal, social, environmental, and intergenerational acceptance indicators. Additionally, our model differentiated between acceptance in general and acceptance close to one's location of residence.

Table 4.1: Survey development.

Survey Items	Papers Used
Experience (E)	
Disaster experience (E1)	Self-constructed
Knowledge (K)	
Sufficiency of climate change knowledge (K1)	Self-constructed
Sufficiency of shale gas knowledge (K2)	Self-constructed
Trust (T)	
Reliability (regulators) (T1)	Tokushige et al. (2007)
Reliability (operators) (T2)	Tokushige et al. (2007)
Disclosure of information about shale gas (regulators) (T3)	Tokushige et al. (2007)
Disclosure of information about shale gas (operators) (T4)	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 (2012) , Huijts et al. (2007)
Intentions (operators) (T8)	Bronfman et al. (2012), Huijts (2012) , Huijts et al. (2007)
Competence in assessment (regulators) (T9)	Bronfman et al. (2012), Huijts (2012) , Huijts et al. (2007), Tokushige et al. (2007)
Competence in assessment (operators) (T10)	Bronfman et al. (2012), Huijts (2012) , Huijts et al. (2007), Tokushige et al. (2007)
Ability to interfere when a problem arises (regulators) (T11)	Tokushige et al. (2007), Huijts (2012), Huijts et al. (2007)
Ability to solve problems (operators) (T12)	Bronfman et al. (2012), Huijts (2012) , Huijts et al. (2007), Tokushige et al. (2007)
Safety concern (regulators) (T13)	Tokushige et al. (2007), Huijts (2012)
Safety concerns (operators) (T14)	Tokushige et al. (2007), Huijts (2012)
Transparency in planning (T15)	Musall and Kuik (2011)
Political independence (operators) (T16)	Bronfman et al. (2012)
Perceived Risks (R)	
Personal risk (R1)	Self-constructed following the approach of Tokushige et al. (2007)
Social risk (R2)	Self-constructed following the approach of Tokushige et al. (2007)
Environmental risk (R3)	Self-constructed following the approach of Tokushige et al. (2007) and Huijts et al. (2007)
Risk to future generations (R4)	Self-constructed following the approach of Tokushige et al. (2007)
Seismic risk (R5)	Self-constructed
Severity of consequences when a problem occurs (R6)	Tokushige et al. (2007)

Table 4.1 continued: Survey development.

Scientific knowledge about risks (R7)	Tokushige et al. (2007)
Perceived Benefits (B)	
Personal benefit (B1)	Tokushige et al. (2007)
Social benefit (B2)	Tokushige et al. (2007)
Environmental benefit (B3)	Huijts et al. (2007), Bronfman et al. (2012)
Benefit to future generations (B4)	Tokushige et al. (2007)
Economic benefit (B5)	Huijts (2012)
Development necessity (B6)	Tokushige et al. (2007)
Perceived Costs (C)	
Development costs (C1)	Huijts (2012)
Procedural Fairness (PF)	Huijts (2012)
Inclusion in decision making (PF1)	
Distributive Fairness (DF)	
Fair distribution of risks and benefits (DF1)	Huijts (2012)
Problem Perception (PP)	
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)	
Consideration of opinions (OE1)	Huijts (2012)
Acceptance (A)	
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)

Overall, Table 4.1 that is provided above summarizes the survey items and the papers utilized in formulating the questions of the survey.

4.3.2 Information Provision

Following Huijits et al. [68], we carried out our analysis based on data from a group that responded to our questionnaires prior to and after having received information from different sources. In line with the feedback received from the pilot run of the questionnaire to be explained in the following sections, a few introductory sentences about shale gas were given to each participant. Following this, each participant was randomly provided with an information package that included a summary of current discourses of key actors involved in the process of shale gas development (see Appendix B). We elicited subjective knowledge levels of the respondents to discern whether participants in the control group considered themselves as less knowledgeable about shale gas development when compared to the information group. Interestingly, the information and control groups evaluated their knowledge levels as comparable ($M = 3.46, SD = 0.1$ for the control group and $M = 3.52, SD = 0.11$ for the information group). This may partly be due to a realization of the lack of detailed knowledge about shale gas development upon reading a short, but informative paragraph.

4.3.3 Survey Format

The major portion of the survey was completed via the distribution of hardcopies to individuals. 75% of individuals were reached by this means. The remaining portion of the questionnaires was completed electronically. The main reason for this was time constraints. As exam dates were approaching some professors agreed to send out the links to online surveys instead of allowing the administration of the questionnaire in class. Overall, data collection ran smoothly.

4.3.4 Pre-testing

All items that were to be measured as identified in Section 4.3.1 were included in a preliminary questionnaire. This questionnaire was pre-tested prior to data collection. The aim of pre-testing was to take some suggestions about the wording and format of the questionnaire, and to determine if all items are adequate for the purpose of studying the acceptance of shale gas development. A total of 50 respondents voluntarily participated in the pilot survey conducted in December 2017, at Middle East Technical University (METU) of Ankara, Turkey. With respect to their statements some items were revised, added to or removed from the questionnaire.

The first contribution of the pilot run was to underline that individuals with previous experience of a natural disaster, particularly that of the earthquake on August 17, 1999 in Golcuk, Turkey, are more susceptible to oppose shale gas development after being informed that the technology has a seismic risk. Individuals who have experienced an earthquake unrelated to shale gas development may also be more susceptible to oppose the technology if they believe that the technology has such a risk. Therefore, the measurement of the experience factor was founded upon the experience of a natural disaster. Another suggestion was related to the ability to follow questions. Many participants indicated that the length of the questions made it difficult to follow the flow. In line with this suggestion, the questionnaire was divided into five sections, each related to different concepts. Finally, while moving forward with our pilot run we realized that individuals had difficulty in answering questions since many of them had not even heard about shale gas. Almost half of the participants either asked us about the technology or immediately took out their phones with the intention to look up shale gas. Thus, we decided to provide a few introductory sentences about shale formations and the extraction of shale gas from these rocks. After making all necessary changes the final version of the questionnaire was prepared (see Appendix A).

4.3.5 Ethical Considerations

Before the survey was conducted, it was sent to the METU Applied Ethics Research Center (AERC). They assessed the questionnaire in terms of basic health, safety, human rights, legal principles and universal ethical principles and approved the data collection method used of this research, see Appendix C for the Ethics Approval document.

Respondents to the survey were informed that their participation to the survey was entirely voluntary and that the study would collect anonymous data. The consent form provided to each respondent also indicated that they could withdraw from the study at any time and that they could leave any question that made them feel uncomfortable blank.

Respondents were initially informed that the survey intended to understand society's approach towards shale gas development. However, they were not informed that each participant would receive a random information package that would be used in a comparison of the relative impacts of information from different sources. Following the completion of the questionnaire, respondents were debriefed about the true nature of the study.

CHAPTER 5

DATA ANALYSIS

This chapter analyzes the responses to the questionnaire by initially presenting general information and comparing information groups. Following this, the validity of constructs and the twelve hypotheses are discussed.

5.1 General Information

Overall, 302 respondents completed the questionnaire for the control group, and 315 completed the survey for the information group. Table 5.1 portrays general information about these groups. The gender distribution is balanced for both groups. As a result of convenient sampling the respondents are relatively young with approximately 66 and 82% of respondents within the age range of 18-24 for the information and control groups, respectively. The majority of participants are from engineering, economic and administrative sciences disciplines, reflecting the distribution in METU campus.

Table 5.1: Distribution of survey respondents by group, age and faculty.

Control Group			**Information Group**		
	Total	**Percentage**		**Total**	**Percentage**
Sample Size			**Sample size**		
Control group			Information from the government	68	21.59%
			Information from the industry	61	19.37%
			Information from NGOs	56	17.78%
			Scientific Information	52	16.51%
			Information from scientists	78	24.76%
Total	302	100.00%	Total	315	100.00%
Age			**Age**		
Female	145	48.01%	Female	144	45.71%
Male	139	46.03%	Male	154	48.89%
<18	0	0.00%	<18	0	0.00%
18-24	248	82.12%	18-24	208	66.03%
25-34	46	15.23%	25-34	88	27.94%
35-44	4	1.32%	35-44	11	3.49%
45-54	0	0.00%	45-54	2	0.63%
55-64	0	0.00%	55-64	2	0.63%
>64	0	0.00%	>64	0	0.00%
Faculty			**Faculty**		
Architecture	1	0.33%	Architecture	1	0.32%
Arts and Sciences	30	9.93%	Arts and Sciences	28	3.17%
Economic and Administrative Sciences	121	40.07%	Economic and Administrative Sciences	63	20.00%
Education	36	11.92%	Education	10	5.08%
Engineering	89	29.47%	Engineering	169	53.65%
Graduate School of Applied Mathematics	0	0.00%	Graduate School of Applied Mathematics	1	0.32%
Graduate School of Informatics	1	0.33%	Graduate School of Informatics	1	0.32%
Graduate School of Natural and Applied Sciences	4	1.32%	Graduate School of Natural and Applied Sciences	16	1.90%
Graduate School of Social Sciences	6	1.99%	Graduate School of Social Sciences	6	6.35%
Not Provided	14	4.64%	Not Provided	20	8.89%
Total	*302*	*100%*	*Total*	*315*	*100%*

5.2 Data Screening: Normality and Outliers Analysis

In terms of data screening, we deleted 65 rows of the control group, and 39 rows of the information group due to having fully incomplete responses. More than 75% of the responses were missing for these cases so we removed them from our data set. As the trust factor had many indicators, we treated it separately for the data screening process and removed 18 and 37 rows for the control and information group respectively, for having more than 25% missing responses.

Following this, before starting to analyze the relationships between constructs, we did a visual inspection of histograms of each variable in SPSS to detect outliers. Outliers can be defined scores that are significantly divergent from the remainder of observations [112]. According to Hawkins [112] outliers have the probability of creating bias in the means and inflating standard deviation values. The examination of histograms revealed no outliers. This could be a result of the structure of the questionnaire that constrained the answer set.

After examining outliers, the normality of the distributions were analyzed in more detail in order to determine whether parametric or non-parametric tests should be used. Kolmogorov-Smirnov and Shapiro-Wilk tests were performed to assess whether the distribution of variables were normal. The results presented in Table 5.2 indicated that all variables showed significant non-normality at the $p < 0.01$ level. Therefore, the use of parametric tests was not very appropriate for this data and the main analysis was done with a less widely used statistical analysis technique called "structural equation modeling," which is discussed in more detail in the following parts.

Table 5.2: Tests of normality.

	Type	Kolmogorov-Smirnova			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Experience	Control	0.413	92	0.000	0.607	92	0.000
	Information	0.370	77	0.000	0.631	77	0.000
Problem Perception	Control	0.297	92	0.000	0.763	92	0.000
	Information	0.315	77	0.000	0.684	77	0.000
Knowledge	Control	0.220	92	0.000	0.894	92	0.000
	Information	0.251	77	0.000	0.887	77	0.000
Procedural Fairness	Control	0.277	92	0.000	0.858	92	0.000
	Information	0.192	77	0.000	0.867	77	0.000
Outcome Efficacy	Control	0.201	92	0.000	0.903	92	0.000
	Information	0.206	77	0.000	0.886	77	0.000
Trust	Control	0.219	92	0.000	0.892	92	0.000
	Information	0.258	77	0.000	0.883	77	0.000
Distributional Fairness	Control	0.213	92	0.000	0.909	92	0.000
	Information	0.205	77	0.000	0.899	77	0.000
Perceived Costs	Control	0.221	92	0.000	0.877	92	0.000
	Information	0.235	77	0.000	0.869	77	0.000
Perceived Risks	Control	0.245	92	0.000	0.877	92	0.000
	Information	0.220	77	0.000	0.898	77	0.000
Perceived Benefits	Control	0.216	92	0.000	0.908	92	0.000
	Information	0.245	77	0.000	0.893	77	0.000
Acceptance	Control	0.229	92	0.000	0.887	92	0.000
	Information	0.255	77	0.000	0.868	77	0.000

a. Lilliefors Significance Correction

5.3 Group-wise Comparison

Before analyzing construct reliability and causal relationships between the dependent and independent variables, a brief comparison of the acceptance indicators of five information groups and the control group was made in order to see whether significant differences exist in terms the acceptance of shale gas development.

First of all, a visual inspection of the basic descriptive statistics for the constructs that is provided in Table 5.3 was made. Among the factors presented in this table acceptance and perceived benefits appeared to diverge more substantially, when compared to others. While the acceptance level was on the positive end of the scale, but close to neutral for the control group, it slightly decreased so as to become closer to dis-

agreement for the information group. Whether this divergence is significant will be explored further on. For the perceived benefits factor one may notice that again its level was on the positive end of the scale, but close to neutral for the control group, it slightly decreased so as to become closer to disagreement for the information group. This signifies that the respondents have tended to perceive less benefits on average after being provided with the information that we prepared. The risk perception, contrary to expected, delineated the exact same pattern, though with less divergence. Whether these divergences contribute to explaining the difference in acceptance will be analyzed later.

Table 5.3: Basic descriptive statistics for the constructs. Abbreviations are listed as follows: E: Experience, K: Knowledge, T: Trust, PF: Procedural Fairness, DF: Distributional Fairness, R: Perceived Risks, B: Perceived Benefits, C: Perceived Costs, PP: Problem Perception, A: Acceptance, OE: Outcome Efficacy.

	E		PP		K		PF		OE		T		DF		C		R		B		A	
Type	Control	Info	Control	Info	Control	Info	Control	Info	Control	Info	Control	Info	Control	Info	Control	Info	Control	Info	Control	Info	Control	Info
Mean	0.36	0.44	4.32	4.39	3.46	3.52	2.52	2.36	2.59	2.44	2.57	2.58	2.78	2.61	3.3	3.36	3.3	3.16	3.03	2.86	3.2	2.9
Std of Mean	0.05	0.06	0.09	0.1	0.1	0.11	0.09	0.12	0.11	0.12	0.11	0.11	0.11	0.11	0.09	0.1	0.1	0.12	0.11	0.11	0.09	0.12
Median	0	0	4.5	5	3.5	4	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Variance	0.233	0.25	0.68	0.767	0.866	0.911	0.736	1.129	1.036	1.15	1.04	0.851	1.095	0.899	0.698	0.761	0.829	1.081	1.197	0.992	0.774	1.015
Std. Deviation	0.482	0.5	0.824	0.876	0.931	0.954	0.858	1.063	1.018	1.07	1.02	0.923	1.046	0.948	0.835	0.872	0.911	1.04	1.094	0.996	0.88	1.008
Range	1	1	4	4	4	4	3	3	4	4	4	4	4	4	4	3	4	4	4	4	4	4
Skewness	0.599	0.24	-1.25	-1.82	-0.289	-0.48	-0.282	0.165	0.078	0.09	-0.053	-0.1	-0.02	0.197	-0.165	-0.06	-0.469	-0.32	-0.169	-0.28	0.098	-0.5
Std of Skewness	0.25	0.27	0.25	0.27	0.25	0.27	0.25	0.27	0.078	0.27	0.25	0.27	0.25	0.27	0.25	0.27	0.25	0.27	0.25	0.27	0.25	0.27
Kurtosis	-1.678	-2	1.874	3.565	-0.141	-0.03	-0.566	-1.19	-0.621	-0.96	-0.836	-0.31	-0.5	-0.17	-0.247	-0.74	-0.105	-0.58	-0.422	-0.4	-0.42	-0.51
Std of Kurtosis	0.5	0.54	0.5	0.54	0.5	0.54	0.5	0.54	0.5	0.54	0.5	0.54	0.5	0.54	0.5	0.54	0.5	0.54	0.5	0.54	0.5	0.54

Following this, a one-way ANOVA test was utilized to examine whether a difference between the means of the acceptance levels of different information groups existed. The post hoc Tukey and Bonferoni test results presented in Table 5.4 suggested that a significant difference between the means of the acceptance of shale gas development close to one's house existed among the control group and the group that received information from scientists.

Table 5.4: Intergroup comparison of acceptance levels.

Dependent Variable	(I) Type	(J) Type	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Not in my back yard (A5)	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
	Bonferoni	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	-0.32	0.76
			Information from NGOs	0.414	0.186	0.401	-0.14	0.96
			Scientific Information	0.144	0.203	1	-0.46	0.74
			Information from scientists	0.508*	0.168	0.04	0.01	1

Although the test does not provide us with information about the source of this difference, the results could have important policy implications. If individuals who are provided with little information coming from scientists display a significantly different attitude when compared to individuals who have not received any information, particularly in the context of location of operations, this could mean that information of proper content from certain actors could possibly help overcome, if not totally resolve, the not-in-my-back-yard challenge.

In addition to the ANOVA test, we explored the validity of the homogeneity of variances assumption with the Levene statistic as presented in Table 5.5. According to the significance values, the homogeneity of variance did not hold for the not in my back yard indicator (Sig. Levene Test< 0.05). However, a further analysis of the Kruskal Wallis test results suggest that the homogeneity of variance assumption hold asymptotically. That is to say, we may claim that the ANOVA result indicating a significance difference between the acceptance levels close to one's house among the control group and the group that receives information from scientists is valid.

Table 5.5: Test of homogeneity of variances.

	Levene Statistic	df1	df2	Sig.
Personal acceptance	0.549	5	399	0.74
Social acceptance	0.231	5	387	0.95
Acceptance of future generations	0.254	5	385	0.94
Environmental acceptance	1.312	5	383	0.26
Not in my back yard (NIMBY)	5.811	5	396	0

Table 5.6: Kruskal-Wallis test for indicator A5.

	Not in my back yard (A5)
Chi-Square	13.513
df	5
Asymp. Sig.	0.019
a. Kruskal Wallis Test	
b. Grouping Variable: Type	

5.4 Structural Equation Modeling (SEM) and the Partial Least Squares (PLS) Method

The inclusion of social and psychological elements in the investigations of social scientists complicates the relationships to be examined [113]. Under the normality assumption, these complicated relationships can be tested through traditional regression analysis methods that analyze the change in a dependent variable in case of a change in the independent variables. Yet, as has been shown in Section 5.2, the violation of the normality assumption precludes us from testing our hypotheses with parametric methods that include multiple linear regression. Moreover, the model that proposed in this thesis consists many direct and indirect effects in a complex setting. Therefore, traditional methods fail to suffice.

Structural equation modeling (SEM) is a statistical technique that combines aspects of multiple regression and factor analysis (that is utilized to represent unobserved, latent factors with multiple observed variables, indicators) to simultaneously estimate interdependent relationships [113]. SEM evaluates the relationships between variables through path diagrams. Latent variables, that reflect upon social, organizational

and psychological concepts, constitute the foundation of these diagrams [113]. In our case these latent variables encompass perceived benefits, risks and costs, procedural and distributional fairness, trust, outcome efficacy, problem perception, knowledge and experience.

The partial least squares (PLS) technique under SEM is utilized to analyze complex relationships among latent factors. For the purpose of this research the PLS technique was beneficial initially in that it placed minimal restrictions on the sample size. Although our sample size ($N = 302$ for the control group and $N = 315$ for the information group) was not small, the complexity of our model would require a substantially large number of observations were we to evaluate relationships through different techniques. The advantage of the nonparametric bootstrap method employed by PLS is that randomly generates subsamples from the original data set and thus allows testing with smaller samples, as well. Secondly, PLS is more appropriate when the normality assumption is violated, particularly because unlike the covariance-based SEM techniques, PLS does not result in negative variance estimates [114].

Thus, PLS was identified as the means of analysis. The software SmartPLS 3.0 was utilized for assessing the validity and reliability of the measurement model and that of the structural model.

5.5 Measurement Model

The conceptual model was set up with eleven constructs that consist either single (for procedural fairness, distributional fairness, perceived costs, experience and outcome efficacy) or multiple items (for perceived risks, perceived benefits, problem perception, knowledge, trust and acceptance). Apart from the yes/no question for the experience variable, the items in the questionnaire were measured with a 5-point Likert scale with the inclusion of a 0: don't know option that was to be evaluated as a missing answer. The items were all evaluated as reflective items. The adequacy of the measurement model was assessed initially with respect to item and construct reliabil-

ity values and then with respect to convergent and discriminant validities [115]. In the following paragraphs the results obtained for the information and control groups are discussed.

5.5.1 Measurement Model Results for the Control Group

The results of the measurement model for the control group presented in Figure D.1 and Table E.1 indicate that several items had loadings significantly lower than the accepted threshold 0.7 [115, 116]. However, for more complex models it is also noted that 0.6 can be considered as the sufficient level [115]. Following this suggestion, the indicators:

- sufficiency of shale gas knowledge,
- 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),
- transparency in planning,
- political independence (operators),
- scientific knowledge about risks,
- economic benefit,
- global warming as a concept against nature's laws

were removed from the construct. The final loadings upon such removals are presented in Figure D.2 and a summary of the measurement properties of the final constructs is presented in Table 5.7.

Table 5.7: Measurement properties of the final constructs.

Construct	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						1.000	1.000	1.000	1.000	1.000	1.000
	E1	1.000	1.000	0.000	0.000						
Knowledge						1.000	1.000	1.000	1.000	1.000	1.000
	K1	1.000									
	K2		1.000	0.000	0.000						
Trust						0.878	0.844	0.900	0.879	0.476	0.477
	T1	0.698	0.715	14.955	17.151						
	T2	0.758	0.764	21.869	22.17						
	T7	0.665	0.677	12.540	15.992						
	T8	0.630	0.680	12.695	15.098						
	T9	0.698		16.17							
	T10	0.734		17.41							
	T11	0.651		11.899							
	T12	0.713		17.343							
	T13	0.726	0.669	19.208	13.942						
	T14	0.611	0.687	11.717	14.344						
	T15		0.692		15.064						
	T16		0.634		11.997						
Perceived Risks						0.909	0.894	0.930	0.924	0.691	0.711
	R1	0.842	0.876	25.939	43.052						
	R2	0.906	0.912	49.901	51.18						
	R3	0.874	0.901	42.526	55.148						
	R4	0.884	0.852	46.971	33.852						
	R5	0.742		14.408							
	R6	0.721	0.645	12.904	11.249						
Perceived Benefits						0.924	0.916	0.943	0.938	0.769	0.751
	B1	0.871	0.909	39.108	47.779						
	B2	0.889	0.888	42.866	41.375						
	B3	0.921	0.858	67.942	32.155						
	B4	0.927	0.894	74.702	51.735						
	B6	0.769	0.777	21.851	22.62						
Perceived Costs						1.000	1.000	1.000	1.000	1.000	1.000
	C1	1.000	1.000	0.000	0.000						
Procedural Fairness						1.000	1.000	1.000	1.000	1.000	1.000
	PF1	1.000	1.000	0.000	0.000						
Distributive Fairness						1.000	1.000	1.000	1.000	1.000	1.000
	DF1	1.000	1.000	0.000	0.000						
Problem Perception						0.567	0.487	0.811	0.792	0.685	0.657
	PP1	0.922	0.750	4.095	2.258						
	PP3	0.721	0.868	2.484	2.872						
Outcome Efficacy						1.000	1.000	1.000	1.000	1.000	1.000
	OE1	1.000	1.000	0.000	0.000						
Acceptance						0.867	0.865	0.905	0.904	0.656	0.655
	A1	0.873	0.852	40.347	29.967						
	A2	0.808	0.888	22.857	37.926						
	A3	0.879	0.871	49.034	39.702						
	A4	0.756	0.758	21.958	17.267						
	A5	0.722	0.653	16.203	13.069						

Before discussing the results of hypothesis testing, scale reliability and validity should be examined. Reliability analysis scrutinizes the scale of measurement in a singular unidimensional construct [117]. The main value that serves to assess scale reliability is the Cronbach's alpha value [117]. According to the results presented in Table 5.7, all modified constructs except one had an alpha value greater than 0.867, which is significantly above the recommended minimum of 0.7 [118]. On the other hand, the alpha for problem perception (alpha $= 0.567$) remained substantially below the minimum. Yet, 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 0.811, 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 that which is an aftermath of measurement error [114]. Apart from the value for the more complex construct of trust, the AVEs for all constructs were at least 0.656, which are higher than the suggested minimum of 0.5 [114, 116]. 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 to the construct were made. Convergent validity was interpreted through an inspection of the square root of AVEs represented in the diagonal elements of Table 5.8. The results show 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 were examined. The main idea for this analysis is that constructs should share more variance with their own measures than they share with the remaining constructs present in the model [115]. Discriminant validity assessments were made by comparing the square root of AVEs given in the diagonal of Table 5.8, and the correlations of the latent variable with different constructs. Results suggest that all square roots of AVEs are higher than the correlations between the focal construct and the remaining constructs [119], hence one may claim that validity measures are quite acceptable.

Table 5.8: Discriminant validity and convergent validity of the constructs of the control group. Abbreviations are listed as follows: E: Experience, K: Knowledge, T: Trust, PF: Procedural Fairness, DF: Distributional Fairness, R: Perceived Risks, B: Perceived Benefits, C: Perceived Costs, PP: Problem Perception, A: Acceptance, OE: Outcome Efficacy.

	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**

5.5.2 Measurement Model Results for the Information Group

The results of the measurement model for the information group presented in Figure D.3 and Table E.1 indicate that several items had loadings significantly lower than the sufficient level 0.6 [115]. Therefore, the indicators:

- sufficiency of climate change knowledge,
- 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),
- ability to interfere when a problem arises (regulators),
- ability to solve problems (operators),
- seismic risk,
- scientific knowledge about risks,
- economic benefit,
- global warming as a concept against nature's laws

were removed from the model. As its item loading still remained low the item "competence in assessment (operators)" was removed in the second step. The final loadings upon such removals are presented in Figure D.4 and a summary of the measurement properties of the final constructs is presented in Table 5.7.

In terms of scale reliability a consideration of the Cronbach's alpha values presented in Table 5.7 suggest that all modified constructs except one had an alpha value greater than 0.844, greater than the recommended minimum [118]. The construct that had an alpha value lower than the threshold is again problem perception (with alpha = 0.487). However, this problem is understandable given that the factor is represented by two items only. As no other indicator for which data could be collected was identified, no changes were made to the construct.

All composite reliabilities were greater than 0.792, which is above the recommended minimum 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 [114, 116]. For trust the AVE value was found to be 0.477, which could be acceptable given the complexity of the model being tested. For convergent validity, the results indicate 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 Table 5.9, and the correlations of the latent variable with different constructs suggest that discriminant validity is attained, as well [119].

Table 5.9: Discriminant validity and convergent validity of the constructs of the information group. Abbreviations are listed as follows: E: Experience, K: Knowledge, T: Trust, PF: Procedural Fairness, DF: Distributional Fairness, R: Perceived Risks, B: Perceived Benefits, C: Perceived Costs, PP: Problem Perception, A: Acceptance, OE: Outcome Efficacy.

	A	**B**	**C**	**DF**	**E**	**K**	**OE**	**PF**	**PP**	**R**	**T**
A	**0.809**										
B	0.783	**0.867**									
C	-0.094	-0.073	**1.000**								
DF	0.290	0.287	-0.083	**1.000**							
E	-0.014	0.053	0.161	0.004	**1.000**						
K	0.025	0.038	0.076	0.129	0.006	**1.000**					
OE	0.050	0.107	0.104	0.144	-0.057	0.163	**1.000**				
PF	0.098	0.118	0.070	0.122	0.051	0.267	0.441	**1.000**			
PP	-0.103	-0.091	0.029	0.062	-0.039	0.006	0.020	0.049	**0.811**		
R	-0.548	-0.501	0.322	-0.186	0.043	0.100	0.097	0.032	0.015	**0.843**	
T	0.397	0.416	0.050	0.440	-0.037	0.093	0.306	0.423	0.053	-0.264	**0.691**

5.6 Structural Model

In order to test the significance of the paths in the structural model, the bootstrap resampling method was utilized. As the number of observations was also high, the recommendation of [114] could be followed, and the resampling size was chosen as 500. A visual delineation of the initial results can be found in Figure D.5 and Figure D.6 for the control group and information group, respectively. The structural model results of the analysis following the removal of items are presented in Table 5.10.

Table 5.10: Structural estimates with hypothesized relationships.

		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 (10% 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	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	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	0.000	Yes (0.1% level)	Yes (0.1% level)
H10	**C → A**	0.025	0.031	0.500	0.786	0.617	0.432	No	No
H11	**DF → A**	0.138	0.069	2.261	1.687	0.024	0.092	Yes (10% level)	Yes (10% level)
H12	**OE → A**	0.053	-0.012	1.118	0.294	0.264	0.769	No	No

5.6.1 Structural Model Results for the Control Group

In the model for the control group many of the paths suggested by the developed model are supported, although not all. Table 5.10 and Figure D.7 represent the causal effects and their significance. The following hypothesized relationships that explain the social acceptance of shale gas development were not confirmed through the analysis:

- The cultivation of knowledge does not have a significant effect on the establishment of trust (Hypothesis 2).
- Placing trust in actors that have a role in shale gas development or in those responsible of supervising shale gas operations does not impact the level of perceived costs associated with the technology (Hypothesis 6).
- Environmental problem perception does not have a significant direct effect on the acceptance of shale gas development (Hypothesis 7).
- Cost perception does not have a significant direct impact on the social acceptance of shale gas development (Hypothesis 10).
- Outcome efficacy does not directly explain the acceptance of shale gas development (Hypothesis 12).

When the antecedents of acceptance were analyzed, the following relationships were confirmed:

- Experience has a positive impact on knowledge development ($Y = 0.175, p = 0.013$) (Hypothesis 1).
- While trust has a strong positive impact on benefit perception ($Y = 0.424, p = 0.000$), it has a significant negative impact on risk perception ($Y = -0.239, p = 0.004$) (Hypothesis 5 and 4, respectively).
- Procedural fairness has a positive impact on trust development ($Y = 0.282, p = 0.000$) (Hypothesis 3).

- Risk perception is negatively associated with the acceptance of shale gas development ($Y = -0.213, p = 0.001$) (Hypothesis 8).

- Benefit perception has a strong positive impact on the acceptance of shale gas development ($Y = 0.598, p = 0.000$) (Hypothesis 9).

- Distributional fairness has a positive but lower impact ($Y = 0.138, p = 0.024$) on the acceptance of shale gas development (Hypothesis 11).

Before proceeding with the results for the information group, with the intention of discussing the overall predictive power of our model the overall model fit statistics should be analyzed [116]. In this sense, the first indicator would be the explained variance (R^2) values. The results in Table 5.11 suggest that the explanatory power for the endogenous variables range between the poor and substantial level ($R^2_A = 0.563, R^2_B = 0.180, R^2_C = 0.004, R^2_K = 0.031, R^2_R = 0.057, R^2_T = 0.080$). For the end goal of acceptance, the model has satisfactory results. In terms of the model fit, the goodness-of-fit formula of Tenenhaus, Vinzi, Chatelin, and Lauro was used [120]. This measure is derived upon taking the square root of the product of the average R^2 value of endogenous variables (which in our case are acceptance, perceived benefits, risks and costs, knowledge and trust) and the average AVE value. For the control group, the computed value is 0.342 (see Table 5.11). Unfortunately, this is below the theoretical cut-off 0.36 [119].

Table 5.11: R^2, communality, and goodness of fit.

	Acceptance A	Perceived Benefits PB	Perceived Costs PC	Knowledge K	Perceived Risks PR	Trust T	Average Average
R^2 (Control Group)	0.563	0.180	0.004	0.031	0.057	0.080	0.153
R^2 (Information Group)	0.651	0.173	0.002	0.000	0.070	0.180	0.179
Communality (AVE) (Control Group)	0.656	0.769	1.000	1.000	0.691	0.476	0.765
Communality (AVE) (Information Group)	0.655	0.751	1.000	1.000	0.711	0.477	0.766
Goodness of Fit (Control Group)	0.342						
Goodness of Fit (Information Group)	0.371						

5.6.2 Structural Model Results for the Information Group

In the model for the information group many of the paths suggested by the developed model are supported, although not all. According to the results in Table 5.10 and

Figure D.8 the following hypothesized relationships that explain the social acceptance of shale gas development were not confirmed through the analysis:

- Experience about shale gas development does not have a significant impact on the acceptance of the technology (Hypothesis 1).
- The cultivation of knowledge does not have a significant effect on the establishment of trust (Hypothesis 2).
- Placing trust in actors that have a role in shale gas development or in those responsible of supervising shale gas operations does not impact the level of perceived costs associated with the technology (Hypothesis 6).
- Environmental problem perception does not have a significant direct effect on the acceptance of shale gas development (Hypothesis 7).
- Cost perception does not have a significant direct impact on the social acceptance of shale gas development (Hypothesis 10).
- Outcome efficacy does not directly explain the acceptance of shale gas development (Hypothesis 12).

When the antecedents of acceptance were analyzed, the following relationships were confirmed:

- While trust has a strong positive impact on benefit perception ($Y = 0.416, p = 0.000$), it has a significant negative impact on risk perception ($Y = -0.264, p = 0.000$) (Hypothesis 5 and 4, respectively).
- Procedural fairness has a strong positive impact on trust development ($Y = 0.429, p = 0.000$) (Hypothesis 3).
- Risk perception is negatively associated with the acceptance of shale gas development ($Y = -0.215, p = 0.000$) (Hypothesis 8).
- Benefit perception has a strong positive impact on the acceptance of shale gas development ($Y = 0.655, p = 0.000$) (Hypothesis 9).

- Distributional fairness has a positive but lower impact ($Y = 0.069, p = 0.024$) on the acceptance of shale gas development (Hypothesis 11).

To assess the explanatory power of our model the overall model fit statistics were analyzed. The results in Table 5.10 suggest that the explanatory power for the endogenous variables range between the poor and substantial level ($R^2_A = 0.651, R^2_B = 0.173, R^2_C = 0.002, R^2_K = 0.000, R^2_K = 0.070, R^2_T = 0.180$). In terms of acceptance, the model has highly satisfactory results. For the goodness of fit, the value computed for the information group is 0.371 (see Table 5.11), that is slightly above the theoretical cut-off 0.36 [119].

CHAPTER 6

DISCUSSION AND CONCLUSION

Recent developments, especially conflicts associated with energy technologies, have delineated that social acceptance has become an imperative consideration in the planning and implementation of energy policies. Fortunately, it is not a challenge, but instead an indicator that can be measured and managed. In this chapter of the research, the theoretical perspective developed specifically for the case of the social acceptance of shale gas development will be summarized. Following this, the findings of the questionnaire developed in line with the model will be discussed. Finally, the research limitations and recommendations for future research will be addressed.

6.1 Theoretical Perspective and Contributions

The first contribution of this study to the literature is to provide an ecological economics perspective to shale gas development through accounting for the links between social, economic and ecological systems [121]. The main contribution of this study to the literature however, is to provide a comprehensive framework that will allow stakeholders to evaluate the social acceptance of shale gas development in different countries, through time. As research in the United Kingdom has shown [17, 19, 18, 6], social acceptance is a continuous process. Once the concerns of the public are identified, projects or policies could be adjusted to account for the opinions and evaluations of the public. In predicting a model that adds up to a complex portrait of the social acceptance of shale gas development, we have concentrated on the psychological factors that were suggested by and tested in literature. The model

we proposed for understanding acceptance encompasses the factors: perceived benefits, risks and costs, procedural and distributional fairness, trust, outcome efficacy, problem perception, knowledge and experience.

In line with Ajzen's theory of planned behavior [58] we accounted for attitudes, social norms and perceived behavioral control in understanding the intention to exert a particular behavior. The behavior in question was expressing an opinion on shale gas development through answering a questionnaire anonymously. As we chose this particular deed, there was no difficulty in performing the behavior and no social pressure that urges individuals not to perform the behavior. Therefore, we excluded social norms and perceived behavioral control from our model. Through including an indicator for the degree of active promotion desired within the acceptance factor, we have considered attitudes, as well. Again, outcomes that influence attitudes, namely benefits, risks and costs were of consequence. In this sense, among many others, we referred to costs such as that of subsidies, risks such as water contamination, deterioration of air quality and seismic events, and benefits such as economic growth, and the solution of energy security problems. We also suggested that only the perceived values of these factors would influence attitudes towards shale gas development.

In the context of normative motives we referred to personal norms, that portray the extent to which people feel they are morally obliged to act in a peculiar manner or refrain from doing so. The action definition allowed us to exclude this factor from our model. However, we accounted for the antecedents of personal norms, namely perceived benefits, risks and costs, outcome efficacy and problem perception. Problem perception, that relates to one's awareness of adverse consequences of human interference with the environment, was also noted as a factor that could impact the social acceptance of shale gas development significantly. The reasoning we presented was the following: the more one thinks we should actively prevent global warming, the more he or she might favor shale gas development, a technology that has been referred to as one that reduces CO_2 emissions. For outcome efficacy we initially examined the portion that relates to the ability of the technology to resolve perceived problems. There we stated that if individuals believe that shale gas has a cleaner en-

vironmental footprint, then they may favor the technology over another. Following this, we examined the portion that relates to the extent to which one believes that his or her attitude would impact the application of the technology. Within this section we argued that individuals who think that they reside in regions where their attitudes have a more significant impact on decision making would be more willing to express an opinion in favor or against the technology. Regarding affect, we proposed considering it together with other factors in our model particularly with perceived risks and benefits. This suggestion was deemed appropriate as the negative affect of worry resulting from natural gas' presence in taps for instance, could be linked to safety concerns, an indicator for perceived risk.

Trust was one of the main factors that impacted acceptance. In placing trust in our model we followed the most frequently depicted relationships and linked it to acceptance through perceived benefits, risks and costs. Moreover, we stated that relying on government organizations, the industry, environmental organizations, scientists and the ideas that they present us through diverse means of communication could be viewed as a substitute to acting upon full knowledge. Therefore, we linked knowledge and trust, as well. Another discussion was related the measurability of the factor. In addressing the matter, we underlined that trust in each actor should be treated independently since the roles of each actor was distinct in the process.

The perceived fairness of the distribution of benefits, risks and costs: distributive fairness, and the fairness in contribution to the decision process that results in the actualization of the technology: procedural fairness were other crucial factors that determined acceptance. Fairness was relevant to the case of shale gas development mainly because the distribution of economic benefits related to the technology has not been as broad as promised. It was also relevant because it was linked to the knowledge channel. Following the work of Earl and Siegrist [96] we claimed that perceived fairness could formulate trust in actors when there is an exigency of information relating to trust. Furthermore, once an actor is trusted, an illusion of perceived fairness could follow. Thus, we allowed for the factors fairness and trust to covary.

The experience factor in our model had two pillars: one that encompassed the impacts associated with the technology directly, the other that encompassed the impacts of a technology that is perceived to generate concerns similar to those associated with shale gas development. For the former pillar we asserted that experience serves as a means of accumulating knowledge that would allow individuals to arrive at a reasoned judgment. For the latter, we stated that it could result in an erroneous evaluation of the risks and could hence impact acceptance. We portrayed the large-scale impact of experience by two arrows: one that points at knowledge and the other that points at all variables in our model, see Figure 1. We considered experience as exogenously given because it is difficult, if not impossible, to limit peoples' exposure to the technology and to establish full immunity from external impacts.

What we suggested in terms of the management of social acceptance was the provision of information. This became a viable option because survey data and numerous opinion polls have underlined 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. While there appears to be no exact solution to the problem of low levels of knowledge, providing information may change the way people perceive the technology. It may formulate the link between risk perception and social acceptance. In this context, we mentioned three channels through which knowledge would allow for spatial divergences in policymaking, namely the source, content and means of communication.

In relation to the source of information we underlined the importance of the credibility of the source in modulating attitudes towards shale gas development. The government, the industry, environmental NGOs and scientists emerged as actors that could possibly influence acceptance. Governments could reduce the level of risk perception or increment the benefit perception through instilling a sense of security to individuals about the environmental risks linked to the energy technology. Industry representatives on the other hand, could undermine the risks associated with shale gas development through underlining their good intentions and capabilities. Environmental NGOs could increment the risk perception through reinforcing the idea that shale

gas development is a temporary fix. Dissimilarly scientists could reduce bias towards the technology through presenting balanced stances.

In terms of the content we stated that discerning the relative impact of information of different contents on acceptance, for instance understanding whether information about the procedure of development has an impact on acceptance or not, should be an imperative consideration for policymakers. The method of information provision was another important consideration. In this context, the medium of communication, frequency and content of the provided information, and the language utilized in this process emerged as determinants of the impact on acceptance. While our model would allow us to test whether novel ways of conveying ideas about shale gas development are effective in managing its social acceptance or not, we advocated for concentrating on the source and content of information in combination with each other since the language that actors employ is much difficult to modulate.

Upon administering a questionnaire developed in line with the model explained above, loadings for each item that explains the social acceptance of shale gas development were obtained. According to the peculiarities and concerns of communities mirrored in these loadings, policymakers could choose to concentrate on improving the moral benefits of the technology, diminishing its environmental damages, distributing the costs and benefits fairly, or on locating operations such that people feel safe. Moreover, tracing the factor loadings through time while exposure to information increases, could allow policymakers to find more effective methods of communication among representatives of the industry, regulatory agencies, environmental NGOs, scientists and members of the general public.

6.2 Findings: Commonalities and Differences Between the Models for the Control and Information Group

The partial least squares (PLS) method of structural equation modeling was used for the model estimation. The final models served useful in explaining the social acceptance of shale gas development with and without the provision of information.

The first important difference between the two groups was that shale gas knowledge did not load high on the latent factor of knowledge in the control group, while it did in the information group. This difference becomes more interesting when thought of together with the fact that the climate change knowledge indicator delineated the exact opposite pattern. It appeared as if respondents were on opposite ends of the scales of knowledge for the two items. Additionally, the cultivation of knowledge was found not have a significant effect on the establishment of trust (which is the channel through which knowledge impacts acceptance) in both the control and information groups. This may provide a substantial insight for further research in the area, because it may signify the necessity of the reconsideration of the measurement of the knowledge factor. A combination of subjective and objective knowledge items may be a possible solution of this problem.

One may interpret the common low item loadings on the indicators:

- 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)

for both the information and control group, as the participants' consideration of information disclosure as a different construct, probably unrelated to the acceptance of shale gas development. That is to say, although the literature that generally concentrates on a narrow range of indicators for trust may suggest that these items are valid

indicators of trust, when combined in a comprehensive framework, these items may become insignificant.

Another common aspect for the two groups was the low loadings of "scientific knowledge about risks" and "economic benefit." Particularly the low item loading of "economic benefit" was unexpected, in that it is one of the most frequently referred to benefits of shale gas development. Yet, the item's loading did not change significantly when all other mentioned variables were removed from the construct. It would be interesting to make cross-sectional comparisons in the loading of this item, because it may be peculiar to the case of Turkey. Unlike the United States in Turkey, the economic benefits derived from energy sources close to your neighborhood do not directly transfer to the inhabitants.

The indicator considering global warming as a concept against nature's laws was differentiated significantly from other items that underlined the substance of the induced change. It was not considered as an acceptable indicator for problem perception. Moreover, the latent factor of environmental problem perception did not have a significant direct effect on the acceptance of shale gas development. Therefore, further studies may exclude this factor from the model and may measure benefit perception with a more specific item relating shale gas development to climate change mitigation efforts.

The elimination of "transparency in planning" in the control group is also notable. This factor may load high on trust in the downstream context, because individuals may be disturbed by not being informed through the process. Therefore, a comparison of the relative importance of this factor in regions where shale gas development is already taking place, could have important policy implications. It may suggest following a precautionary approach and exploring communication options among authorities and the public at very early stages of the technology's adoption.

One crucial divergence of the control and information groups is related to the "seis-

mic risk" indicator. The indicator had a low loading in the information group. It was surprising to see that individuals placed importance on the factor when uninformed, and that they did not perceive it as that crucial when provided with more detailed information. This may be due to prejudices that are founded upon previous unfortunate experiences. The negative connotation of the phrase "cracking rocks" included in the common information package may have triggered such an attitude.

In terms of the structural model, in the control group, the variable of experience is a direct determinant of knowledge, while this is not the case among the information group (Hypothesis 1). This suggests that a more practical approach is followed by participants. When individuals are provided with information they tend to rely on the knowledge acquired through that piece. On the other hand, when no such information exists experience serves as a means of accumulating knowledge. This is important for future policy making because it underlines that selecting an adequate means of communication between members of the public and relevant actors could break the utilization of previous experience to construct a knowledge base.

The significance of the fairness factors in both models is an important conclusion (supporting Hypothesis 3 and 11 for procedural fairness and distributional fairness, respectively). While the impact channels for procedural and distributional fairness are different, it should be noted that the significance of the impact of distributional fairness on trust is 10%. This particular result deserves attention since it is substantially close to the upper boundary for acceptable significance levels. If a more representative sample of the population can be utilized for similar analysis, this result may be subject to change, and this may shape the complexity of the model. More studies could be done on this matter to ensure the validity of our results.

The hypothesized relationship between trust in actors that have a role in shale gas development or in those responsible of supervising shale gas operations and the level of perceived costs associated with the technology was not confirmed in either group (Hypothesis 6). Similarly, PLS results suggest that cost perception does not have

a significant direct impact on the social acceptance of shale gas development (Hypothesis 10). In this sense, it is probable that individuals do not view any harm to themselves from the high costs of development. In cases where the industry bears all costs of development, in further analysis the perceived costs factor may be eliminated from the model. In countries where substantial amounts of funds from government budgets are allocated to development or exploration operations, this factor most probably would remain in the model. Therefore, tailored approaches are necessary in the case of social acceptance analysis.

Again, the hypothesized relationship between environmental problem perception and acceptance was not confirmed in either group (Hypothesis 7). This may be important for future research since it may signify the sufficiency of integrating environmental concerns into the risk factor in explaining the acceptance of shale gas development. The benefit of doing this would be the simplification of the model and the diminution of required observations for analysis.

The PLS results suggest that knowledge does not have a significant impact on the development of trust (Hypothesis 2). It would have been reasonable to envision that for instance, a person who has numerous read articles about the precautions taken during the development process could have been more trusting of the actors involved in the development process, while a person who has not read much about the technology could have been more skeptical about it due to uncertainties. On the other hand, an individual who has read a lot of excerpts that have accentuated the risks associated with shale gas development could have become less trusting of responsible institutions, while someone who hasn't read such reports could have just felt that he or she should trust the more knowledgeable project implementers and regulators. However, neither standpoint has been validated in this research.

Although the effect was not found to be significant, one interesting finding is the reversal of the sign of the path coefficient from outcome efficacy to acceptance when information is provided to respondents (Hypothesis 12). No literature support is found

for this trend in the literature. However, whether this phenomenon is universal, can be the scope of further research. In both the information and control groups trust had a significant negative impact on risk perception (Hypothesis 4) and a strong positive impact on benefit perception (Hypothesis 5). The benefit perception also had a strong positive impact on the acceptance of shale gas development. The path coefficient associating perceived benefits to acceptance is the highest among the antecedents of acceptance (Hypothesis 9). Contrary to this, risk perception is strongly but negatively associated with the acceptance of shale gas development (Hypothesis 8). Both results are in line with that of Slovic et al. [65] that attribute 92% of the variance in public acceptance to the two factors of risk perception and benefit perception.

Finally, in addition to the discussion above that is founded upon the direct effect values, to execute robustness check, a multigroup analysis (MGA) with 5000 sub samples was conducted with a model where all common indicators to both groups are present. It was important that this research rely on statistical comparisons rather than numerical comparisons. The results presented in Table 6.1 reveal that no significant difference was present among the path coefficients of both groups. That is to say, although numerical differences in the relative impact of factors on each other may exist, information provision does not alter the relationships among psychological factors that impact the acceptance of shale gas development significantly.

Table 6.1: PLS MGA structural estimate differences.

	Path Coefficients-diff (| Control - Information |)	**p-Value (Control vs Information)**
B $\rightarrow$ **A**	0.062	0.779
C $\rightarrow$ **A**	0.003	0.520
DF $\rightarrow$ **A**	0.072	0.163
E $\rightarrow$ **K**	0.055	0.726
K $\rightarrow$ **T**	0.099	0.825
OE $\rightarrow$ **A**	0.065	0.164
PF $\rightarrow$ **T**	0.101	0.847
PP $\rightarrow$ **A**	0.024	0.642
R $\rightarrow$ **A**	0.007	0.533
T $\rightarrow$ **B**	0.040	0.317
T $\rightarrow$ **C**	0.097	0.801
T $\rightarrow$ **R**	0.034	0.384

Overall, this research has concluded that problem perception and outcome efficacy do not impact the acceptance of shale gas development significantly. While the impact of problem perception can be incorporated into the risk and benefit structure, outcome efficacy can directly be eliminated from the model. Similarly, trust does not significantly impact perceived costs of shale gas development operations and perceived costs do not reflect upon acceptance levels. Thus, it is possible to remove the cost item from the construct. Experience does not translate into the accumulation of knowledge when individuals are informed, while it does when individuals do not have prior knowledge about the energy technology. That is to say, policymakers should consider accelerating the dissemination of information about shale gas development in regions where previous natural disaster experience exists, to ensure that this negative experience not constitute a foundation for one's opinions. Knowledge does not appear to impact the trust cultivated in key actors involved in shale gas operations. However, the PLS estimations also reveal differences in terms of the importance of climate change and shale gas knowledge in explaining the knowledge level. Therefore, future research may test the relationship between knowledge and trust with a modified version of the knowledge construct, possibly with a combination of subjective and objective measures.

6.3 Limitations and Future Works

First of all, as a convenience sample of surveys was used in this thesis rather than a random investigation due to difficulties in obtaining high quality data about a complicated model. That is to say, the sample in this thesis did not reflect the Turkish population, particularly in terms of education. The respondents of this survey all had at least high school level of education. Therefore, the findings cannot be utilized to make generalizations. However, the foundation of the research upon psychological factors makes the conceptual model universally applicable it would be interesting to see if the results of this analysis changed once a more brother sample is studied. It would also be interesting to see other studies analyze if there are similarities or differences among cultures regarding the attributes presented in this text. In line with

the factor loadings obtained from cross-sectional studies, policymakers could make adjustments to the designs of policies or projects. According to the peculiarities and concerns of communities, policymakers could choose to concentrate on improving the moral benefits of the technology, diminishing its environmental damages, distributing the costs and benefits fairly, or on locating operations such that people feel safe.

Secondly, interestingly, the PLS results suggest that the economic benefit derived from shale gas operations is not of crucial importance in explaining the benefit perception of individuals. A similar conclusion relates to seismic risk's not contributing to the risk perception of individuals in the information group. Although it is probable that the latter conclusion be the product of being assured by key actors involved in the process of development, both results deserve further attention. Whether this is peculiar to the case of Turkey may be within the scope of future research.

Finally, transparency in the planning of shale gas operations is found not to be of crucial importance for the control group. This may be the result of studying the social acceptance of shale gas development at a single point in time in the upstream context. Yet, this study measured the social acceptance of shale gas development at a single point in time. Yet, particularly research in the United Kingdom [17, 19, 18, 6] has shown that approaches are subject to change over long time periods. In this case, longitudinal studies could provide a better insight about how information provision may impact acceptance.

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APPENDIX A

SURVEY

Type VI

This questionnaire is part of a master's thesis for the Earth System Science Department. Your participation is entirely voluntary. If there are items you do not feel comfortable answering, please skip them. Thank you for your cooperation.

Please read the following information before continuing with the questionnaire:

Shale gas is natural gas formed and held within shale formations. Shales are fine-grained sedimentary rocks that form from the compaction of silt and clay-size mineral particles that we commonly call "mud." Shale gas development involves the injection of a mixture of water sand and chemicals down and across wells, causing the rock later to crack.

Questions

Age: □ Under 18 years □ 18-24 □ 25-34 □ 35-44 □ 45-54 □ 55-64 □ Age 65 or older
Gender: □ Male □ Female □ Prefer not to answer
Faculty: …….
Natural Disaster Experience: Have you ever experienced a natural disaster? □ Yes □ No

Please indicate your level of agreement or disagreement with each of these statements about shale gas development:

	Don't Know	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Part A						
I think we should **actively prevent** global warming.	0	1	2	3	4	5
I think global warming is **against nature's laws.**	0	1	2	3	4	5
I think global warming is **negative legacy** from the development of civilization.	0	1	2	3	4	5
Part B						
I think I have sufficient **knowledge about climate change.**	0	1	2	3	4	5
I think I have sufficient **knowledge about shale gas.**	0	1	2	3	4	5
Part C						
I think I am **given a say in the planning process** of shale gas development.	0	1	2	3	4	5
I think **public opinion is sufficiently regarded** in the planning process of shale gas development.	0	1	2	3	4	5
I think the **regulators** of the shale gas industry are **reliable.**	0	1	2	3	4	5
I think the **organizations** and people operating shale gas development are **reliable.**	0	1	2	3	4	5
I think the **regulators** of the shale gas industry **disclose information** including that **disadvantageous to them.**	0	1	2	3	4	5
I think the **organizations** and people operating shale gas development **disclose information** including that **disadvantageous to them.**	0	1	2	3	4	5
I think the **regulators** of the shale gas industry disclose information about **alternatives** to shale gas.	0	1	2	3	4	5
I think the **organizations** and people operating shale gas development disclose information about **alternatives** to shale gas.	0	1	2	3	4	5
I feel confident that the **regulators** of the shale gas industry are **concerned about safeguarding the interests of the citizens and the environment.**	0	1	2	3	4	5
I feel confident that the **organizations** and people operating shale gas development are **concerned about safeguarding the interests of the citizens and the environment.**	0	1	2	3	4	5
I feel confident that the **regulators** of the shale gas industry have **specialized knowledge, skills and experience to assess the risks and benefits** and make adequate decisions.	0	1	2	3	4	5
I feel confident that the **organizations** and people operating shale gas development have specialized **knowledge, skills**	0	1	2	3	4	5

Figure A.1: Generic survey questions.

Type VI

and experience to assess the risks and benefits and make adequate decisions.						
I feel confident that the **regulators** of the shale gas industry have specialized **knowledge, skills and experience** to **interfere** when a **problem arises** during shale gas development**.**	0	1	2	3	4	5
I feel confident that the **organizations** and people operating shale gas development have **specialized knowledge, skills and experience** to **solve** forthcoming **problems.**	0	1	2	3	4	5
I feel confident that the **regulators** of the shale gas industry make sure that adequate **safety measures** are met.	0	1	2	3	4	5
I feel confident that the **organizations** and people operating shale gas development make sure that adequate **safety measures** are met.	0	1	2	3	4	5
I think the **planning** of shale gas development is **transparent.**	0	1	2	3	4	5
I feel confident that the organizations and people operating shale gas development act without **political or private pressures and obligations.**	0	1	2	3	4	5
I think the **distribution of benefits and drawbacks** of shale gas development with respect to myself and others is **fair.**	0	1	2	3	4	5
Part D						
I think that shale gas development is **costly.**	0	1	2	3	4	5
I think shale gas development poses a risk to **me.**	0	1	2	3	4	5
I think shale gas development poses a risk to **society.**	0	1	2	3	4	5
I think shale gas development poses a risk to the **environment.**	0	1	2	3	4	5
I fear shale gas development is a threat to **future generations.**	0	1	2	3	4	5
I think shale gas development poses risk for induced **seismicity.**	0	1	2	3	4	5
I think the consequences are **severe** when **something bad happens** in the process of shale gas development.	0	1	2	3	4	5
I think the **risks** of shale gas development are **known to science.**	0	1	2	3	4	5
I think shale gas development benefits **me.**	0	1	2	3	4	5
I think shale gas development benefits **society.**	0	1	2	3	4	5
I think shale gas development benefits the **environment.**	0	1	2	3	4	5
I think shale gas development benefits **future generations.**	0	1	2	3	4	5
I think shale gas development contributes to **economic activities.**	0	1	2	3	4	5
I think shale gas development is **necessary for society.**	0	1	2	3	4	5
Part E						
I think shale gas development is acceptable to **me.**	0	1	2	3	4	5
I think shale gas development is acceptable to **society.**	0	1	2	3	4	5
I think shale gas development is acceptable to **future generations.**	0	1	2	3	4	5
I think the **environmental risks** associated with shale gas development are acceptable.	0	1	2	3	4	5
I would **tolerate** shale gas development **close to my house** if it is accepted by society.	0	1	2	3	4	5

Figure A.2: Generic survey questions, continued.

APPENDIX B

INFORMATION PROVIDED TO RESPONDENTS

Type I

The <u>regulators</u> of the shale gas industry state the following:

Access to oil and gas: Natural gas is used to **generate a quarter of the nation's electricity**.
Economic indicators: Shale gas **generates government revenue** via taxes, **creates new jobs** and **contributes to the Gross Domestic Product**.
Climate change: Shale gas can help achieve a **reduction in CO_2 emissions**.
Water: A number of studies caution that surface and **groundwater contamination remain a risk**; some studies document contamination from above-ground chemical spills, leaks, wastewater mishandling and other incidents.
Regulations: Requirements from numerous **laws** apply to shale gas development. Consequently, the fracturing of wells is a process that is **highly engineered, controlled and monitored.**
Air: Natural gas is efficient and clean compared to other fossil fuels, emitting less nitrogen oxide and sulfur dioxide than coal and oil, no mercury and very few particulates. However, drilling can release chemicals such as **benzene** and **methane**, a very reactive greenhouse gas. Data in this area is lacking and under study.
Induced Seismic Events (Earthquakes): Studies thus far indicate the energy released during **hydraulic fracturing** is generally not large enough to trigger a seismic event that could be felt on the surface. However, **waste fluid disposal** through underground injection can "pose some risk for induced seismicity."
Fracture Fluids: Fracture fluid is largely composed of water (99%); but a number of additives are mixed with it to increase the effectiveness of the operation. **Hydraulic fracturing fluids** can contain hazardous chemicals and, if mismanaged, spills could leak harmful substances into ground or surface water. However, good field practice, governed by existing regulations, **"should provide an adequate level of protection"** from fracturing fluid risks.
Surface Impacts: There is a risk of increased traffic or other habitat disturbances that could affect residents, agriculture, farming, fishing and hunting.

<u>Industry representatives</u> state the following about shale gas development:

Energy and Opportunity: By helping to lower power and materials costs and stimulating economic activity, fracking has provided benefits to individual households, manufacturers and other businesses.
Land use: Hydraulic fracturing allows multiple wells to be drilled from one spot, reducing the size of the drilling area above ground by as much as 90 percent.
Energy Security: Fracking has unlocked vast reserves of shale to produce an energy renaissance that has seen a dramatic lowering of natural gas imports.
Employment: Natural gas access by the shale boom contributed to 1.9 million jobs economy-wide in 2015.
Industry Standards: Existing industry standards, best practices and effective regulation is protecting communities and the environment while safely making available increasing volumes of cleaner-burning natural gas.
Fracking fluid: The fracturing mixture consists primarily of fresh water mixed with some sand and a small proportion of common chemicals.
Groundwater protection: The industry has developed detailed standards based on field experience and significant advances in drilling and construction techniques. Hence, there have been no confirmed cases of groundwater contamination in the at least 2 million wells fracked over the past 68 years.
Water Use and Conservation: Water conservation efforts include: using lower quality water from nontraditional sources, reusing produced water and creating new infrastructure to transport water.
Water Treatment Technologies: Companies are diligent about capturing water produced during exploration and production. New technologies and sophisticated fracturing chemistries help companies make more frequent use of water.
Air emissions: The environmental benefits of natural gas go well beyond CO_2 reductions. Greater use of natural gas in power generation will also reduce NO_x, SO_2, PM, acid gasses, Hg and non-Hg heavy metal emissions.
Methane emissions: Recent reports show that methane emissions from hydraulically fractured natural gas wells have fallen nearly 65% between 2012 and 2015 due to industry practices. Furthermore, methane emissions from the natural gas industry make up just 4 percent of total greenhouse gas emissions in the economy.
Seismic Activity: Industry takes seriously earthquake incidents that may be associated with the disposal of produced water from energy development. The majority of disposal wells don't pose a hazard for seismicity, but under some geologic and reservoir conditions a limited number of injection wells have been determined to be responsible for earthquakes.

Figure B.1: Information provided to respondents by regulators and industry representatives.

Type I

A coalition of environment and health Non-Governmental Organizations (NGOs), have grave concerns about hydraulic fracturing (fracking) of shale gas. In particular, because of its impacts in the following areas:

Climate: there is no scientific agreement that shale gas will have significantly lower total greenhouse gas emissions compared to other conventional fossil fuels (e.g. coal);
Energy: development of shale gas will be at the expense of cheaper and safer policies to save energy and speed up the transition to renewable energy and the reduction of greenhouse gas emissions;
Water pollution: fracking could cause the contamination of surface and groundwater (including drinking water) with toxic chemicals used in fracking fluids*, increasing the concentration in such water of methane and hazardous and radioactive materials that naturally occur in shale and coal;
Water use: fracking involves pumping vast amounts of freshwater underground, much of which becomes irretrievable and/or contaminated; this will create significant social and environmental pressures at least at a local and regional level, and particularly in regions suffering from water scarcity;
Air pollution: unconventional gas drilling/operations produces soot and smog precursors, particulate matter, methane and natural gas;
Soil pollution: fracking carries the risk of leakages from polluted tailing ponds, wastewater and well blowouts;
Land use: fracking disrupts the landscape and impacts upon rural and conservation areas;
Noise: shale gas development generates noise pollution from equipment and transport that affects local residents, agricultural livestock and wildlife;
Seismic activity: fracking increases the risks of earthquakes, which in turn increases the risk of damage to, and leakages from, gas wells;
Socio-economic impacts on communities: fracking can drive "boom and bust" cycles in local economies, undermining more sustainable agricultural and tourism economies.

All of these effects have direct and indirect impacts on individual and public health. Many of these impacts are not only local, but can be felt regionally and even globally. **Until all these problems are adequately addressed, we believe that no further shale gas activities should proceed.**

Scientists that assessed the overall impact of shale gas development noted the following:

Abundance of supply: An assessment of 48 shale gas basins around the world in 32 countries, concluded that the resource was "vast," with proven reserves amounting to almost the same level as conventional natural gas.
Lower natural gas prices: The average cost of shale gas is about 50–66 percent cheaper than production from new conventional gas wells. This can translate into "cheap electricity".
Cleaner environmental footprint: Shale gas has a cleaner environmental footprint than other fossil fuels, mainly oil and coal. It has lower emissions of sulfur oxides, nitrogen oxides, and mercury than coal and oil.
Economic development: Shale gas promises employment, jobs, infrastructure, revenues, and taxes.
Seismic events: Induced seismicity events have been limited to sites implementing deep well injection of wastewaters.
Risks to water resources: Spills, leaks, land disturbance, and disposal of inadequately treated hydraulic fracturing fluids or wastewater can cause contamination of surface water and shallow groundwater.
Risks to air quality: An estimated 1.5% of produced gas is emitted to the atmosphere. Radioactive pollutants could persist in the produced gas traveling through pipelines, enter households and eventually lead to lung cancer.
Social-psychological stress: Rapid and dramatic changes can disrupt cultural values and identities.
Displacement: Shale gas competes with green energy technologies, slows their development and distracts politicians and the public from developing a long-term sustainable energy policy.
Socioeconomic and Community Effects: Expected hazards include boom-bust economic cycles; impacts on preexisting local industries; demands on community infrastructure, police and social services; uneven distribution of private benefits, costs, and externalities; and community conflict and mistrust.
Climate Change Impacts: The net effect of shale gas comes both from direct emissions of greenhouse gases and from the economic effects of substituting natural gas for coal in power production due to lower natural gas prices.

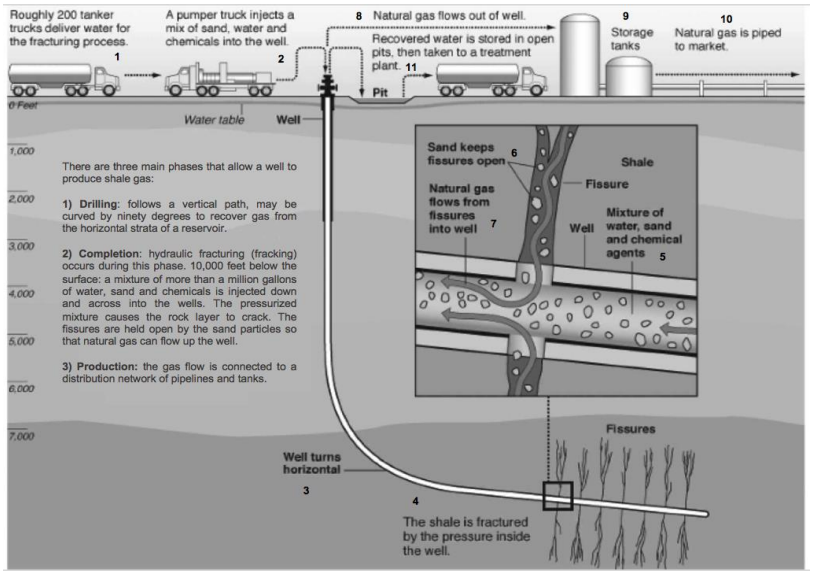
Figure B.2: Information provided to respondents by non-governmental organizations and scientists.

Type I

Unclear profitability: The difficulty in measuring proven reserves; the low profit margins of existing fields; the economic impacts on traditional producers of natural gas; and the economic cost of externalities suggest that hydraulic fracking may not be profitable.
Synergies across risk domains could amplify risks and produce cumulative effects, but knowledge of these amplification pathways is still limited.

Please read the following information before continuing with the questionnaire:

Shale gas is natural gas formed and held within shale formations. Shales are fine-grained sedimentary rocks that form from the compaction of silt and clay-size mineral particles that we commonly call "mud." Shale gas development involves the injection of a mixture of water sand and chemicals down and across wells, causing the rock later to crack.

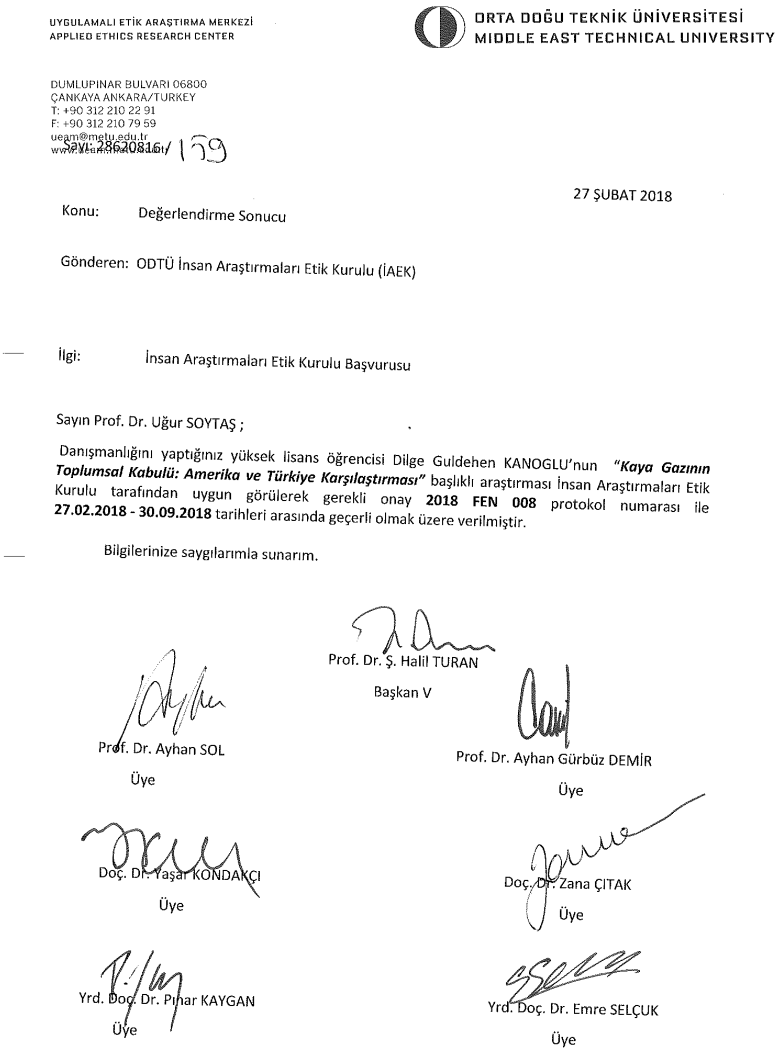


This figure is adapted from AFDC, 2014. Hydraulic Fracturing and Shale Gas Production: Technology, Impacts, and Regulations.

Figure B.3: Scientific information provided to respondents.

APPENDIX C

ETHICS APPROVAL DOCUMENT



UYGULAMALI ETİK ARAŞTIRMA MERKEZİ
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27 ŞUBAT 2018

Konu: Değerlendirme Sonucu

Gönderen: ODTÜ İnsan Araştırmaları Etik Kurulu (İAEK)

İlgi: İnsan Araştırmaları Etik Kurulu Başvurusu

Sayın Prof. Dr. Uğur SOYTAŞ ;

Danışmanlığını yaptığınız yüksek lisans öğrencisi Dilge Guldehen KANOGLU'nun ***"Kaya Gazının Toplumsal Kabulü: Amerika ve Türkiye Karşılaştırması"*** başlıklı araştırması İnsan Araştırmaları Etik Kurulu tarafından uygun görülerek gerekli onay **2018 FEN 008** protokol numarası ile **27.02.2018 - 30.09.2018** tarihleri arasında geçerli olmak üzere verilmiştir.

Bilgilerinize saygılarımla sunarım.

Prof. Dr. Ş. Halil TURAN
Başkan V

Prof. Dr. Ayhan SOL
Üye

Prof. Dr. Ayhan Gürbüz DEMİR
Üye

Doç. Dr. Yaşar KONDAKÇI
Üye

Doç. Dr. Zana ÇITAK
Üye

Yrd. Doç. Dr. Pınar KAYGAN
Üye

Yrd. Doç. Dr. Emre SELÇUK
Üye

Figure C.1: Ethics approval document by the METU Applied Ethics Research Center.

APPENDIX D

PLS OUTPUT RESULTS

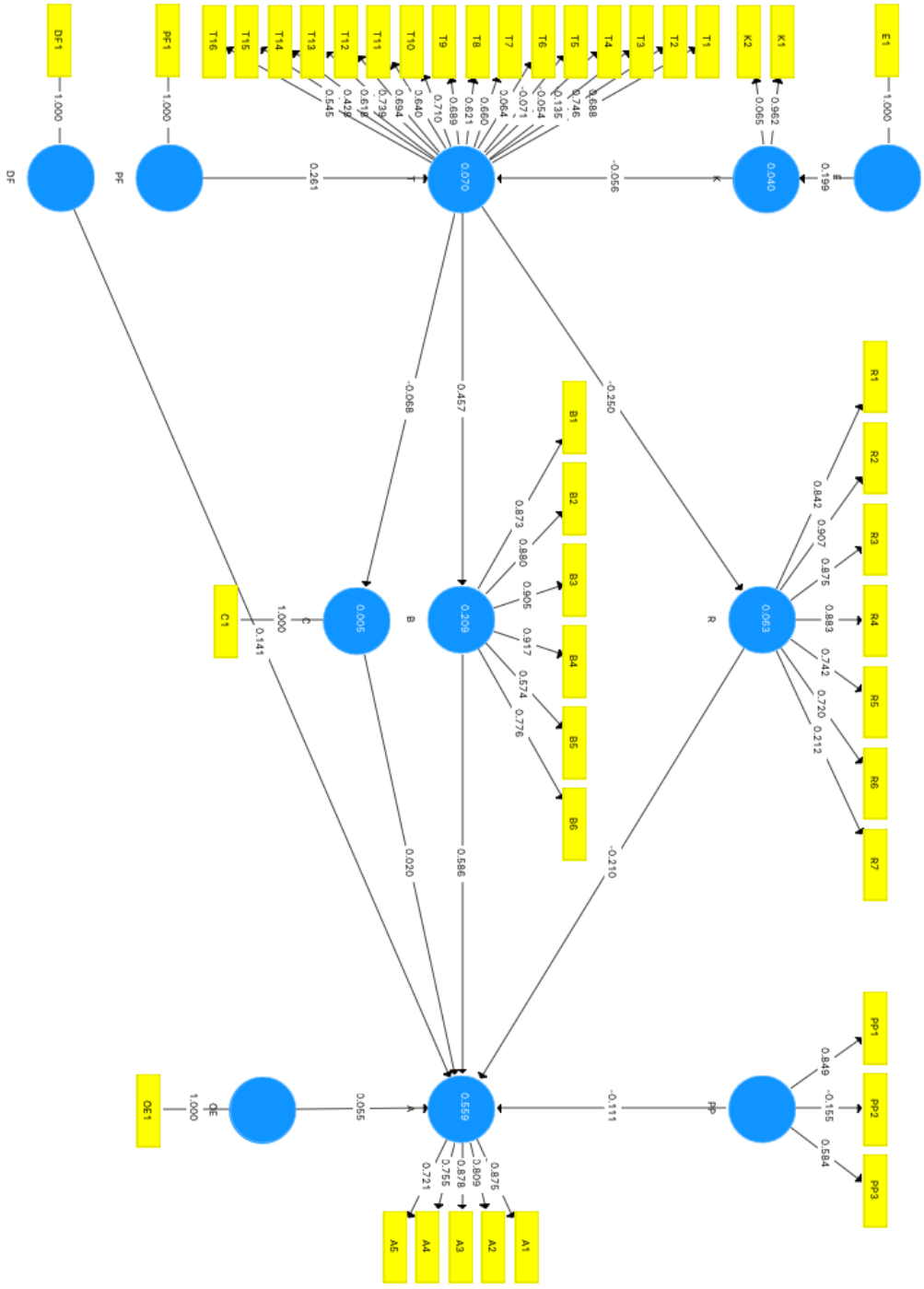

Figure D.1: Initial PLS output for the control group.

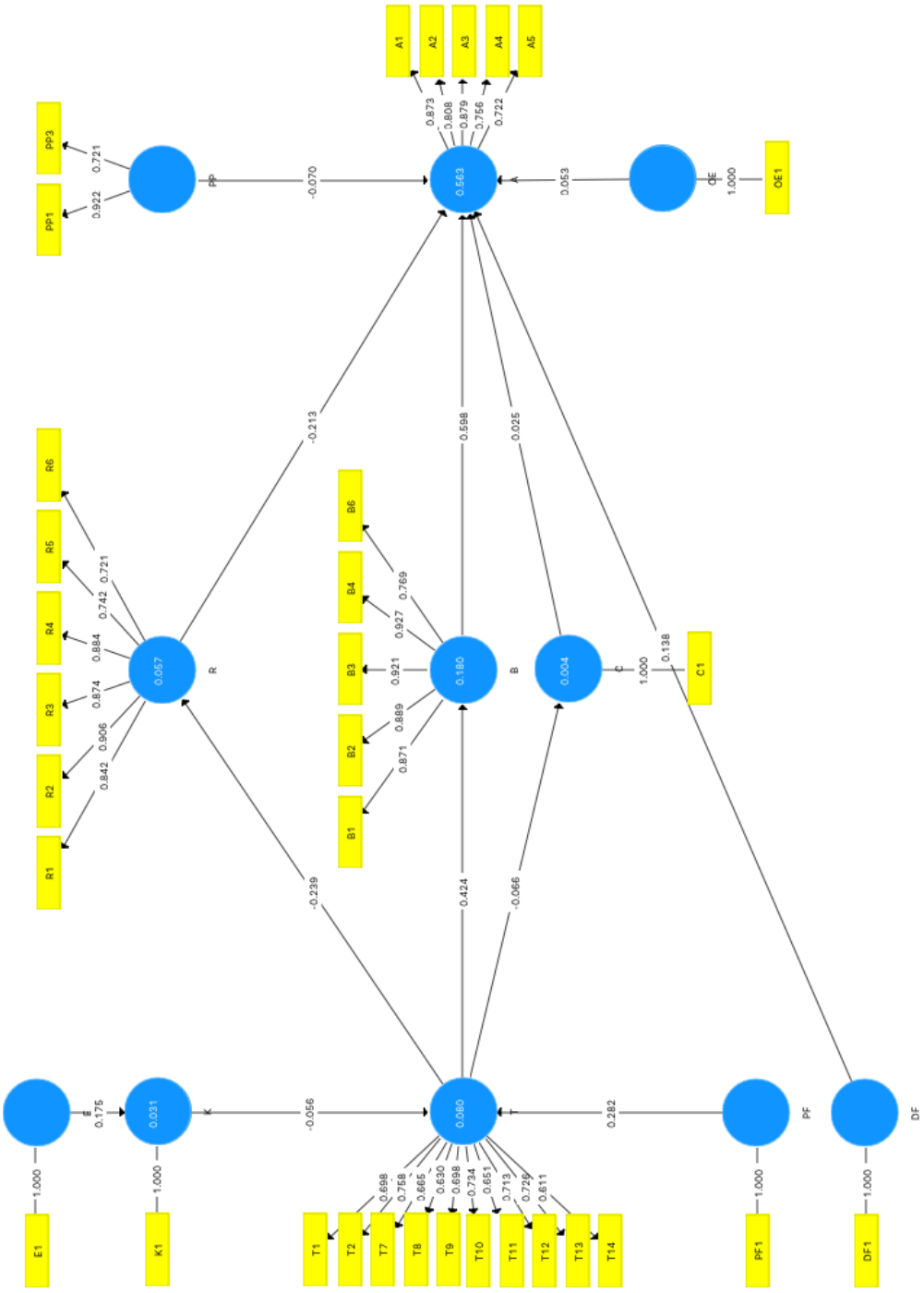

Figure D.2: Final PLS output for the control group.

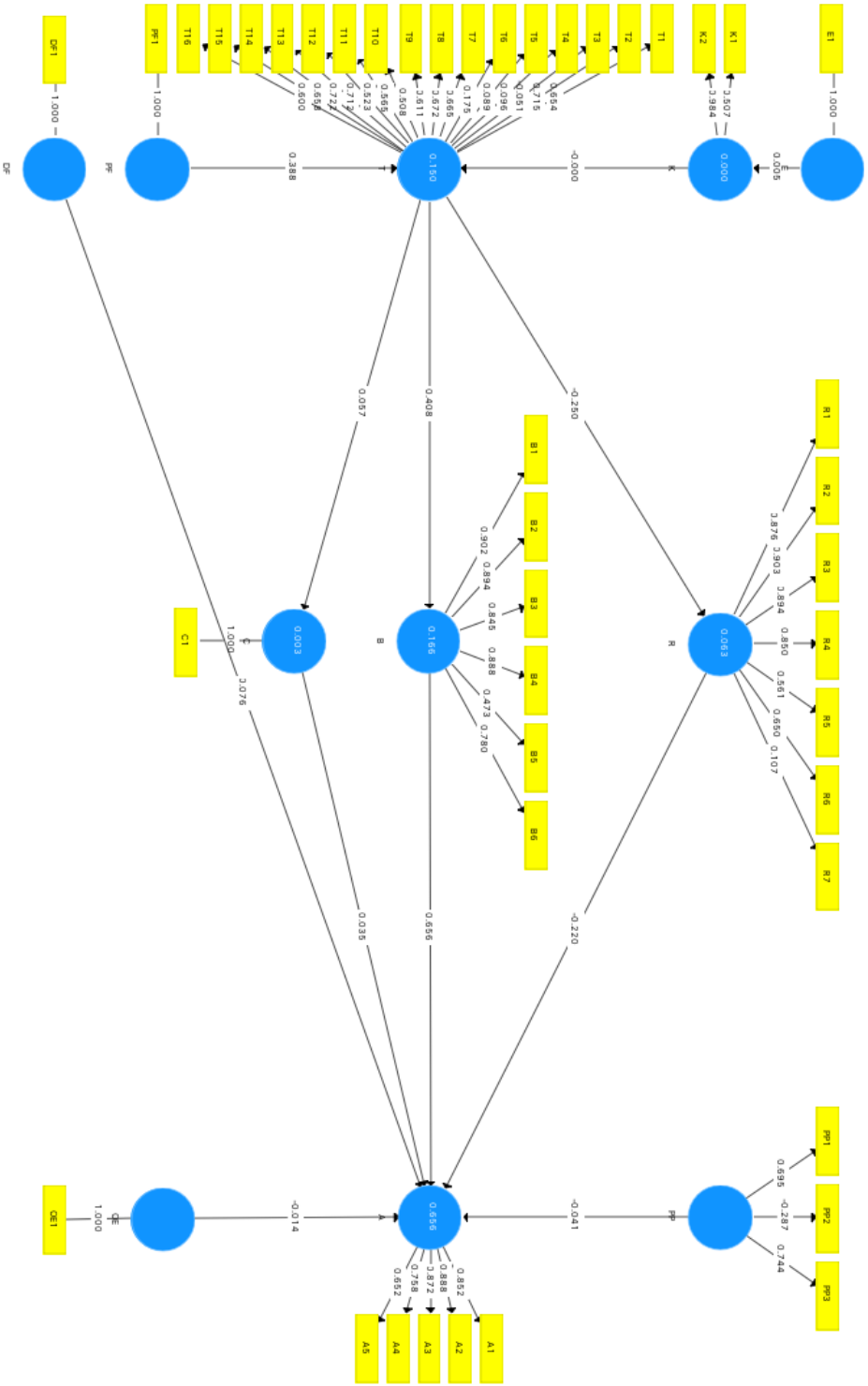

Figure D.3: Initial PLS output for the information group.

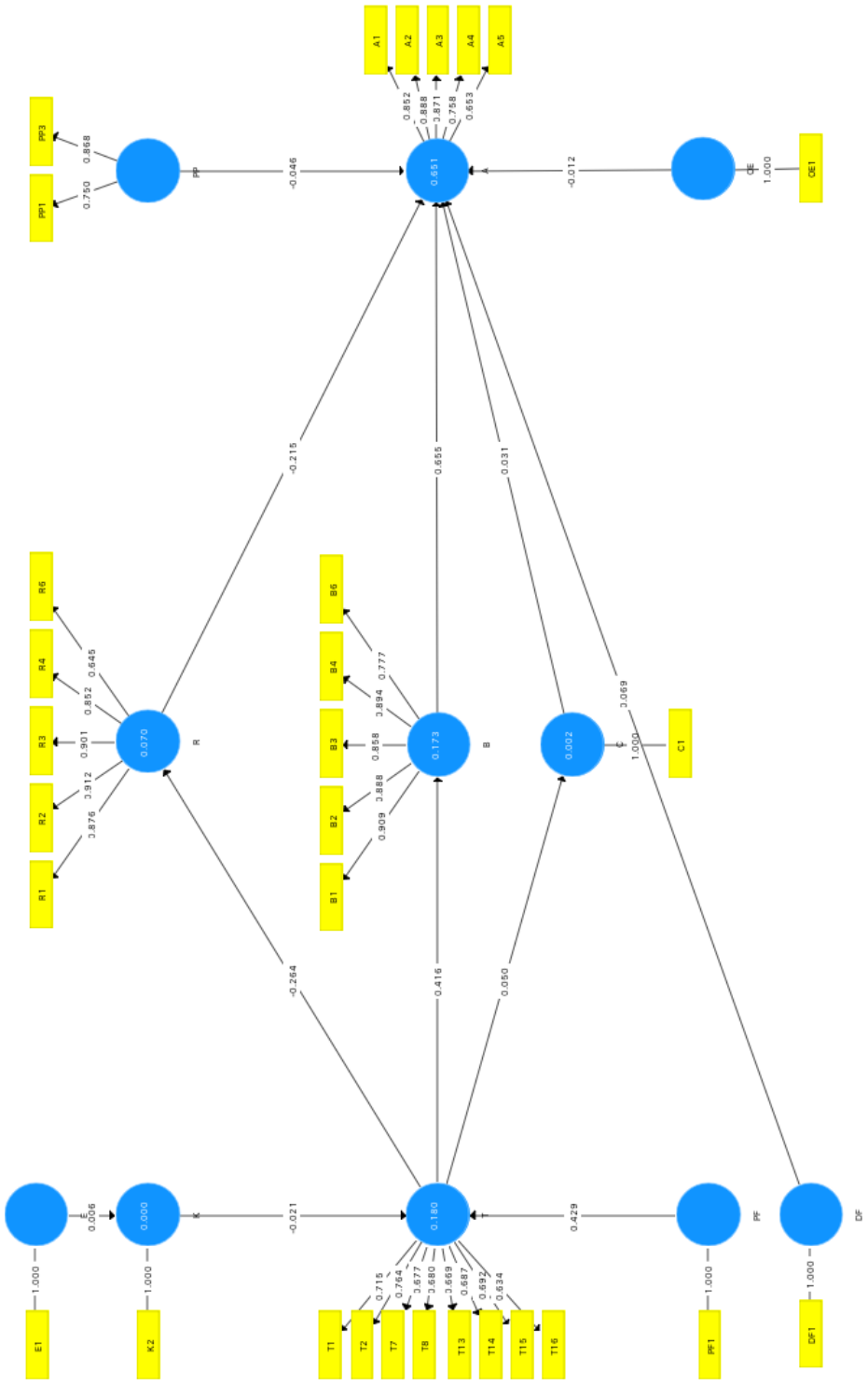

Figure D.4: Final PLS output for the information group.

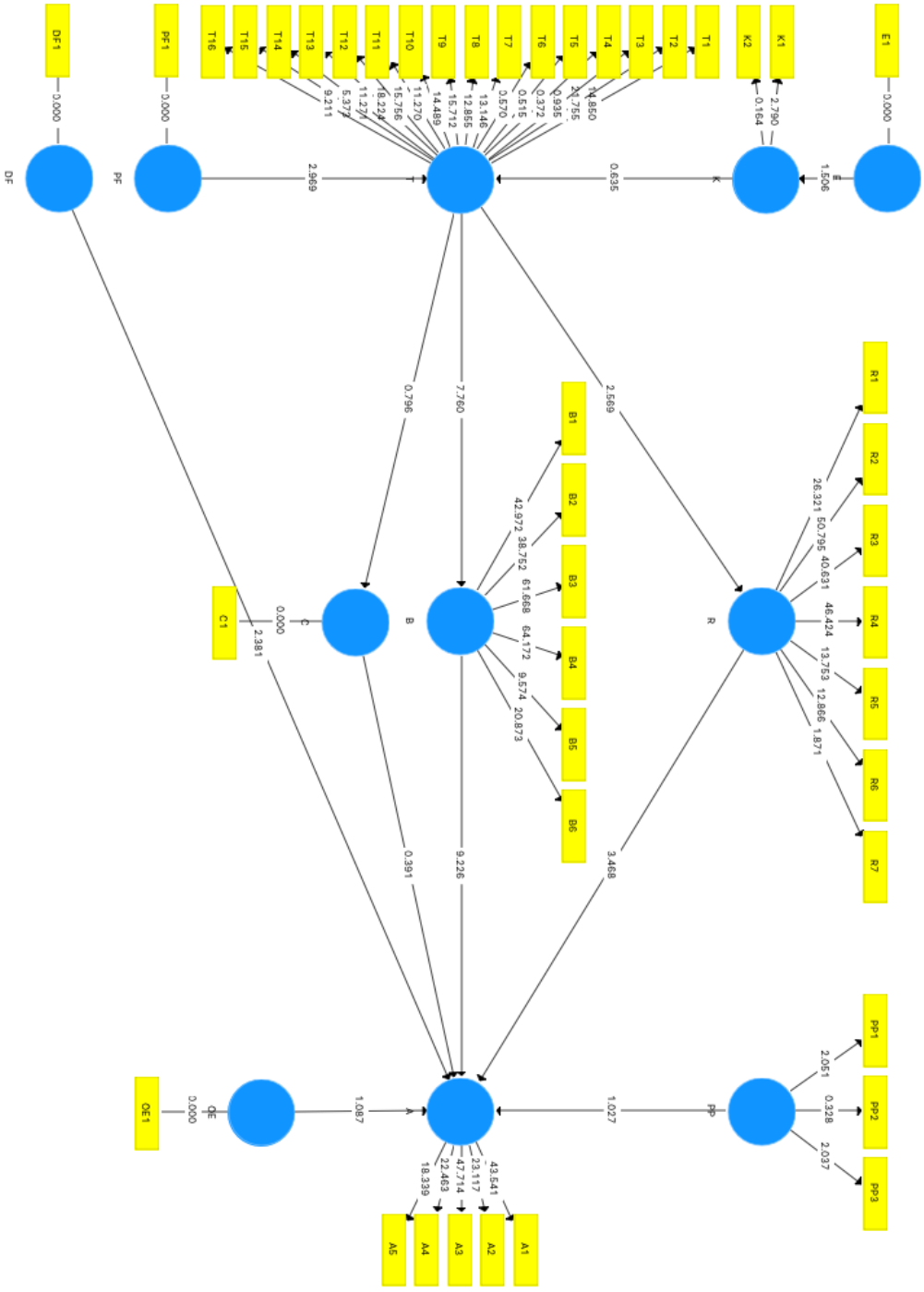

Figure D.5: Initial bootstrap output for the control group.

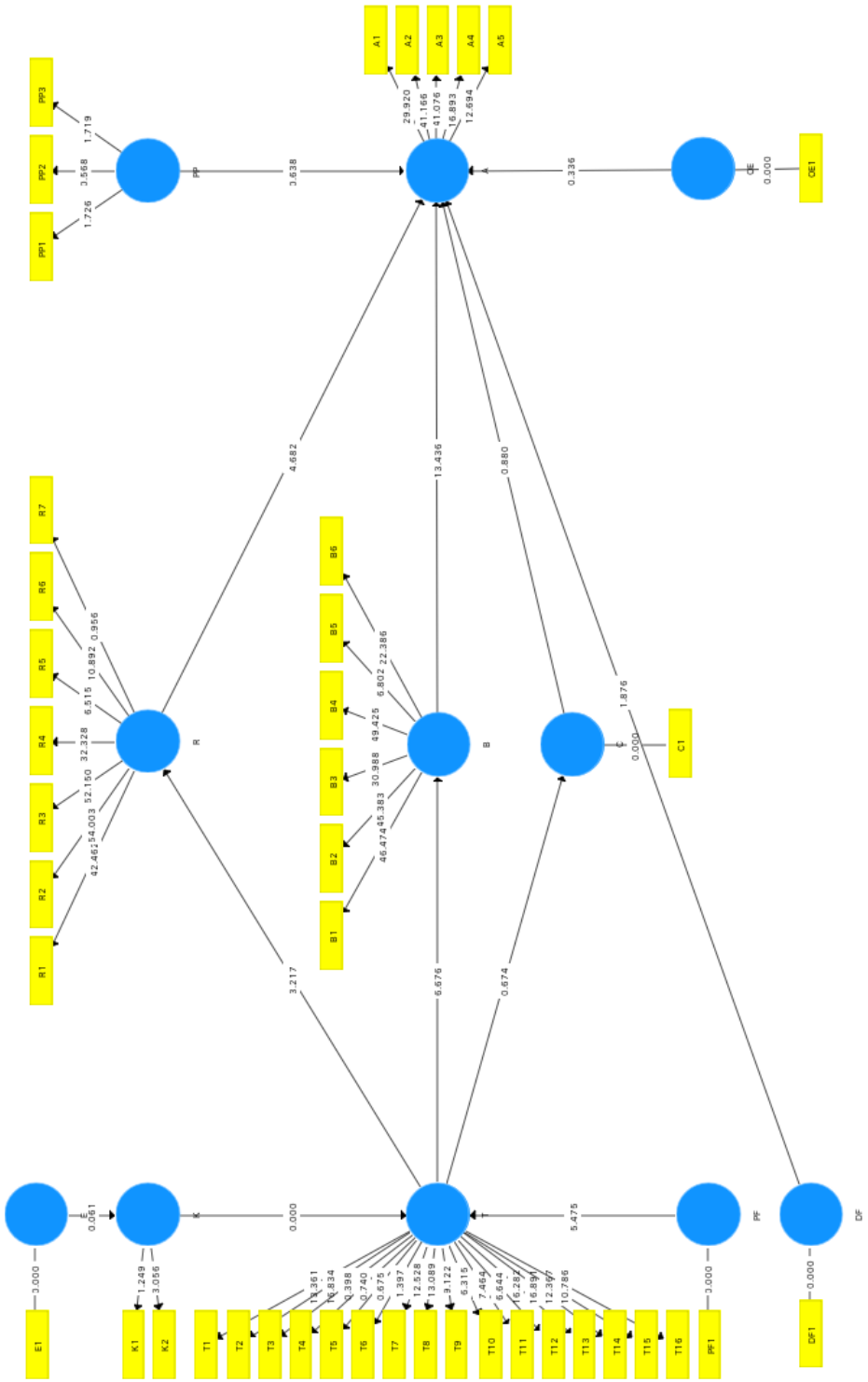

Figure D.6: Initial bootstrap output for the information group.

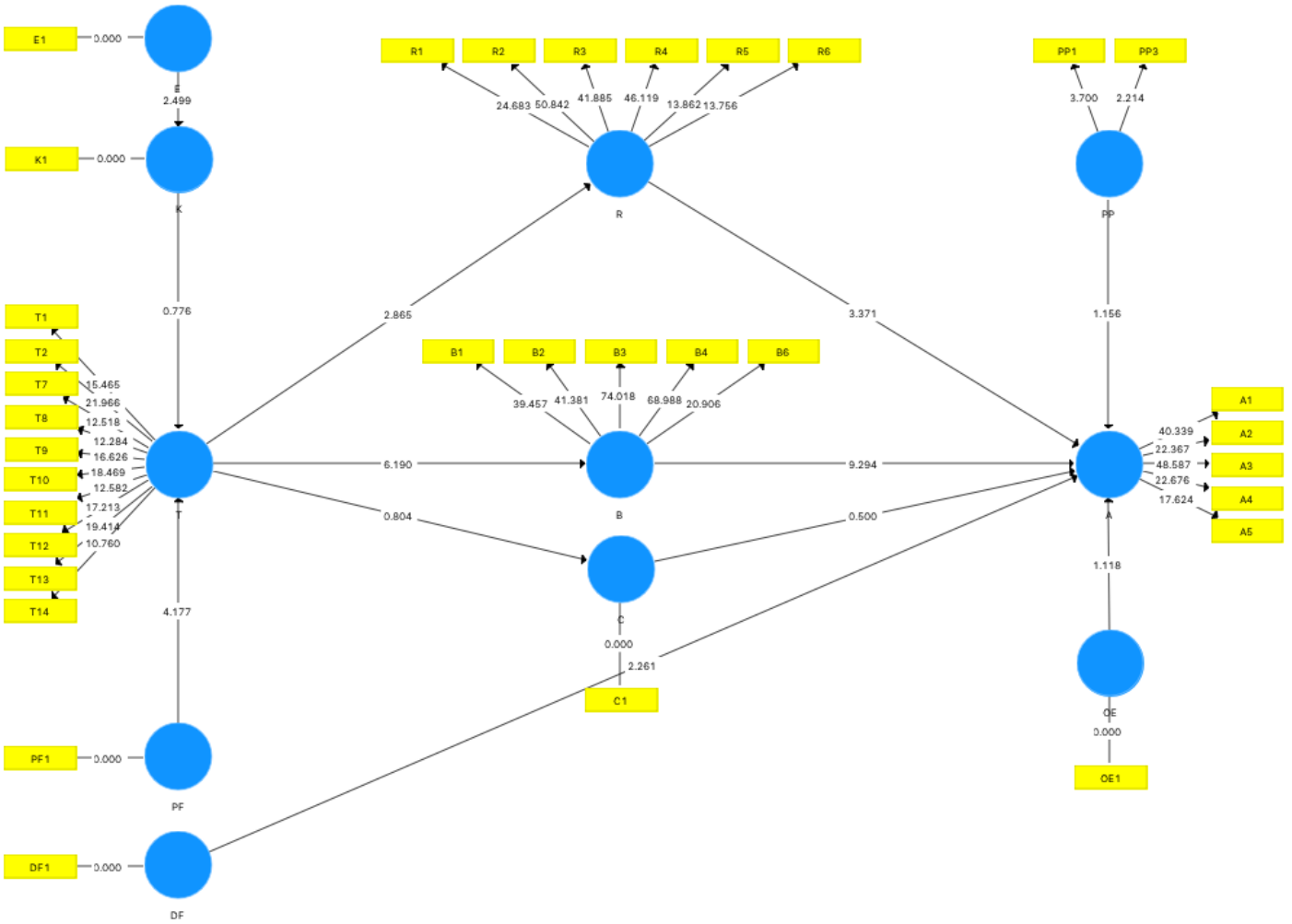

Figure D.7: Final bootstrap output for the control group.

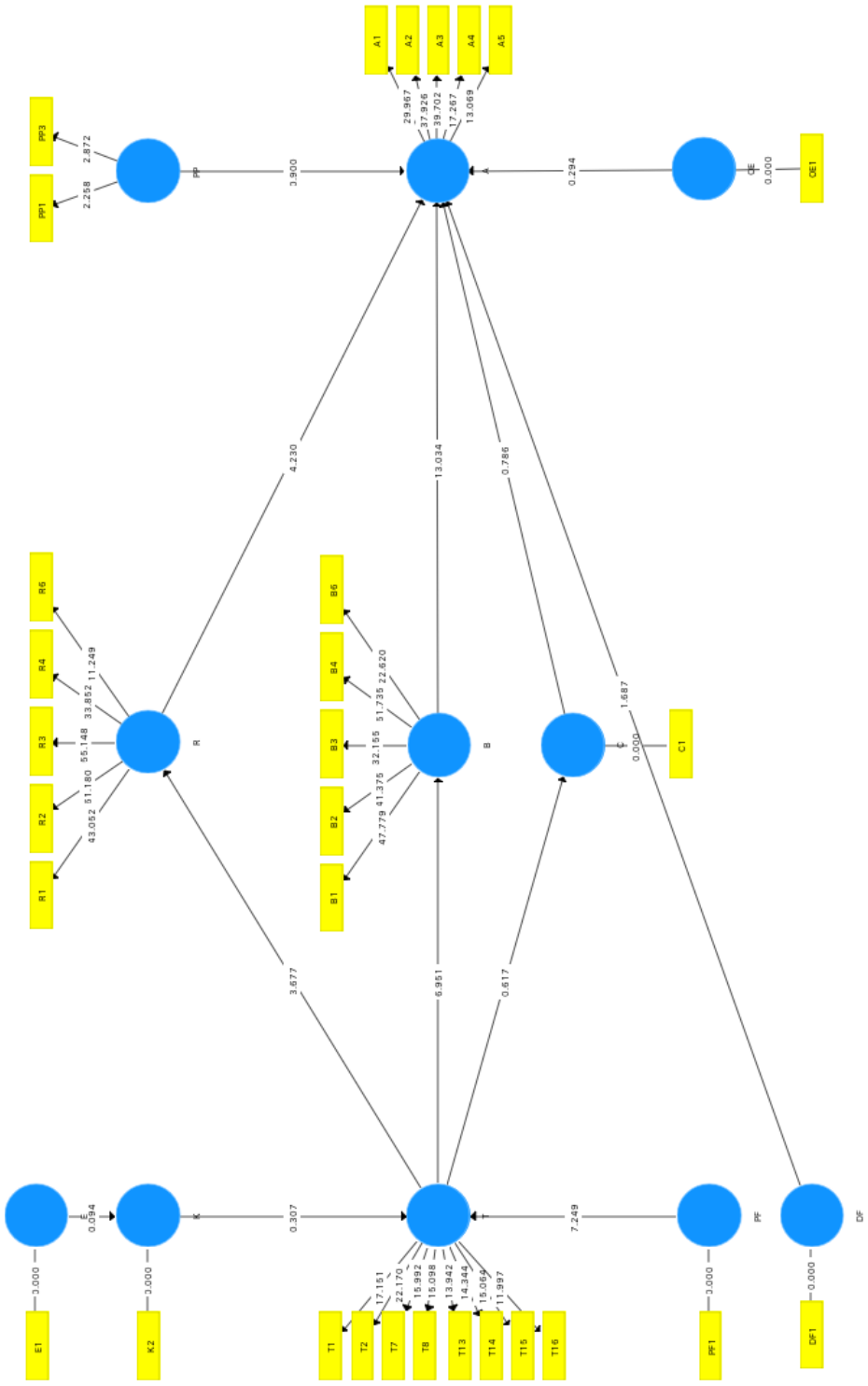

Figure D.8: Final bootstrap output for the information group.

APPENDIX E

MEASUREMENT PROPERTIES OF THE FIRST CONSTRUCTS

Table E.1: Measurement properties of the first constructs.

Construct	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						1.000	1.000	1.000	1.000	1.000	1.000
	E1	1.000	1.000	0	0						
Knowledge						0.500	0.511	0.497	0.741	0.465	0.612
	K1	0.962	0.507	2.79	1.249						
	K2	0.065	0.984	0.164	3.056						
Trust						0.826	0.838	0.841	0.850	0.323	0.308
	T1	0.688	0.654	14.85	13.361						
	T2	0.746	0.508	21.755	16.834						
	T3	-0.135	0.565	0.935	0.398						
	T4	-0.054	0.523	0.372	0.74						
	T5	-0.071	0.712	0.515	0.675						
	T6	0.064	0.722	0.57	1.397						
	T7	0.660	0.658	13.146	12.528						
	T8	0.621	0.600	12.855	13.089						
	T9	0.689	0.715	15.712	9.122						
	T10	0.710	-0.051	14.489	6.315						
	T11	0.640	0.096	11.27	7.464						
	T12	0.694	0.089	15.756	6.644						
	T13	0.739	0.175	18.224	16.282						
	T14	0.618	0.665	11.271	16.891						
	T15	0.428	0.672	5.373	12.367						
	T16	0.545	0.611	9.211	10.876						
Perceived Risks						0.874	0.841	0.905	0.882	0.599	0.551
	R1	0.842	0.876	26.321	42.462						
	R2	0.907	0.903	50.795	54.003						
	R3	0.875	0.894	40.631	52.15						
	R4	0.883	0.850	46.424	32.328						
	R5	0.742	0.561	13.753	6.515						
	R6	0.720	0.650	12.866	10.892						
	R7	0.212	0.107	1.871	0.956						
Perceived Benefits						0.905	0.888	0.928	0.918	0.688	0.658
	B1	0.873	0.902	42.972	46.474						
	B2	0.880	0.894	38.752	45.383						
	B3	0.905	0.845	61.668	30.988						
	B4	0.917	0.888	64.172	49.425						
	B5	0.574	0.473	9.574	6.802						
	B6	0.776	0.780	20.873	22.386						
Perceived Costs						1.000	1.000	1.000	1.000	1.000	1.000
	C1	1.000	1.000	0	0						
Procedural Fairness						1.000	1.000	1.000	1.000	1.000	1.000
	PF1	1.000	1.000	0	0						
Distributive Fairness						1.000	1.000	1.000	1.000	1.000	1.000
	DF1	1.000	1.000	0	0						
Problem Perception						0.589	0.437	0.461	0.413	0.362	0.373
	PP1	0.849	0.695	2.051	1.726						
	PP2	-0.155	-0.287	0.328	0.568						
	PP3	0.584	0.744	2.037	1.719						

Table E.1 continued: Measurement properties of the first constructs.

Outcome Efficacy					1.000	1.000	1.000	1.000	1.000	1.000
	OE1	1.000	1.000	0	0					
Acceptance					0.867	0.865	0.905	0.904	0.656	0.655
	A1	0.875	0.852	43.541	29.92					
	A2	0.809	0.888	23.117	41.166					
	A3	0.878	0.872	47.714	41.076					
	A4	0.755	0.758	22.463	16.893					
	A5	0.721	0.652	18.339	12.694					