



Research article

How do beliefs and attitudes of people influence energy conservation behavior in Pakistan?

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ABSTRACT

Policymakers in developing countries like Pakistan mostly ignore the behavioral aspects of climate change mitigation, whereas literature is also deficient in advocating evidence-based mitigation strategies. This study aims to analyze the impact of personality traits, social norms, and attitudes on energy conservation behavior. Face-to-face interviews of 361 households are conducted in the capital city of Pakistan using random sampling. According to the characteristics of the data, the ordered logistic regression model is applied. The results reveal that education and gender do not contribute significantly toward energy conservation. In contrast, the behavior is more influenced by convenient lifestyle, the number of vehicles, distance of residence from the workplace, income, perception of energy security, and availability of transport. Furthermore, knowledge about sustainability and age is also critical to influencing energy conservation behavior. Therefore, the study recommends using different mediums to enhance the knowledge base of households about energy conservation and environmental sustainability, aligning the urban planning in view of location choices and use of public transport.

1. Introduction

Globally, the residential sector contributes 27 percent of energy demand and 17 percent of carbon emissions (Nejat et al., 2015). However, the recent evidence shows that carbon emissions decreased significantly after the emergence of COVID-19, but the residential energy demand is increased due to more extended stays at home for online education and work from home (Liu et al., 2020; Tollefson, 2020; Klemeš et al., 2021; Rouleau and Gosselin, 2021). Therefore, it critically signifies the need for policymaking for energy conservation.

Various attempts have been made globally to construct energy-efficient buildings, use sustainable materials, and install energy-efficient electric equipment (Li et al., 2013; Shi et al., 2016; Klemeš et al., 2021; Weng et al., 2020; Rouleau and Gosselin, 2021). However, policymaking has not given due importance to personal traits. For instance, Alvi et al. (2018) provide evidence about the rebound effect; individuals use energy-efficient electric appliances for more time, which accounts for the energy conservation strategy. It thus requires vigorous attempts to develop and implement a behavior-driven energy conservation strategy. It has certain benefits. First, it can reduce the energy demand of households

from 10 to 30 percent (Hafner et al., 2020; Xu et al., 2021). Second, it requires a minimum capital investment than any other energy conservation measure. However, significant time is needed to align the behaviors with the strategic goal. It is crucial for countries like Pakistan, where the residential sector consumes more than 47 percent of the total energy in the country.

A targeted approach to promoting energy-saving behavior is more of promising nature for the sustainable development of societies (Allcott and Rogers, 2014). However, it requires understanding the psychological factors based on specific behavioral theories. Recent literature has reasonably provided theories that explain the psychological process (Wittenberg et al., 2018). These theories include the theory of planned behavior (Wolske et al., 2017), nudge theory (Abdulkadriov, 2016), game theory (Gintis, 2009), and reinforcement learning theory (Ertugrul and Tagluk, 2017), and prospect theory (Dasgupta, 2017).

The theory of planned behavior (TPB) considers personal traits (attitude, perceived behavior controls, and subjective norms) so well that the energy-saving behavior of households in pro-environmental studies is more often modeled using this theory (Ru et al., 2018; Liu et al., 2020). Hafner et al. (2020) have analyzed behavioral interventions for residential

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energy conservation. Wittenberg et al. (2018) also conclude that motivational factors are important for strategizing or tuning the type of energy-saving behavior. Literature also reports heterogeneity in households' behavior and psychological attributes to use energy as critical factors for modeling energy-saving efforts (Allcott and Rogers, 2014; Poškus, 2020; Mi et al., 2021). Interestingly, Ma et al. (2013) find that households with similar socioeconomic characteristics have different habits for energy use. This heterogeneity made the policy's effectiveness uncertain. It thus requires modeling the perception, thinking, and behavior of individuals or households to recognize the underlying origins of this heterogeneity (Mi et al., 2021; Fiske, 1949; Brick and Lewis, 2016).

According to economic research, price and income are important determinants of individuals' choice regarding energy conservation measures. However, underlying income inequalities lead to conservative behavior on the part of the poor segment of society (Lenzen et al., 2006), whereas the behavior of rich people may remain unattended and ends up in the failure of the energy conservation objective. The same lies with the changes in energy prices (Zhang and Cheng, 2011). According to Shi et al. (2019), external policy interventions are not sustainable if necessary psychological conditions do not prevail. Further, human behavior is critical to determining the implications of energy conservation measures and solving the environmental problem (Gardner and Stern, 1996; Vlek and Steg, 2007). Therefore, understanding the behavior of individuals is necessary for sustainable policy measures. Globally, behavioral understanding has attracted much attention from academicians, practitioners, and policymakers. However, among very few in Pakistan who focus on behavioral aspects, Alvi et al. (2020) analyzed the evidence collected from individuals' surveys in Pakistan and Bangladesh and referred to lack of awareness as the primary societal feature threatening climate change mitigation. Nawaz and Alvi (2018) also share insights on Pakistan's energy security determinants. Huang et al. (2022) argued that technological progress is a powerful tool to control energy consumption in China. As such, literature that may provide understanding about critical factors to deal with energy conservation behavior is unavailable. Therefore, this study aims to bridge this gap.

Cognitive bias toward energy conservation for overall environmental sustainability is a critical aspect that policymakers usually ignore. The TPB is extended or modified to study attitudes and behaviors, but residential location choice, the role of transport, lifestyle, and knowledge about sustainability are not taken. Furthermore, the research community and the policymakers did not consider the due significance of behavioral aspects of energy consumption, whereas data is also not available. As such, most of the studies have focused on China and Europe, whereas no attempt has been made to study behavioral aspects of energy consumption in any of Pakistan's cities. Also, very few who captured the urban or residential aspects have not covered the residential location from an energy consumption perspective.

This study is novel in two dimensions. First, residential location choice in view of distance of residence from the workplace is critical for energy consumption for commutation, especially when public transport is not available and households want a convenient lifestyle and their knowledge about sustainability is also limited. Then, it becomes critical to develop a model by including its main drivers, which are missing in the literature. For instance, Yu et al. (2012) considered the residential environment attributes but did not capture the importance of residential location choice given the distance of residence from the workplace (commuting), which is a significant source of energy consumption. It is especially relevant for countries like Pakistan, where public transport facility is limited, and residents are hesitant to use or occasionally visit restaurants, parks, shopping malls, and other places. Hence they use an insignificant proportion of their income on energy requirements other than going to the workplace. However, it does not ignore the socioeconomic factors and energy security aspects. Therefore, this study developed a more decent model that fills this literature gap. Second, it provides the correct data collected from household interviews to holistically cover Pakistan's capital city's residential sector and analyze it

through a rigorous econometric model. This study is important for countries like Pakistan, where energy deficiency and reliance on imports devastate the economic outlook, whereas the residents are least concerned about changing their behavior. As such, no efforts are made at the government or community level to discuss this aspect, especially when this is relevant from a climate change mitigation perspective.

This study is organized as follows; the introduction is in section 1, and the literature is reviewed in section 2. Methodology, in section 3, provides insight into the study area, sampling frame, questionnaire design and administration of interviews, description/construction of variables, and empirical model (order-logistic regression model). Section 4 analyzes the estimated results, from the descriptive understanding of the data to diagnostic testing. Finally, section 5 concludes the study and offers policy recommendations.

2. Review of literature

The behavior of residents is critical for energy use, depending on their needs and comfortability (Hu et al., 2017). Therefore, targeting energy-saving behavior can have promising implications for sustainable development strategy (Zheng et al., 2014; Paone and Bacher, 2018). This section reviews the literature to define energy conservation behavior, its classification, and influencing factors and links it with the relevant behavior theory. It thus underpins the gap in the literature, especially in the case of Pakistan.

The daily and habitual practices of households to use energy with a focus on usage reduction are defined as energy-saving behavior by Troтта (2018). Urban and Scasny (2016) define it as one-dimensional behavior to deal with energy conservation goals. However, there can be different motives to conserve energy that can be considered for its definition. For instance, these motives may include general energy-saving behavior for electrification, air, and temperature control through electricity, gas, coal, or any other. Also, environmental sustainability is an important growing global concern that can motivate households to conserve energy. Further, the sustainability of future generations through energy saving is a critical dimension of energy-saving behavior. Therefore, energy conservation can be made possible by adopting pro-environmental behavior, an energy-efficient system, or both (He and Veronesi, 2017).

Literature dictates two approaches to classifying energy-saving behavior by scene and nature. First, Chen et al. (2013) focus on three scenes (bedroom, kitchen, and living room) to analyze energy-saving behavior. However, by scene approach is restricted to include environmental aspects only. Following the second approach, Caputo et al. (2013) categorize energy-saving behavior into (1) heating, air conditioning, and ventilation, (2) domestic hot water use, and (3) lighting. Hager and Morawicki (2013) also included the cooking behavior sustainability aspect in this approach. This approach is also limited in scope as it does not cover efficient appliances' use and timely maintenance, as argued by Busic-Sontic et al. (2017) and Ali et al. (2019). Further, Yue et al. (2013) also included interpersonal interactions and promoting energy-efficient appliances as energy-saving categories.

Considering the literature, this study constructed the energy conservation index more holistically. For instance, it is categorized into energy-saving behavior, environmental concerns, and sustainability of future generations. The literature stresses discouraging the unnecessary use of lighting and ventilation and sustainable use of hot water and air conditioning so that energy consumption may be reduced (Hager and Morawicki, 2013; Jareemit and Limmeechokchai, 2017; Schleich, 2019; Liu et al., 2020a). However, there can be different motives for the households that derive their behavior toward energy saving. For example, high energy prices can be critical for energy saving through forced avoidance of unnecessary use. Therefore, it includes the use of appliances, kitchen energy saving, saving hot water, and lighting. This study uses all of these dimensions under the first category. Other motives include bio-spheric values (environmental protection) and concern about the sustainability of future generations are also critical for energy sustainability from an

energy conservation perspective. Therefore, a holistic measure that may incorporate these dimensions while measuring energy conservation is more meaningful.

TPB is one of the most used psychological models for explaining behavior regarding environmental or energy sustainability (Tan et al., 2017). It postulates the conduct of behavior rationally, using the available set of information and knowledge. According to Ajzen and Madden (1986), in addition to knowledge, attitude, perceived behavioral control and subjective norms are critical factors that influence decision-making. Behavioral beliefs about the outcome are derived from a person's attitude. For instance, if a person believes that his energy-conservation behavior leads to environmental protection, then he is more likely to behave rationally, adopting energy-conservation measures and vice versa (Liu et al., 2020a). Subjective norms reflect the impact of social or external pressure on behavioral intention, with essential referent individuals or groups serving as the primary source of this influence. For example, children may observe their parents' expectations to conserve energy (De Leeuw et al., 2015). Perceived behavioral control (PBC) and convenience level are critical factors affecting individuals' energy-conservation behavior (Liu et al., 2020a). According to Ajzen (1991), PBC is an important contributor to TPB.

Consumers' knowledge about the environmental consequences of more energy use has important implications for curtailing its consumption (Tanner and Kast, 2003). Mainieri et al. (1997) and Pickett-Baker and Ozaki (2008) have observed that one is more likely to purchase pro-environmental appliances and equipment if one has pro-environmental beliefs. However, it is not necessarily true to act pro-environmentally if an individual carries such values, but there are many chances to do so (Pickett-Baker and Ozaki, 2008; Khattak et al., 2022). Consumers can help preserve the natural environment by adopting energy conservation measures if they have certain beliefs (Niemeyer, 2010). If there exists a value-action gap, then consumers do not behave rationally. Thus, it is critical for theorizing the energy-saving behavior to treat them as holding rational choices (Ajzen and Fishbein, 1980). Shi et al. (2019) conclude that values significantly influence energy conservation beliefs. Furthermore, different values (egocentric, altruistic, and biospheric) can negatively or positively correlate with energy conservation behavior. For instance, according to Abrahamse and Steg (2009, 2011), altruistic and biospheric values are positively correlated, whereas the latter dominates the impact of the former. On the other hand, the literature has contradictory findings on the correlation between egocentric values and energy conservation behavior.

Attitude and external conditions are the main contributing factors to affect energy conservation or pro-environmental behavior (Guagnano et al., 1995). In this perspective, TPB states behavioral intentions as necessary for determining behavior (Ajzen, 1991). Therefore, attitudes may or may not affect energy conservation behavior. For instance, Brandon and Lewis (1999) found an insignificant impact of attitude on energy conservation behavior in the UK. On the other hand, Hines et al. (1987) argued that attitude is critical for energy conservation behavior. Behavioral intention as an intermediary variable for attitude is positively correlated with energy conservation behavior (Michele et al., 2004). Assuming rational behavior, attitudes are derived from beliefs and are likely to positively affect energy conservation or environmental behavior (Ajzen, 2002; Tanner and Kast, 2003). Many studies are available for developed countries that investigated the impact of attitudes and beliefs on energy conservation or environmental behavior (Arksteijn and Oerlemans, 2005; Faiers and Neame, 2006; Hansla et al., 2008; Lane and Potter, 2007; Niemeyer, 2010; Sidiras and Koukios, 2004). However, the literature on developing countries, especially Pakistan, is deficient. It is also not given due importance in policy making. Therefore, this study contributes to Pakistan's empirical and policy research.

An individual is likely to intend to perform a particular behavior depending on the level of PBC (De Leeuw et al., 2015). Subjective norm is a significant driver of energy-saving behavior (Nie et al., 2019). However, Lim et al. (2016) and Liu et al. (2020a) found its impact insignificant. It can be due to the inclusion of personal norms or other related factors in the model (Ru et al., 2018). TPB is augmented with personal

norms (Tan et al., 2017). Personal norms significantly affect purchase behavior, as Tan et al. (2017) concluded based on a survey of 210 buyers of household appliances in Malaysia. Chen (2016) and Shalender and Sharma (2021) also provide evidence on carbon emissions reduction and purchasing electric vehicles in China and India, respectively.

Personal characteristics are instrumental in affecting energy conservation behavior (Wang and He, 2011; Xie et al., 2013; Gao and Zhang, 2015). These characteristics include household income, education, gender, age, and social norms. Many studies, including Brechling and Smith (1994) and Scott (1997), suggest a positive correlation between education level and energy conservation behavior. According to Schultz (1975), education reduces the cost of acquiring information. Furthermore, daily consumption behavior is also modeled by many scholars as a possible explanation for energy conservation behavior. For instance, work location (distance from residence to workplace) and public transport use are critical factors for improved energy conservation (Qu et al., 2014). The number of vehicles owned by households, awareness about sustainability, and energy security from availability, affordability, efficiency, and acceptability perspective are also critical for understanding the policy perspective on how to deal with energy sustainability. However, these are largely missing in the literature while augmenting the possible factors in the model. Most studies rely on a questionnaire-based survey from university students, employees, and households, whereas multivariate econometric and statistical tools are employed to conduct empirical analysis.

3. Research method

3.1. Case study area and questionnaire design

The case study approach is very helpful in an in-depth analysis of the phenomena by covering the socioeconomic, demographic, political, and environmental cultural attitudes and preferences. The case study is also instrumental when data on particular aspects of the phenomena is missing in the national census data. In the study, Islamabad, the capital city, is selected as the case study area. Capital Development Authority (CDA) in Islamabad regulates the Zone (I–V) of Islamabad, and the territory is 906 Sq Km spread. From a planning perspective, Islamabad is mostly a well-planned new city with a grid structure, and the situation of urban amenities is much better compared to the rest of the country.

This study analyzed the data collected through face-to-face interviews through a designed questionnaire from 361 households in the capital city of Pakistan, Islamabad. For this study, ethical approval is obtained from the School of Social Sciences and Humanities Ethics Committee, confirming that informed consent is obtained from all participants. The structured questionnaire devised for the research has four sections, and each section discusses people's behavior, attitudes, and preferences toward sustainability. The questionnaire contains then open-ended and Likert scale questions. The residents are asked about their attitudes and preferences regarding energy conservation and sustainability using random sampling. The first section of the questionnaire obtained information about household characteristics, including marital status, family size and composition, levels of educational attainment, employment status, and income. This data would provide the basis to differentiate households and individuals as heterogeneous entities and to determine how these attributes shape their attitudes and behavior regarding energy conservation.

3.2. Sample design and conduct of interviews

The sampling technique used in the study is random sampling. In the first step, clusters or residential sectors are selected to ensure sufficient geographical coverage (urban and peri-urban areas) and socioeconomic variations for the different income groups. While in the second step, fifty random households are selected from each cluster, ensuring our sample is representative and allowing us to generalize our findings.

Table 1. Sample Design and details of Sectors.

Zone	Sectors/Areas
Zone-I	G-6, G-9, Mehr-Abadi, G-13,F-6, F-10, I-8, I-9, I-10
Zone-IV	Jinnah Garden, PWD Town, Bahria, and Pakistan Town
Zone-III	Shahzad Town, Tramari, and Chatta Bakhtawar.

The total household population is 3,40,000, according to the 2017 national census. Using the Yamane formula table with a precision of 0.7 and a confidence interval of 95%, the sample should be around 204 respondents (Israel, G. D., 1992). However, this study conducted 361 face-to-face interviews, sufficient to test the model. Given the considerable sample size, enumerators were recruited and trained to conduct interviews.

Islamabad, a planned capital city, is divided into five zones wherein zone I, the largest residential area, is divided into sectors with their names in the alphabet (<https://www.cda.gov.pk/housing/ictmap.asp>). This study has covered Zone-I, Zone-III, and Zone-IV of Islamabad's capital territory. In Zone-I, G-6, G-9, G-12 (Mehr-Abadi) G-13, F-6, F-10, I-8, I-9, and I-10 are covered. In Zone-III, the rural areas of Tramari and Chatta Bakhtawar are selected, while in Zone-IV, Jinnah Garden, PWD, Bahria, and Pakistan Town are covered. Table 1 briefly describes the sample design.

Table 2 shows the measurement unit, description, and construction of variables used for the ordered logistic regression analysis.

3.3. Hypothesis

Many dimensions, including beliefs, norms, attitudes, social influences, behaviors, government policy, and energy efficiency, are covered in the prior research for many countries. However, very few existing studies have focused on a model that may cover driving factors of energy conservation at the household or micro level. From this perspective, it is important to build the conceptual framework on TPB with some modifications. For instance, Cognitive self-regulation and intentions to perform a given behavior are challenging to measure because they change over time. However, the literature shows a positive correlation of intentions with beliefs and attitudes. Therefore, it calls for attitudes and beliefs to be

modeled because of their relevance to driving the motivation for energy conservation behavior. Furthermore, it is hard to see any study for developing countries from a sustainability perspective, especially from a climate change perspective and reliance on fossil fuels to meet the energy demand. As such, no prior study is available for Pakistan. Therefore, given the state of existing literature and the significance of energy conservation, this study tests four hypotheses about lifestyle, transport, energy security, and residential location choice, which are given below.

H1. Beliefs and Attitudes toward a convenient lifestyle affect energy conservation behavior.

H2. People's Attitude toward environmentally friendly transport affects energy conservation behavior.

H3. People's beliefs and attitudes toward energy security influence energy conservation behavior.

H4. Residential location choices determine energy conservation behavior.

3.4. Empirical model

The study used the ordered logistic regression analysis to explain and quantify the relationship between a scalar outcome variable and two or more independent/explanatory variables. However, the empirical method selection depends on the outcome variable's nature.

The ordered logistic regression model is used for the empirical investigation of the model in Eq. (1). The ordered logistic model is a sub-categorization of logistic models in which the dependent variable is ranking. Usually, logistic models assign the variable's probability to a specific value. However, the ordered logistic model assigns the probability of a variable below a certain threshold in the Likert scale data. There are two reasons to select an ordered logistic regression model. First, it is more robust regarding including any "Casual factors" unfounded and arbitrary (Victor and Yang, 2012). Second, the outcome variables are based on the Likert scale, which is the ordinal scale. So, this model can consider the natural ordering of alternatives on Likert scale data, thus improving upon

Table 2. Description and measurement of variables.

Dependent Variables		
Variable Name	Unit	Description and Measurement: Definition of Variable
Energy Conservation	Continuous number (Ranking)	Energy conservation is the effort to reduce energy consumption that can be achieved by using energy more efficiently or reducing the energy service used (Stern 1992; Sutherland, 1996; Omer, 2008). In the present study, respondents are asked about their behaviors toward energy conservation. The weighted average constructs this index of energy conservation in the wake of the answers to the following questions of energy conservation behavior. i. I keep heating/air conditioning low to save energy ii. I turn lights off in unused rooms iii. I do not want to use my car if affordable, frequent, and convenient public transport is available
Independent Variables		
Household Income	Pakistani Rupees	In this study, the total income of a household is taken as an independent variable, and it is ranged into five income brackets as i. < 50,000 ii. >50,000–100,000 iii. >100,000–200,000 iv. 200,000–300000 v. >300,000
Education	Continuous	The education level of the household head is taken as years of schooling.
Gender	Binary	Gender of the household head.
No. of Vehicle	Continuous	This variable is measured by the number of cars and bikes, used by each household.
Convenient Lifestyle	Ranking	In this study, respondents are interviewed about their beliefs and attitudes toward convenient lifestyles and taken as independent variables. They are inquired about how they rank a comfortable living whereas good telecommunication and infrastructure is available
Energy Security	Ranking	This study uses energy security preferences as an independent variable which is the component of three questions. i. uninterrupted availability of energy, ii. energy should be affordable iii. Energy should be environmentally friendly.
Residential Location	Ranking	Likert scale opinion about work/job and residential location should be near to reduce energy use.
Public Transport availability	Ranking	Likert scale opinion about public transport availability, which is accessible and time efficient.
Do not know Sustainability	Ranking	Likert scale opinion about the awareness of the concept of sustainability

the typically used regression models and ANOVA techniques (Snipes et al., 1998). These reasons make ordered logistic regression an appropriate model for the empirical analysis of this study.

$$EC_i = \beta_1 I_i + \beta_2 Ed_i + \beta_3 G_i + \beta_4 Veh_i + \beta_5 Life_i + \beta_6 EngSec_i + \beta_7 WJL_i + \beta_8 PTE_i + \beta_9 SUKN_i + \varepsilon_1 \tag{1}$$

The above equation shows the regression forms of energy conservation behavior of households EC_i that depends on the vector of household characteristics, including income I_i , Education Ed_i ; households; Gender G_i number of vehicles Veh_i convenient lifestyle $Life_i$; attitude and behaviors toward the energy security $EngSec_i$; work job location WJL_i and knowledge about the sustainability $SUKN_i$. The construct of the energy conservation index EC_i are the weighted average of Energy-saving behavior x_1 , concerns about the environment and future generation x_2 and sustainable use of energy x_3 explained below in Eq. (2).

$$EC_i = \sum_{j=1}^3 \mu_j x_j \tag{2}$$

4. Analysis

This section analyzes the data in two stages. First, it provides an orientation about data depicting demographic and socioeconomic characteristics of respondents, their knowledge, attitude, and perception about measures for energy conservation. Second, an analysis of Ordered Logistic Regression model results is offered.

4.1. Socioeconomic and demographic characteristics of respondents

Table 3 indicates the respondents' characteristics, including age, education, income, marital status, and occupation. Among 361 respondents, 241 (67%) are male, and 120 (33%) are female, which aligns with the local demographic characteristics. Moreover, the household income of 27% is less than PKR 50,000 and from 50,000 to 100,000 for 48% of the respondents. The household income profile also matches the local statistics. Since most of the Pakistani population are adults of young age, the proportion of respondents between 18 to 24 years is relatively high (148, 41%). Also, the proportion of elderly respondents over 60 is relatively low (7, 2%). In terms of occupation, more respondents are engaged in private sector jobs, 42%, while 24% of the respondents are

Table 3. Demographic and socioeconomic characteristics of households.

Characteristics	Range	Count	Percentage
Age	18–24	148	41
	25–44	154	43
	45–60	52	14
	over 60	7	2
Gender	Male	241	67
	Female	120	33
HH Income	Less than 50, 000	99	27
	50,000–100,000	174	48
	100,000–200,000	64	18
	200,000–300,000	7	2
	300,000–400,000	10	3
	400,000–500,000	3	1
	over 500,000	4	1
Main occupation	Public Sector Job	123	34
	Private Sector Job	153	42
	Business/Self-employed	85	24
Education	School	95	26
	College	37	10
	Undergraduate	176	49
	Postgraduate	53	15

self-employed. 64% of the respondents have an education of higher than twelve years (49% undergraduates and 15% postgraduates). The characteristics of respondents highlight interesting findings. First, most of the respondents have an income level of below one hundred thousand Pakistani rupees, which highlights the significance of their energy conservation measures. Most are also reasonably educated (12 years of education or more). Second, the majority of the respondents are male of young age. Therefore, it seems more convenient for the civil society and government to communicate the importance of energy conservation for their personal and societal welfare along with inter and intra-generation sustainability.

4.2. Knowledge, attitude, and perception of energy conservation

Table 4 depicts the descriptive statistics of variables that are either of count or Likert scale nature. Convenient Lifestyle (Not at all important to extremely important) has an average of 4.21, meaning thereby convenient lifestyle, in terms of energy and communication infrastructure, public and private transport, and living environment is very important. However, it ranges from 2 (slightly important) to 5 (extremely important). Energy security is very important among households. Thus, households require available, affordable, efficient, and acceptable energy. Furthermore, households agree on reduced energy use if the distance between work/job and residential locations is minimal. The average response is more than 4 (agree), with a range from 1 (strongly disagree) to 5 (strongly agree).

Interestingly, the majority of households recognize the public transport mode as environmentally friendly, considering that the average lies near 4 (agree). However, on average, households do not know how to take action toward sustainability. The average response is more than 3, ranging from 1 to 5. The number of vehicles owned by every household is on average more than 1, ranging from zero to 6 (see Figure 1). More than 81% of the households have either 1 or 2 vehicles in their use, whereas around 16% have either 3 or 4 vehicles. Understanding the significance of minimizing the distance between residence and work location and focusing on a convenient lifestyle with an income level that does not allow to reside near work location highlights the role of urban planning and government policies to focus on housing facilities and verticle urbanization. However, it has never been seen as a component of urban policy. Furthermore, as a matter of cultural practice, everyone wants to reside in a house, not a flat. Also, if respondents understand the importance of energy security as the case, their attitudes must be aligned with their beliefs. Nevertheless, because of convenience, they rarely bother to use public transport due to less efficient availability and avoiding last mile distance. It highlights the multi-dimensional strategy, including providing efficient public transport, developing and implementing verticle urbanization, and providing housing facilities to low-income groups on easy terms with energy-efficient and solar-powered buildings that would improve sustainability with more energy conservation and mitigate climate change.

In addition to testing causality between dependent and independent variables, diagnostic tests for normality and heteroscedasticity of residuals are also performed. Table 5 provides the results of the Shapiro-Francia W Test for Normality, and Table 6 gives the results of the White and Breusch-Pagan tests for heteroscedasticity. Since all p-values reject the null hypotheses, no evidence is found against normality and homoscedasticity. It is therefore concluded that variables have no issue of heteroscedastic, and all the variables follow a normal distribution.

Table 7 shows the Chi-square values of the causality test that indicate the causal effect of all independent variables with the energy conservation index. Since the P value reject the null hypotheses concluded that variables have associations with the dependent.

4.3. Analysis of ordered logistic regression results

This study applies the Ordered Logistic Regression, and the results are provided in Table 8. It is revealed that all variables except education and

Table 4. Knowledge, attitude and Perception.

Variable	Mean	Min	Max	1	2	3	4	5
Convenient Lifestyle	4.216066	2	5	0%	4%	13%	40%	43%
Energy Security	4.260388	1	5	1%	3%	9%	43%	44%
Work/Job location	4.260388	1	5	2%	3%	8%	40%	47%
Public Transport is Env. Friendly	3.523546	1	5	6%	18%	17%	35%	24%
Don't know Sustainability	3.565097	1	5	7%	16%	19%	32%	27%

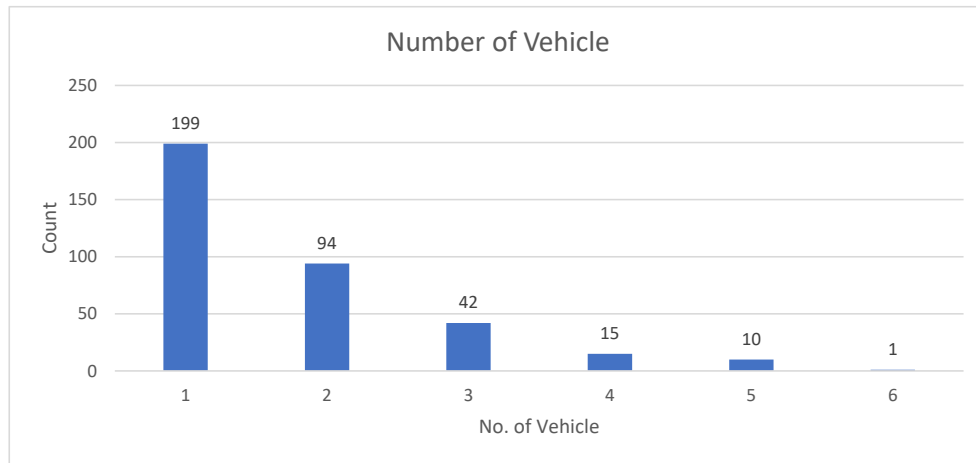


Figure 1. Frequency distribution of number of vehicles.

Table 5. Shapiro-francia W test for normality.

Variable Name	Z	Prob > Z
HH Income	11.086	0.00001
Education	10.998	0.00001
Sex	11.028	0.00001
Age	10.532	0.00001
No of Vehicle	8.474	0.00001
Convenient Lifestyle	4.957	0.00001
Energy Security	7.911	0.00001
Work/Job Location	8.133	0.00001
Public Trans/Env Friendly	8.366	0.00001
Do not Know Sustainability	6.7534	0.00001

Table 6. Heteroscedasticity test.

Heteroscedasticity Test	White's Test	Breusch-Pagan Test
	1.81 (0.1732)	1.92 (0.1845)

gender are likely to affect energy conservation behavior significantly. The household income is expected to influence energy conservation behavior negatively. Results show that with a one-unit increase in household income, the log of odds about energy conservation behavior decreases by 0.265. It is necessary because if households' average income increases, it is less attractive for them to conserve energy due to improved price affordability. Therefore, with the increased income, people use more energy and do not switch off unnecessary lights and appliances. The results follow the literature. [Barr et al. \(2005\)](#), [Farajzadeh and Nematollahi \(2018\)](#), [Trotta \(2018\)](#), [Muller and Yan \(2018\)](#), [O'Doherty and Lyons \(2008\)](#), and [Soltani et al. \(2020\)](#) confirm the negative impact of income on energy conservation behavior. Thus, it is more critical to influence the

Table 7. Causality between energy conservation and independent variables.

Variable Name	Chi-Square Test Statistics	P Value
HH Income	188.9	0.000
Degree of Education	178.5	0.031
Gender	15.5	0.075
Age	35.2	0.641
No. of Vehicle	75.7	0.017
Lifestyle	77.7	0.000
Energy Security	85.0	0.003
Residential Location	130.5	0.000
Public Trans/Env	75.3	0.019
Lack of Knowledge about Sustainability	74.3	0.023

Table 8. Ordered logistic regression model results.

Variable	Coefficient	P-Value
HH Income	-0.26471	0.011
Degree of Education	-0.31005	0.274
Gender	-0.22732	0.919
Age	0.39608	0.003
No. of Vehicle	-0.23007	0.072
Lifestyle	0.29230	0.025
Energy Security	0.25100	0.046
Residential Location	0.43087	0.000
Public Trans/Env	0.62606	0.000
Lack of Knowledge about Sustainability	-0.14973	0.073

behavior of rich households through awareness of the significance of energy conservation for environmental and overall societal sustainability, not only for them but also for future generations. Otherwise, controlling behavior through the escalating principle of price decisions has limited

scope. Implementing a climate-related tax regime or carbon tax on use above a certain level can help energy conservation as a practice. However, it is critical to make people understand the consequences of their actions and attitudes toward energy use so that they might be able to show responsible behavior. In this perspective, the role of government is very critical.

Education is likely to have an insignificant impact on energy conservation behavior. It depicts that household heads with more education may not show more energy conservation patterns. For instance, it is likely to be more critical to strategize persuasive energy conservation education. Trotta (2018) and Poortinga et al. (2003) reveal that people with more education do not show energy conservation compared to those with low education. Chen et al. (2019) argued that persuasive communication is essential for energy conservation. Therefore, it is critical to influence behavior through targeted education programs to promote energy conservation and sustainability practices.

The impact of gender is found to be insignificant on energy conservation. It depicts that gender is not relevant to energy conservation behavior. However, it may depend on the socialization and training of men and women at various stages of life. The results are also validated by the findings of Martinsson et al. (2011) and Soltani et al. (2020). With the growing age, households are more responsible for using energy. That is, age is likely to impact energy conservation positively. Barr et al. (2005), Trotta (2018), and Soltani et al. (2020) are of the view that older household heads are more active in conserving energy than younger ones. However, the finding of Poortinga et al. (2003) is contrary to it because of education programs younger people receive for energy conservation. Also, it is more likely to believe that younger people can be more responsible for conserving energy due to climate change threats to their future. Again, it highlights the significance of targeted education programs to make the behavior responsible for environmental sustainability. It is more critical for a society like Pakistan, where the proportion of the young population is two-thirds.

The impact of the number of vehicles owned by a household is noticeable. That is, it is expected to have a negative impact on energy conservation. The increase of 1 unit of the vehicle decreases the log odds by 0.23 units of energy. Sun et al. (2018) found the same results while working on household-level data collected from Beijing. Social norm or status-sensitive households own a vehicle for daily traveling to the workplace or marketplace, increasing gasoline use and compromising energy conservation strategy. However, it can be more meaningful to decrease the use of vehicles by providing friendly public transport facilities across all areas of Islamabad. By doing so, significant energy can be conserved. Litman (2013), while comparing cleaner vehicles and mobility management strategies, recommends mobility management as a better strategy due to the rebound effect and life cycle impact. Alvi et al. (2018) also signify the limitations of energy-efficient equipment due to the rebound effect. Therefore, the government should understand the significance of behavioral change in households by targeting their beliefs and attitudes through a comprehensive plan. As a prior, it is necessary that the government first understand the significance of targeting behavior for sustainability. As such, only the government can deal with it at all its tiers, including local bodies, and by engaging the community.

A convenient lifestyle, in terms of the living environment, transport, and other infrastructure availability, enables households to make wise decisions about energy conservation. As such, a 1-unit increase in inconvenience is expected to increase the energy conservation by 0.29 units. It signifies the importance of aligning lifestyle with energy conservation. Wei et al. (2007) provide evidence in favor of lifestyle's direct and indirect impact on energy conservation and controlling CO₂ emissions. Another critical control of energy conservation is the focus on energy security. Availability, affordability, efficiency, and acceptability ensure energy security, likely to impact energy conservation positively. According to Poortinga et al. (2012), energy security concerns motivate individuals to avoid those practices prone to high carbon emissions. Nevertheless, beliefs and attitudes must be aligned with energy conservation behaviors.

Residential location choice (distance between residential and work location) is critical for energy conservation. A household near the workplace will positively influence energy conservation (Biying et al., 2012). Spatial structure or the residential location choice has attracted due importance in the literature in specific dimensions like landscape ecology, transportation, and community design (McGarigal, 2004; Hickman and Banister, 2007; Clifton et al., 2007). However, it is least explored in energy conservation, whereas it has long-term implications for household energy consumption. Therefore, taking the lead from work done by Biying et al. (2012), this study highlighted the significance of urban planning for energy conservation and environmental and overall sustainability. The evidence here shows that residential location choice is likely to impact energy conservation positively. It calls for the attention of policymakers and urban planners to prioritize the behavioral implications of residential location by making the housing sector cost-effective for the households to the nearby location to workplaces.

If available, an efficient and safe public transport facility is likely to impact energy conservation positively. The results align with the literature (Bailey et al., 2008; Litman, 2013; Hu and Fan, 2020). Knowledge about sustainability is also critical for influencing behavior regarding energy conservation, as argued by many, including Abrahamse et al. (2005), Chen et al. (2008), Osbaldiston and Schott (2012), and Delmas et al. (2013). The results show that low knowledge about sustainability is likely to negatively affect energy conservation behavior. Therefore, it is iterated that enhancing the knowledge of households should be a point of focus by the policymakers to influence individual behavior and meet the environmental sustainability target.

5. Conclusion and policy recommendations

This study has validated the attitude, belief, and behavior link by collecting evidence from primary household interviews with residents of Islamabad. This study developed and estimated a model wherein energy conservation behavior is regressed on a set of variables, including personal traits (demographic and socioeconomic), gender, lifestyle, efficiency and safety of public transport, residential location, number of personal vehicles, and knowledge about sustainability. Based on the empirical results, it is concluded that modeling behavior is critical for devising and implementing energy conservation policies so that attitudes, subjective norms, and perceived behavioral controls can be aligned to the goal of sustainability. This study also concludes that high-income households are less concerned about energy conservation, whereas the degree of education also negatively influences energy conservation. Therefore, it is recommended that persuasive and targeted education programs and awareness campaigns should be an essential ingredient of energy policy. Various media campaigns can be initiated by an inclusive approach with the help of all the stakeholders. These media campaigns will help to spread awareness among those who are an adult or started their professional life. The main idea is to attempt to align their behavior toward energy sustainability. Price control measures are not meaningful, at least to target the otherwise educated and rich segment of society who is also the main energy consumer.

Irrespective of their gender, individuals show more responsible behavior with the rising age. Therefore, it is critical for societies to provide relevant education where the young population is dominant, like in Pakistan. Further, social norms, lifestyle, and knowledge about sustainability are critical to deriving energy conservation behavior. Providing an energy-saving environment is a critical perspective to improve sustainability by taking two initiatives. First, comfort for public transport through enhanced connectivity and transport infrastructure, use of big data and other technological measures for high-quality transportation, and intelligent information system for traffic should be the policy priority. Second, promoting and transforming buildings for improved energy efficiency can be significant for energy

conservation. Group-level or community-based energy conservation initiatives and incentive mechanisms can be proved as successful measures to align energy conservation and sustainability behaviors. From a residential location choice perspective, the role of urban planning is highly significant. Therefore, housing policy should be inclined toward the residence-workplace distance minimization principle. Ultimately, households' knowledge enhancement should be a point of focus to meet the target of environmental sustainability.

This study is limited to focusing on the residential sector while investigating the role of beliefs and attitudes in influencing energy conservation behavior. However, it implicitly assumes that residents work in hotel and commercial sectors and that their beliefs and attitudes are critical for energy conservation at workplaces. But, it does not undermine the significance of conducting such studies in the future. For instance, a dedicated study should be attributed to analyze guests' environment and energy conservation-related behaviors for sustainable hotel operations. An experimental study or a choice modeling approach would be critical to study extraversion levels with social norms, personality traits, past behaviors, and psychological factors. It will be significant for strategizing actionable measures to promote energy conservation behaviors and guests' satisfaction. Also, residents' heterogeneity of energy-saving behavior among different personality traits (positives, temperate, conservatives, and introverts) is critical for simulating appropriate energy conservation interventions. This study has also not included the significance of the rebound effect due to the use of energy-efficient appliances. Further, it has focused on TPB and does not consider a range of structural and institutional issues. However, this limitation does not undermine the importance of these issues. Therefore, conducting research in these dimensions would be critical to complement the current study. In the future, conducting a comprehensive study to estimate through Structural Equation Model and factor analysis would be vigorous.

Declarations

Author contribution statement

Shahzada M. Naeem Nawaz: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools and data; Wrote the paper.

Shahzad Alvi: Conceived and designed the experiments; Contributed reagents, materials, analysis tools and data; Wrote the paper.

Abid Rehman: Performed the experiments; Contributed reagents, materials, analysis tools and data; Wrote the paper.

Tayyaba Riaz: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools and data; Wrote the paper.

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Data availability statement

Data will be made available on request.

Declaration of interests statement

The authors declare no conflict of interest.

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