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RENEWABLE ENERGY BEHAVIOR MODELING BASED ON POTENTIAL USERS

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ABSTRACT

This paper analyzes the knowledge that consumers have about the different types of renewable energies. To model consumer behavior towards renewable energies, research-based on reasoned action theory positively relates prior experience about renewable energies with attitude. Taking pro-environmental behavior as a starting point and exogenous variable, the existence of a strong relationship between this variable and knowledge about renewable energies is demonstrated. On the other hand, between this concern for the environment, attitude, and intention, a less intense relationship is shown since renewable energies' installation represents an effort that slows down the consumer.

1. Introduction

The global development model is generating climate change throughout the planet due to the massive consumption of fossil fuels or air and water pollution, among other reasons. It has also been shown that human activity is one of the leading causes of climate change, mainly due to energy consumption. Therefore, the current situation demands more than ever a change in energy management models. Natural resources and sustainable practices are rationalized; so that part of the traditional energy demands is replaced. For this, a change is necessary not only in values and attitudes but also in individual behaviors. To understand how consumers and their consumption behavior influence the market, one must start from prior knowledge of environmental variables and the impact of marketing activities and their relationship with business marketing decisions.

Furthermore, the study on consumers and green or ecological markets must be increasingly complemented with other variables' analysis. As Schrijver, Dobbins, Murtagh, and Petrinec (2014) recommends, especially those related to the consumer from a psychosocial perspective, considering variables such as attitudes, motivations, or concern for the environment, among others. This work models consumer behavior under this psychosocial perspective because the installation of biomass energy, solar thermal energy, and photovoltaic solar energy strongly depends on a personal decision. For this purpose, the research hypotheses that are described in the following section are presented. In the third section, the methodological aspects of the research are specified. The main findings derived from the data analysis are shown below in the results section. Finally, from the fifth section, the main conclusions and recommendations are drawn.

2. Literature Review

2.1 Modeling of behavior in favor of renewable energies

Research on renewable energies has addressed both the influence that cultural and social factors and psychological factors have on the demand for this facility type. Variables Key measures in our model are pro-environmental behavior or environmental concern, prior knowledge of renewable energies, attitude towards alternative facilities to traditional ones, and the intention to purchase different renewable energies sources (Sun, Zhang, & Liu, 2014). In the present study, both the concern for the environment, shown through activism and energy-saving and personal beliefs about the knowledge of renewable energies considered, are the main determinants of consuming these energy sources. These variables will be addressed below.

2.2.1 Concern for the environment

Pro-environmental behavior includes behaviors related to the protection of the environment, and that involves little effort. The antecedent environmental concern factors have provided a large amount of literature since its inception, which can differentiate. In the first stage, we can distinguish Chaves and Terry Bahill (2014), who wanted to know the individual motives that lead to responsible behavior with the environment. Authors such as Aoki, Tanikawa, et al. (2014) indicated that in Western countries, a change was taking place in the vision of the world, moving towards what they called the "New Environmental Paradigm", which was concerned with aspects of environmental aesthetics and energy saving. Other

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researchers, such as Deflorian, et al. (2010) considered that environmental concern came from the risks environmental problems could bring.

In the second stage, researchers such as Albareda, et al. (2010) stated that demographic factors such as age, income or education, and moral values, were those that led individuals to be concerned about the environment. At present, the most significant concern focuses on the different countries' particular problems since environmental problems have worsened, and global overheating is beginning to be considered (Alonso, 2013). Due to this, some of the factors that are being given more importance are energy-saving and activism, as shown by the studies of Kappenman (2013). In work, it has been used to explain pro-environmental behavior, both pro-environmental activism and energy saving.

I. Activism has been the object of study by much of the research in environmental psychology. Doukas, et al. (2011) define it as: "the performance of specific behaviors". This definition encompasses different behaviors, such as belonging to an environmental group, participating in political actions favoring the environment, intentionally engaging in behavior committed to the environment, or engaging in environmental protection behaviors.
II. Energy savings are directly and indirectly related to the different individuals living in a home's energy consumption behavior. Researchers use this saving as an indicator of pro-environmental behavior.

People's daily habits are related to specific and coherent actions such as saving energy or buying products that respect the environment. This grouping of responsible environmental behaviors has been observed in different countries and can facilitate a transition towards lifestyles that improve the environment. This pro-environmental behavior turns out to be a determining factor, both direct and indirect, of specific environmental actions, such as acquiring renewable energies.

2.2.2 Prior knowledge

Prior knowledge has a significant impact on the evaluation of possible alternatives and purchase decisions (Shi et al., 2014). Through their own experiences, people can acquire knowledge through third parties or visual, verbal, and sensory stimuli, such as advertisements, journalistic texts, magazines, or television programs. Following Buck, Elliott, Niehaus, Rives, and Thomas (2012), it is assumed that the consumer first uses their knowledge when purchasing since this information processing is easier and more efficient. Miller, Antonio, and Bonanno (2011) indicate that knowledge about energy efficiency products can contribute in a tangible way to the formation of attitudes towards this type of products.

Previous knowledge has been used in earlier research by researchers such as He et al. (2013). Concluding that higher levels of knowledge are not related to attitude but to intention. This research indeed inquired about ecological behavior in general. In the present work, we will measure the subjective knowledge about renewable energies of the surveyed individuals.

2.2.3 The attitude towards renewable energies

The research that we found on attitudes towards renewable energies indicates generalized support for these energy sources. The works of Pankratov, Blum, and Shleev (2014) stated that it was personal and contextual factors that explain the public's attitudes towards this type of energy sources. Herrera and Vázquez (2014) identified consumers' supportive attitudes when making decisions about the kind of energy to consume, indicating that these decisions were motivated by protecting the environment.

2.2.4 The predisposition to adopt renewable energies.

The importance of studying the intentions to purchase renewable energy is related to the proximity between this intention and future purchase behavior. These relationships are described in the theory of reasoned action, TRA, and planned behavior - TPB. The TPB theory raises a strong relationship between attitude and intention, supported in many research fields, but the relationship between intention and behavior has less support in the environmental area. This difference between purchase intentions and actual behavior has been called the "action gap" by researchers (Chang, et al. 2016; Parrot & Tierney, 2012).

2.3 Statement of research hypotheses

2.3.1 Effects of pro-environmental behavior and prior knowledge

In this work, the environmental concern that is revealed when carrying out a series of responsible behaviors with the environment has been used as a precedent of prior knowledge about renewable energies, attitude, and intention to buy them. Consumers who carry out pro-environmental behavior in their daily lives say they prefer products that are respectful of the environment.

When an issue involves personal values such as the future of the children or the protection of the environment, the search for information increases. This search can lead to higher consumer awareness about possible alternative solutions to environmental problems, such as renewable energy. Consequently, we must expect that those concerned about the

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environment and demonstrate this through their pro-environmental behaviors have more excellent prior knowledge about the renewable energies studied (Perninge, et al. 2011). Derived from the previous arguments, we propose the following research hypothesis.

H1: The more pro-environmental behavior is exercised, the greater the knowledge of renewable energies.

2.3.2 Effects of pro-environmental behavior

Environmental problems such as global warming or climate change will give rise to interest in renewable energies. The discrepancy between pro-environmental behavior and purchase intentions for renewable energies is due to variables that moderate this influence. Seki and Tadakuma (2010) indicated that attitudes favoring energy conservation are more likely to turn into action if said action has a small cost about time, money, or sacrifice.

H2: The more pro-environmental behavior is exercised, the greater the attitude towards renewable energies.

H3: The more pro-environmental behavior is exercised, the greater the intention to purchase renewable energies.

2.3.3 Effects of prior knowledge and attitude

Kitamura, et al. (2014) defend that the positive relationship between knowledge and attitudes indicates that more factors affect renewable energies' attitude. These factors are the so-called "situational factors" that include economic limitations, social pressures, and opportunities to choose different energy supply forms. Individuals who carry out pro-environmental behavior may have a more positive attitude towards these green energies since they are aware of the advantages of installing saving systems based on renewables.

Makino, et al. (2014) in their work indicated that as consumers become more aware of the relative advantages of alternative energies, they are willing to pay more for these energy sources. Based on the literature, we suggest the following research hypothesis.

H4: Greater prior knowledge about renewable energies has a positive influence on the attitude towards these energies.

In applying the TRA theory of Ajzen and Fishbein (1980), for the case of renewable energies, it is indicated that the attitude towards renewable energies mediates between the effect of pro-environmental behavior and the intention to purchase. Holburn and Zelner (2010) found a direct influence of pro-environmental behavior on intention and an indirect impact through attitudes about consumers' intention when buying alternative energy. TRA indicates that her intention influences an individual's behavior.

2.3.4 Effect of the individual's attitude

According to the TRA theory of Ajzen and Fishbein (1980), the existence of a positive and robust relationship between the individual's attitude and the intention to carry out said behavior is proposed. If a person makes a favorable evaluative judgment, their attitudes will lead to intentions to perform a specific action. According to the TRA, the intention is the main predictor of purchasing behavior; however, this relationship has arisen in products or services. There were no impediments that could stop the intention to carry out the behavior.

H5: A favorable attitude towards renewable energies has a positive effect on the purchase intention towards the different types of installations based on renewable energies.

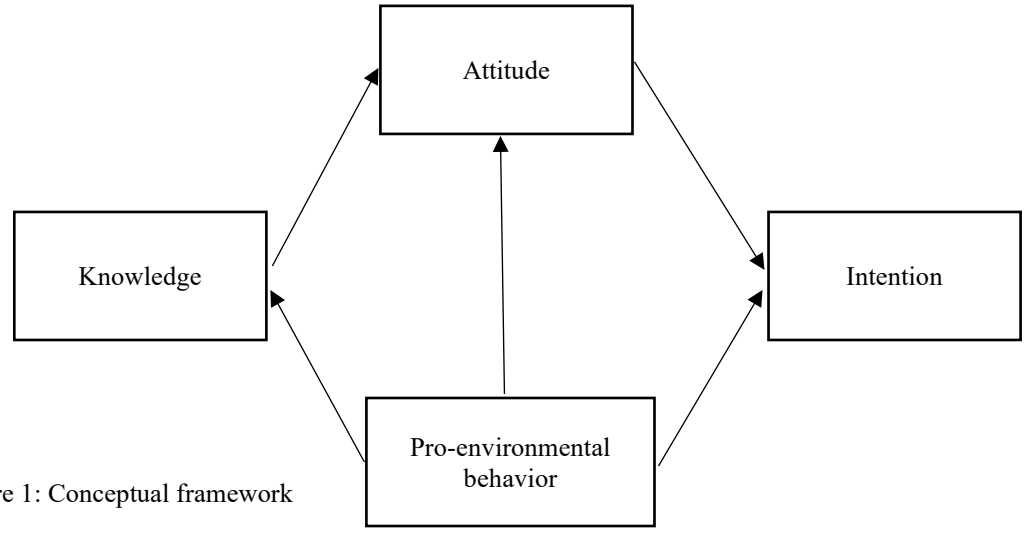

Figure 1: Conceptual framework

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3. Research Methodology

Below we present the methodology's main aspects, which refer to the questionnaire used, prepared after a review of the scientific literature on the subject under study and subjected to a critical review by three environmental experts; it was programmed with the tool online forms of google drive. It includes Likert-type measurement scales with five possible responses, with 1 (lowest value) and 5 (highest value) being extreme. In the introduction of the questionnaire, it is reported that the answers will be anonymous, it is ensured that there are no correct or incorrect answers and that they must respond as sincerely as possible. This indication helps reduce common method biases, especially at the data collection stage. This clarification can mitigate any concerns in evaluating the participants and make them less likely to give more desirable answers, indulgent, compliant, and consistent with how they think the research wants them to respond.

3.1 Sample characteristics and data collection

The population under study was defined as the owners of residential homes in Libya since they are the ones who have the independence to make decisions about the energy system to use at home. Specifically, we can say that homeownership influences investment in energy-saving systems (Guikema, et al. 2010). The research focused on single-family buildings (semi-detached or semi-detached) and houses integrated into buildings (blocks of flats). The data collection method was based on convenience sampling, using the online personal survey with a structured and pre-coded questionnaire. The selection of the sample was made by sharing the publication on Facebook, Twitter and via email. Participation in the study was voluntary. The fieldwork was carried out from April to July 2014, and the confidentiality and privacy of the interviewees were guaranteed. The initial database was made up of 253 surveys; after applying the sample refinement using both response time and homeownership criteria, they led to the elimination of responses with a duration of fewer than 5 minutes (speeders) and of individuals who did not own the home, obtaining a total of 218 valid questionnaires.

3.2 Scales used to measure the study variables.

The web questionnaire used is available in Annex 1. Regarding the measurement scales used, the ecological behaviour scale (ECE) is based on Karp's pro-environmental behaviour scale (1996). Energy-saving and activism have been used by Senbel et al. (2014) in a recent study conducted by the British Columbia University. In this work, the ECE scale has been adapted to the energy problem using 14 items on a Likert-type scale (where one is never and five is always), referring to two of the dimensions, which have been validated (through factorial analysis exploratory). The two-dimensionality of the scale was demonstrated with an exploratory factor analysis that yielded an explained variance of 65.73%. The reliability analysis from the internal consistency indicators (Cronbach's alpha or Composite Reliability - SCR) obtained values greater than the one used as a reference (0.70) in the literature (Okumoto et al., 2013). Specifically, Cronbach's alpha statistic showed a value of 91.8%. High levels of reliability (≥0.90) allow summary or sum variables to be obtained in the data analysis as good indicators of the constructs that collect the data variability. This decision will preside over the formation of general levels of the dimensions of this measurement scale. Thus, the first six items were averaged in a summary variable called "activism". For their part, the eight remaining items referring to energy savings were also averaged and collected by the variable "energy savings".

The subjective prior knowledge scale used in work, responds to a Likert made up of 5 items (ranging from 1 that totally disagrees to 5 totally agree) was adapted from the scale used by Rijnsoever and Farla (2014). In these analyzes, the unidimensionality of the scale was revealed, explaining 68.59% of the variance. Through the alpha value, the scale's internal consistency was demonstrated since the result of this analysis is 88.5%. The attitude was measured in this work from a classic five-point Likert-type single-item scale (where one is not at all favourable and five is very favourable) adapted from Bruner (2009). The intention was measured with a four-item Likert-type scale (where one totally disagrees and five totally agree). The items on this scale refer to the intention of future purchase of each of the three types of renewable energies that is contemplated in the study, and the last one considers the intention of future purchase of renewable energy in general. It was adapted from the Jamieson scale (1989).

The unidimensionality of the intention was demonstrated by a factor analysis whose explained variance is 62.53%, and the internal consistency of the scale analyzed with Cronbach's alpha statistic was 80%. All the measurement scales used in the work are internally consistent since their Cronbach's alpha is greater than 0.70. Therefore, we can say that they are generally accepted and have adequate reliability indicators. To contrast the hypotheses, a structural equation model has been used. The pro-environmental behaviour was considered an exogenous variable, and both the prior knowledge and the attitude and intention to purchase renewable energy are considered as variables. Endogenous. The AMOS 18 software was used to analyze the data.

The previous univariate analysis showed that the critical ratios referring to symmetry followed a normal distribution, but those referring to kurtosis were not distributed in the same way as the normal distribution, so it was concluded that there were deviations from the univariate normality. The Mardia multivariate kurtosis statistic, which considers the sample's joint distribution, is 2.86 with a critical value of 1.16 within the acceptance region (± 1.96). Therefore, was found

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empirical evidence to consider that the sample follows a multivariate normal distribution. Viewing the data and with a sample size greater than 200, the maximum likelihood method was used to estimate the model.

3. Data Analysis

4.1 Modeling of the potential adoption of renewable energies

4.1.1 Reliability and validity of the measurement scales

The main results of the reliability and validity of the measurement scales used in modelling the behavior of adoption of renewable energies appear below. In the first place, the composite reliability of the pro-environmental behavior scale is almost 66%, although it is close to the established limit of 70%, it does not exceed it. The variance extracted is 0.5, so it could be said that pro-environmental behavior shares 50% of the variance with its indicators, exceeding the cut-off limits recommended by the scientific literature. The composite reliability of prior knowledge indicates that this scale explains, on average, 89% of its indicators, exceeding the cut-off limit recommended by the literature. The variance extracted is 0.61, reaching the value established as a reference by the literature, 0.50, considering a scale with adequate psychometric properties.

Observed Variables	Standardized coefficient	R^2	CE^2	$1-R^2$	Composite reliability	Variance extracted
saving	0,776	0,60	0,60	0,40		
activism	0,624	0,39	0,39	0,61	0,66	0,50
CP1	0,796	0,63	0,63	0,37		
CP2	0,755	0,57	0,57	0,43		
CP3	0,773	0,60	0,60	0,40		
CP4	0,79	0,62	0,62	0,38		
CP5	0,784	0,61	0,61	0,39	0,89	0,61
Int1	0,729	0,53	0,53	0,47		
Int2	0,727	0,53	0,53	0,47		
Int3	0,74	0,55	0,55	0,45		
Int4	0,628	0,39	0,39	0,61	0,80	0,50

The intention to adopt obtains compound reliability of 80%, being higher than the 0.70 that is established as the cutoff limit recommended in the literature. The variance extracted from intention is 0.5, so we can say that it also meets the cutoff recommended by the literature. The scales considered globally could be regarded as good since, although one of the indicators of pro-environmental behavior is lower than the limit established by the literature, the remaining scales' indicators are good.

4.1.2. Model of behavior in favor of renewable energies

4.1.2.1 Global adjustments of the model: Below are the values of the indicators of goodness of the global adjustment of the model.

Chi- square	p-valor	GFI	AGFI	CFI	RMSEA
69,375	0,36	0,950	0,922	0,983	0,042

The alternative adjustments (to Chi-square) calculated, such as the GFI that represents the degree of the global adjustment, meet the requirements set by the literature (> 0.90). The AGFI, which considers the global fit of the model considering the number of parameters, is considered equally adequate (> 0.90). The CFI adjustment index that compares the estimated model with the null model also reaches an acceptable value (close to 1). The RMSEA, an indicator that considers the residuals generated by the calculated model, is less than (0.05) the value recommended by the literature. All the indicators except the Chi-square show that the model reproduces the population variance-covariance matrix reasonably well.

4.1.2.2. Significance of the estimated coefficients:

To contrast the hypotheses collected in the literature, we will analyze the standardized coefficients. As can be seen (see Figure 2), the relationships between the proposed model composed are positive and significantly different from zero, confirming all the research hypotheses. Furthermore, the model explains a significant percentage (61%) of the variability of the intention to purchase renewable energies. In the first place, there is empirical evidence to support the first research hypothesis Huda and Heroza (2016) confirming the strong relationship between pro-environmental behavior and prior knowledge of renewable energies, with a significant standardized coefficient greater than 0.5 ($\beta = 0.725$; sign. = 0.00). Therefore, it is discovered that more concern or pro-environmental behavior tends to be more knowledgeable about renewable energies.

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Hypothesis H2, which supports a relationship between pro-environmental behavior and attitude towards renewable energies, is confirmed with a somewhat more moderate relationship between these variables (β = 0.316, sign. = 0.0016). The coefficient is standardized between 0.1 and 0.5. In this way, it is discovered that the greater the pro-environmental behavior, the greater the attitude towards the renewable energies considered (biomass, solar and photovoltaic).

The relationship posed by H3, between pro-environmental behavior and purchase intention, is moderate and significant as in the previous case (β = 0.315, sign. = 0.000). In this way, it is made known that the greater the pro-environmental behavior, the greater the intention to purchase renewable energies. The H4 that establishes the relationship between prior knowledge and attitude is confirmed, showing an influence on the dimension relationship like the two previous relationships (β = 0.312; sign. = 0.008). In this way, it is discovered that the greater the prior knowledge about renewable energies, the greater the attitude towards these energy sources. H5 is confirmed, establishing a strong relationship between the variables considered, with a significant standardized coefficient and a value greater than 0.5 (β = 0.571, sign. = 0.00). Thus, it is discovered that the more favorable the attitude towards renewable energies, the greater the purchase intention towards some of the facilities considered. The results obtained by the proposed model are following the previous studies carried out and mentioned in the section on the scientific literature review.

4. Conclusions and final Recommendations

This research has modelled consumer behavior in the face of renewable energies, finding support in the theory of reasoned action (TRA) by positively relating prior knowledge about renewable energies with attitude. Additionally, pro-environmental behavior was taken as an exogenous variable, showing a strong relationship between this variable and knowledge about renewable energies. The results achieved are consistent with other research results on environment and marketing, such as those of Egea and Frutos (2013), Pagiaslis and Krontalis (2014) or Lin and Syrgabayeva (2016). The main difference with these studies is that they predict the willingness to pay more to consume renewable energies. In contrast, our study analyzes the purchase intention showing that between concern for the environment, attitude and intention, The same strength in the relationship, since the installation of renewable energies involves an effort, slows down both the attitude and the consumer's purchase intention. However, consumers who care about the environment and have knowledge about renewable energies are influenced by situational variables, which decrease both the attitude towards them and the intention to buy them.

One of the problems that marketing companies may encounter is the initial investment that stops these facilities' purchase. Another problem is the lack of credibility and the ability to convince consumers of renewable energy benefits. The knowledge of these advantages will generate more favourable and more stable attitudes, which will stimulate the purchasing behavior of such energy systems. Since attitudes are based on knowledge, these companies must use advertisements informing and convincing about the energy and economic savings. Their installation in the home implies in the medium and long term. One way to achieve this would be to offer in campaigns a comparison between conventional systems and those based on "green" energies, adding the monetary equivalent of the savings generated for one year.

5. Limitations and Future lines of Research

The legislation and the operation of electricity companies in other countries make the investigations consider situations that do not occur in Libya (such as consuming renewable energy while paying more on the bill). However, it was believed that it is an exciting and controversial topic that should be analyzed in greater depth. It would be essential to test the model's robustness since the sample size used due to its ease of access does not allow us to infer the results obtained from other Libyan provinces. In this way, the research would improve the external validity of the results achieved. Finally, it is proposed to analyze the effectiveness of companies' advertising. It is also suggested public administrations focused on green energies through the methodology of eye tracking and other psychophysiological measures such as functional magnetic resonance imaging, electroencephalograms, galvanic skin response.

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