An extension of the theory of planned behavior to understand factors influencing Pakistani households' energy-saving intentions and behavior: a mediated–moderated model

Sikandar Ali Qalati · **Naveed Akhtar Qureshi** · **Dragana Ostic** · **Mohammed Ali Bait Ali Sulaiman**

Abstract This study aims to explore the factors influencing households' intentions and actual behavior in relation to saving energy. This study is based on the theory of planned behavior (TPB), extending it by adding descriptive norms and moral responsibility. An online survey was administered to collect data from randomly selected households and data analysis was run using partial least squares structural equation modeling (PLS-SEM). The research findings reveal the positive and significant effect of TPB factors (attitude, subjective norms, and perceived behavior control) and the extended factors (descriptive norms and moral responsibility) on households' intention to save energy, as well as the significant effect of perceived behavior control, moral responsibility, and intention on household's energy-saving behavior. This study also evidences the significant mediating and moderating role of households' intention to save energy and moral responsibility. This study's model explains 70.5% of variations in households' intention to save energy and 63.1% of variations in households' energy-saving behavior. In particular, the extended model explains 11.6% more of the variation in households' intention to save energy compared to the TPB model. This research has several theoretical and practical implications for scholars, environmental protection agencies, and policy-makers.

Keywords Theory of planned behavior · Energy-saving behavior · Energy consumption · Households

S. A. Qalati (✉) · D. Ostic
School of Finance and Economics, Jiangsu University, Zhenjiang, China
e-mail: sidqalati@gmail.com

D. Ostic
e-mail: dostic@ujs.edu.cn

N. A. Qureshi
Department of Business Administration, Sukkur IBA University, Sukkur, Pakistan
e-mail: naveed@iba-suk.edu.pk

M. A. B. A. Sulaiman
Department of Marketing and Entrepreneurship, Dhofar University, Salalah, Oman
e-mail: msulaiman@du.edu.om

Introduction

Energy consumption has become a major contributor to global warming and has thus attracted the global interest of scholars and practitioners (Liu et al., 2020a, 2020b, 2020c, 2020d). Improving energy-efficient products and energy use efficiency, promoting energy-efficient technology, and encouraging households to save energy in daily routine activities are effective ways to decrease energy consumption. However, bearing in mind the rebound effect, improving energy use efficiency and promoting energy-efficient technology and products are insufficient to reduce

energy consumption. Therefore, an individual's (i.e., household, employee) motivation to perform energy-saving behavior and save energy may potentially contribute to reducing energy consumption (Gao et al., 2017; Neves & Oliveira, 2021).

Globally, the residential sector accounts for 27% of energy consumption and 17% of carbon emissions (Pablo-Romero et al., 2017). Although the global COVID-19 pandemic improved air quality and led to an overall decrease in global warming (Rupani et al., 2020), the residential sector has recorded a gradual increase in energy consumption. This is due to the implementation of lockdowns, home working, online learning, home improvements, home quarantine, and mobility restrictions (Carvalho et al., 2021; Qarnain et al., 2020). In addition to energy-saving methods (i.e., the use of sustainable materials and energy-efficient building services), several studies have confirmed that energy-saving interventions can increase energy savings by 10–30% (Nie et al., 2019; Vogiatzi et al., 2018). Furthermore, behavior-driven energy-saving strategies require less time and capital than other methods. Therefore, promoting energy-saving behavior among households seems a promising sustainable strategy in the residential context (Alalouch et al., 2019).

Currently, there is growing interest among the research community regarding individuals' energy-saving behavior, especially in the context of developing countries (Hu et al., 2018; B. Wang et al., 2018). The extant empirical research devoted to individuals' energy-saving behavior has mainly emphasized such behavior in companies (Cai et al., 2019; Gao et al., 2017; König et al., 2020; Tang et al., 2019; Zhang et al., 2018a, 2018b), although some research has focused on households' energy-saving intentions (Ru et al., 2018; Vogiatzi et al., 2018; Wang et al., 2021a, 2021b). However, most studies, both in the workplace and at home, have evidenced that individuals are willing to save energy and reduce energy consumption. Personal factors, companies' policies, energy-saving awareness, personality factors, norms, and situational factors significantly affect energy-saving intention and behavior.

To the best of the authors' knowledge, few studies have empirically explored the factors influencing households' energy-saving intention and behavior in Pakistan and in the wake of the COVID-19 pandemic. During the COVID-19 pandemic, overall energy consumption decreased by 10–15%, but increased by over 40% in the residential sector in Pakistan (Aslam & Sheikh, 2020). This increase is due to several partial lockdowns at the national and provincial levels, leading to individuals in Pakistan and other developing countries (e.g., India) spending over 90% of their time at home. Due to the COVID-19 pandemic, the government provided subsidies to residential sectors, which are considered free goods, leading to more energy consumption than before. Therefore, households' energy-saving intention and behavior during the COVID-19 pandemic represent an important empirical and theoretical issue and a research gap requiring further research to provide a comprehensive understanding of what factors influence a household's energy-saving intention and behavior.

To investigate the factors influencing households to save energy, this study proposes a model grounded on the theory of planned behavior (TPB). TPB (and its extensions) is the most used theory in relation to individuals' energy-saving behavior (Wang et al., 2021a, 2021b), comprising three factors: attitude; subjective norms; and perceived behavior control. Previously, several scholars have employed TPB to investigate individual (i.e., household, employee, and consumer) pro-environmental behavior, such as green buying behavior (Amit Kumar, 2021), employees' energy-saving behavior (Tang et al., 2019), households' waste behavior (Wang et al., 2021a, 2021b), and other sustainable behaviors. Other authors have recently used TPB to investigate households' pro-environmental behavior in an energy-saving context (Wang et al., 2021a, 2021b; Xu et al., 2021). Therefore, this study also uses TPB as a fundamental model to understand households' intention to save energy. Apart from the three common factors (attitude, subjective norms, and perceived behavior control), this study extends the TPB framework by adding descriptive norms and moral responsibilities, exploring how these factors influence households' energy-saving intention. To the best of the authors' knowledge, very few studies have explored the intervening and causal mechanism using TPB in the context of households saving energy. The aim of this study is limited not only to exploring the effect of factors influencing households' energy-saving behavior, but also to empirically test the mediating role of intention to save energy between TPB factors and energy-saving behavior and how moral responsibilities moderate the relationship between perceived behavior control and households' energy-saving behavior.

This paper makes several contributions to the existing literature. First, it contributes to the direct and indirect effects of the determinants that influence households to save energy, which provides a holistic view of households' energy-saving behavior. Second, it explores the moderating effect of moral responsibility in the link between perceived behavior control and households' energy-saving behavior. Finally, the empirical results will enable creative advertising and effective policies that motivate households to save energy. Furthermore, this paper also benefits governments, environmental protection agencies, and nongovernmental organizations. The remainder of this paper is structured as follows. Section "Theoretical framework and hypothesis development" provides the theoretical background and develops the hypotheses. Section "Method" presents the research methodology, measures, and analytical approach used in the present study. Section "Data analysis" presents a detailed analysis of the results. Section "Discussion" provides a brief discussion, including the theoretical and practical implications of the study, as well as its limitations. Conclusions are provided in Section "Conclusion."

Theoretical framework and hypothesis development

Theoretical support and extension of the theory of planned behavior (TPB)

Regarding behavioral intention, Ajzen and Fishbein (1975) initially proposed the theory of reasoned action, which stated that an individual's intention is affected by attitude and subjective norms. Attitude towards a particular behavior represents the person's evaluation of behavioral beliefs and consequences. Subjective norms are related to motivation to comply with others' normative beliefs (i.e., individual motivation must be consistent with the opinion of others). Some recent studies have applied the theory of reasoned action model in relation to pro-environmental behavior, including understanding consumers' intention to adopt electric vehicles in Saudi Arabia (Alzahrani et al., 2019), understanding individuals' intention to conserve water (Untaru et al., 2016), and the green smartphone context (Liu & Tsaur, 2020). However, several authors have stated that the theory of reasoned action has several limitations, which may

lead to individuals' volitional behavior not being fully explained (Ajzen, 1985, 1991; Kippax, 1993). The aim of TPB is to address these limitations (Ajzen, 1985), using three main constructs (attitude toward behavior, subjective norms, and perceived behavior control) to determine behavioral intention and its impact on action.

Several studies have evidenced the significant direct effect of TPB factors on intention. Their results have evidenced the significant role that TPB factors play (Wang et al., 2014), leading to the argument that a households' intention is a key proxy for determining pro-environmental behavior in Pakistan (Ali et al., 2019). However, Liu et al. (2021) argued that the relationship between factors and behavioral intention still lacks theoretical coherence. Critics have stated that, under certain conditions, attitude has little (and weak) influence on individual intention (Chiou, 1998). However, Nie et al. (2019) found that subjective norms had the strongest influence on the intention to save energy, although other authors have observed a lesser effect (Gao et al., 2017; Liu et al., 2020a, 2020b, 2020c, 2020d). The effect of subjective norms could be reduced, or even disappear, with the addition of another construct, such as personal norms (Ru et al., 2018). This is also the case with perceived behavior control, which has been found to have an insignificant effect on consumers' recycling intention in developing countries (Khan et al., 2019).

Ajzen (1991) stated that there are two types of social norms (subjective and descriptive). In the context of TPB, social norms are usually considered subjective norms. However, the influence of subjective norms on a household's intention is relatively limited in the TPB context, therefore reducing the explanatory power of social norms (Liu et al., 2020a, 2020b, 2020c, 2020d; Zhang et al., 2014). Furthermore, criticisms have been leveled that TPB is a self-interest theory and that all three factors are rational (Bertoldo & Castro, 2016). In addition, Broman Toft et al. (2014) argued that pro-environmental behavior is not only affected by self-interest motivation but also by pro-social motivation. Furthermore, Schwartz (1977) argued that individuals behave in a "pro-social way" given the fact that they feel a moral responsibility to do so.

Similarly, Liu et al., (2020a, 2020b, 2020c, 2020d) and Wang and Wang (2016) stated that the prediction of environmental-based intention and behavior is

insufficient without moral obligation. Meta-analysis also evidenced that moral obligation, also called personal norms or personal responsibility, is a significant extending factor of the TPB model (Klöckner, 2013; Morren & Grinstein, 2021; Russell et al., 2021). It has been proposed that, in parallel with the original TPB factors (i.e., attitude, subjective norms, and perceived behavior control), the inclusion of moral responsibility and descriptive norms improves the explanatory power of energy-saving intention (Chen, 2020; Gao et al., 2017). For example, Liu et al., (2020a, 2020b, 2020c, 2020d) confirmed that the addition of moral norms increases the explanatory power of the original TPB model by 12%. Similarly, Knowles et al. (2012) evidenced that the addition of moral responsibility to the TPB model accounted for 5% of changes in intention. Gao et al. (2017) recently confirmed that the inclusion of moral norms and descriptive norms accounted for an increase of 12.3% of change in employees' energy-saving intention. Based on the above shortcomings and their importance, this study extends TPB by using two additional variables (descriptive norms and moral responsibility).

Hypothesis development

Energy-saving attitude and intention

According to certain definitions, attitude denotes behavior tendency and the evaluation of certain behaviors. It normally incorporates outcome evaluation and behavioral beliefs (Ajzen, 1991). Outcome evaluation refers to the assessment of output to a particular behavior, whereas behavioral beliefs refer to the subjective probability of performing a particular behavior (Ajzen, 1985). Attitude is one of TPB's key factors in relation to affecting a household's behavior intention (Wang et al., 2021a, 2021b). The more individuals that hold a positive attitude towards a behavior, the more likely it will be that individuals will intend to perform a behavior (Ru et al., 2018). Wang et al. (2014) evidenced the significant effects of environmental attitude on residents' energy-saving behavior. Furthermore, many studies have confirmed the significance of attitude in forecasting individual pro-environmental behavior in various contexts, including green smartphones (Liu & Tsaur, 2020), green product consumption (Paul et al., 2016), waste sorting (Wang et al., 2021a, 2021b), and employees' energy-saving behavior in companies (Gao et al.,

2017). In the context of households' energy-saving behavior, it can be argued that if households consider energy-saving behavior to be valuable, significant, and beneficial in reducing global warming and supporting sustainable development, they will hold a positive attitude and will be likely to act based on the intention to save energy. Therefore, we hypothesize:

> H1: Attitude towards saving energy has a positive and significant influence on a household's intention to save energy.

Subjective norms and intention to save energy

Subjective norms refer to "an individual's perceived social pressure from others who are important to him that he thinks he should or not follow to perform the behavior" (Gao et al., 2017). This affects an individual's decision-making and pro-environmental intention, and is TPB's second key element. Wang et al., (2021a, 2021b) evidenced that decisions made by households in sorting waste are based on considering the decisions of others (i.e., relatives, families, friends, and others). Similarly, other authors have evidenced that a household's energy-saving intention requires the approval of others who are important to them (Ali et al., 2019; Liu et al., 2021, 2020a, 2020b, 2020c, 2020d; Xu et al., 2021). Thus, we speculate that, if an individual realizes that most people (i.e. family members, friends, relatives, and others) think that she/he should save energy, she/he will feel pressure and will intend to save energy. Therefore, we hypothesize:

> H2: Subjective norms have a positive and significant influence on a household's intention to save energy.

Perceived behavior control and intention to save energy

Perceived behavior control refers to the individual's belief regarding the ability to control one's own behavior (Ajzen, 1985). In other words, it refers to the perceived ease or difficulty of performing a particular behavior (Gao et al., 2017). According to Ajzen (1985), perceived behavior control can be divided into control beliefs and self-efficacy, and it has a significant influence both on individuals' intention and behavior. Several studies have

noted that perceived behavior control affects both pro-environmental intention and behavior, including individuals' energy saving, green consumption, waste sorting, green purchasing, and households' energy saving (Gao et al., 2017; Ru et al., 2018; Wang et al., 2021a, 2021b; Zhang et al., 2014). The present study argues that various factors, e.g., time, opportunity, skills, and resources, may not be under the control of an individual and therefore affect their intention to perform a behavior. If households have a significant amount of control over themselves, they will exhibit a significant level of intention to save energy. In addition, if households feel comfortable regarding, and have substantial skills and knowledge in relation to, saving energy at home, they will be more likely to demonstrate the intention to save energy. Therefore, this study hypothesizes:

> H3(a): Perceived behavior control has a positive and significant influence on households' intention to save energy.
> H3(b): Perceived behavior control has a positive and significant influence on energy-saving behavior.

Descriptive norms and intention to save energy

According to Ajzen (1991), there are two types of social norms (subjective and descriptive). Subjective norms refer to an individual's perception of what others think she/he should do, whereas descriptive norms are related to what others do, which subsequently affect what the individual thinks she/he should do (Gao et al., 2017). According to self-categorization theory, individuals are more likely to categorize themselves as part of a particular group and perform actions that others have performed to follow the trend; otherwise, they risk being isolated and losing legitimacy (Bertoldo & Castro, 2016; Ru et al., 2018; Tang et al., 2019). In this context, it has been evidenced that the behavior of others has a significant influence on individuals' behavior. Gao et al. (2017) stated that individuals are more likely to imitate and follow actions that others have performed in relation to saving energy. In addition, pro-environmental behavior is more likely to occur if households believe that others in society regularly perform the same actions. Grounded on the same logic, it can be argued that, if other households are engaged in saving energy, others will also follow the trend and perform energy-saving behavior. Therefore, we hypothesize:

H4: Descriptive norms have a positive and significant influence on a household's intention to save energy.

Moral responsibility and energy-saving behavior

Moral responsibility is defined as an individual being concerned with the level of obligation/responsibility to behave immorally or morally when encountering ethical situations, which is better described through personal norms and often ascribed as responsibility (Kaiser & Shimoda, 1999). Several authors have stated that moral norms are significantly related to pro-environmental intention (Lu et al., 2020; Ru et al., 2018; Zhang et al., 2013), while others have observed that moral responsibility plays a key role in decision-making processes concerning environmental sustainability behavior (Chen, 2016; Ru et al., 2018; Wan & Shen, 2015). Chen (2016) discovered that people's moral obligations have the greatest effect on reducing carbon emissions and implementing energy-saving behavioral intentions. Similarly, Ru et al. (2018) stated that moral norms are an important factor in an individual's intention to save energy. Furthermore, Gao et al. (2017) extended the TPB framework to incorporate personal moral norms and descriptive norms, proposing an individual's morals as one of the critical factors for an individual's intention to save energy in companies. Regarding households' energy-saving behavior, it is estimated that individuals with strong moral norms will likely have more moral responsibility towards energy saving. Wasting energy will thus be contrary to personal obligations and norms, which can lead to a sense of discomfort or guilt. Therefore, it can be argued that households with high moral responsibility will be more likely to exhibit energy-saving behavior. Thus, we hypothesize:

> H5(a): Moral responsibility has a positive and significant influence on a household's intention to save energy.
> H5(b): Moral responsibility has a positive and significant influence on energy-saving behavior.

Intention to save energy and energy-saving behavior

Using the TPB model, many scholars have asserted that a particular pro-environmental behavior depends on behavioral intention. For instance, Si et al. (2020)

recently used partial least squares structural equation modeling (PLS-SEM) for 705 users' responses to understand Chinese participants' intention and behavior towards the sustainable use of bike-sharing. The authors evidenced the significant effect of sustainable usage intention on the behavior of users. Similarly, He et al. (2021) confirmed the importance of intention in green purchasing behavior in the context of new-energy vehicles. In the energy-saving context, Liao et al. (2020) illustrated that most Chinese residents have a sustainability-related intention to purchase energy-saving appliances to reduce energy consumption; this has also been evidenced in the context of waste sorting (Wang et al., 2020a, 2020b) and energy saving (Liu et al., 2021) in households. Thus, based on the above theoretical and empirical insights, we hypothesize:

H6: Households' intention to save energy has a significant influence on households' energy-saving behavior.

Mediating role of intention to save energy

Many scholars have empirically tested and confirmed the direct relationship between perceived behavior control and an individual's intention to save energy (Ali et al., 2019; Liu et al., 2021, 2020a, 2020b, 2020c, 2020d; Nie et al., 2019; Wang et al., 2021a, 2021b) and between an individual's intention and energy-saving behavior (Liu et al., 2021; Zhang et al., 2018a, 2018b). In this context, some studies have employed pro-environmental intention as a mediator; for example, Liu et al., (2020a, 2020b, 2020c, 2020d) studied a sample of 2824 participants from China and evidenced the full mediation of environmental behavior intention between environmental knowledge and pro-environmental behavior. Similarly, Rahman et al. (2020) analyzed a sample of 314 respondents from Bangladesh and found that green purchase intention mediated the relationship between perceived environment knowledge, peer influence, and perceived consumer effectiveness in the context of energy-saving lights. However, few authors have explored the mediating role of pro-environmental intention between individual or overall TPB factors (i.e., attitude, subjective norms, and perceived behavior control) and pro-environmental behavior. Notable exceptions include

Mafabi et al. (2017), who collected data from managers working at a hospital in Uganda and evidenced that behavioral intention mediates the relationship between overall TPB factors and knowledge sharing behavior, and Thorhauge et al. (2019), who also confirmed the full mediation of intention between TPB factors and pro-environmental behavior. These authors also called for further studies to explore the mediating role of intention in different pro-environment contexts. Thus, this study hypothesizes:

H7: Intention to save energy positively mediates the relationship between TPB factors (i.e., attitude, subjective norms, and perceived behavior control) and energy-saving behavior.

Moderating role of moral responsibility

Several prior studies have predicted the direct effect of moral norms/responsibility/obligation on the pro-environmental intention to save energy in different contexts, including the workplace, waste sorting, and recycling (Gao et al., 2017; Lu et al., 2020; Ru et al., 2018; Wang et al., 2021a, 2021b), calling for further studies to reveal the causal mechanism. Some studies have responded to this call; for example, Wang et al., (2021a, 2021b) examined the moderating role of moral responsibility in the context of waste sorting and found a moderating effect. Roh and Park (2019) also evidenced the moderating role of moral obligation in the context of online to offline services and suggested that individuals with high moral obligations are reluctant to transform their basic convenience-seeking tendencies into actual adoption intention relative to those with low moral obligations. Using the TPB model, Bang et al. (2014) also proved that moral obligation moderates the relationship between perceived behavior control and an individual's intention. Wang et al., (2021a, 2021b) empirically tested the moderating the role of knowledge, involvement, and moral obligation on the relationship between perceived behavior control and behavior for household waste sorting, calling for future studies to empirically test the moderating roles of constructs (i.e., knowledge, involvement, and moral obligation) in the household setting. Therefore, we speculate that the influence of an individual's perceived behavior control

on a household's energy-saving behavior may be improved by the household's moral responsibility in relation to energy-saving behavior. However, empirical studies on households' energy-saving behavior are limited, requiring further theoretical and empirical support. Thus, we hypothesize:

H8: Moral responsibility positively moderates the impact of perceived behavior control on a household's energy-saving behavior, such that perceived behavior control has a substantial influence on a household's energy-saving behavior in the presence of a high level of moral responsibility.

Figure 1 illustrates the proposed model and its hypothesized relationships (a dashed line represents a mediating relationship).

Method

Energy situation in Pakistan

The energy sector of Pakistan has faced several challenges since its establishment. Some of the challenges are related to the heavy reliance on natural gas and oil. The dependence on domestic energy sources, coupled with insufficient domestic energy production, the financial fragility of power companies, power

production capacity, and the low utilization of coal and hydrological resources, has led to severe energy shortages (Rehman et al., 2021). Approximately, 64%, 30%, and 6% of energy are generated through thermal system, hydroelectric system, and nuclear power, respectively (Chandio et al., 2019). Although Pakistan is the sixth most populous country in the world, one of the fastest-urbanizing South Asian nations, and a rapidly emerging economy, 25% and 50% of the population lack access to electricity and clean cooking facilities, respectively (Biresselioglu et al., 2019).

According to the Pakistan Economic Survey, households consume over 50% of energy, followed by industry (26%), agriculture (10%), and the commercial sector (8%) (GOP, 2018). According to 2021 figures, Pakistan has a population of 223 million (48.5% female; 51.5% male). A total of 37.3% are living in urban areas and 62.7% are in rural areas. The Pakistani government is trying to switch residential sector energy consumption from "dirty fuel-wood choices to clean energy," such as solar, natural gas, and electricity to reduce carbon emissions. Regarding environmental sustainability, the country has initiated many programs, for example the Clean Energy Pakistan movement, the Eco-system Restoration Initiative, the Ten Billion Trees Tsunami Program, the Carbon Market Initiative, the Forest Degradation Scheme, the Clean Green Cities Index, reduced emission from deforestation, and seasonal tree planting campaigns (Government of Pakistan, 2019).
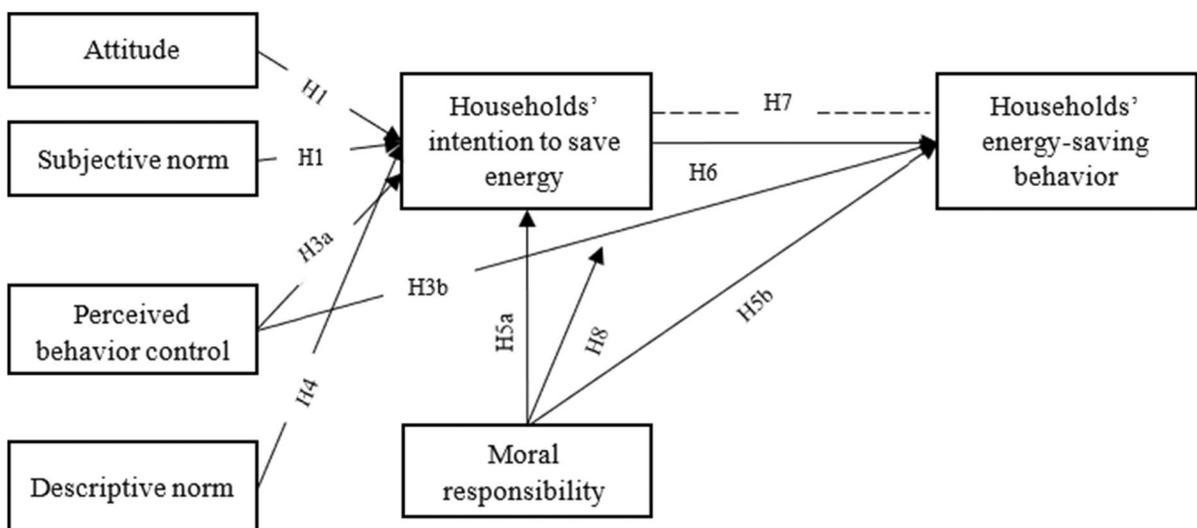

Fig. 1 Proposed framework

Population, sampling, and data collection

The results of the 2017 census stated that there are 31.9 million households in Pakistan, among which 19.83 and 12.07 million are in rural and urban areas, respectively (Pakistan Bureau of Statistics, 2022). The present study used a convenience random sampling approach. Specifically, due to the COVID-19 pandemic, this study administered a Web-based survey to collect data from households across the country, which is a widely employed data-collection strategy among the research community. Apart from the COVID-19 pandemic, there are several other benefits of using an online survey, including being an efficient way to reach a large audience, having low administration costs, having interactive features, facilitating quick response rates, ensuring the anonymity of participants, enabling easy follow-up and reminders to enhance the response rate, and reducing the time required to collect the required data. A survey was designed using Google Forms and a survey link was shared via social media platforms (i.e., Facebook, WhatsApp, etc.) and e-mail.

To avoid common method bias (CMB) issues, the authors included a restriction in the survey; respondents could only submit a single response, so that each respondent represents a single household. In addition, respondents were asked to provide the number of people in the household and to confirm that only a single respondent was responding for each household. The data collection was conducted for 1 month (from 10 January 2021 to 10 February 2021). We approached 800 households; after excluding incomplete responses, 556 responses were used for data analysis, representing a response rate of 69.5%.

Table 1 illustrates that, after 1 month, 556 respondents had responded (41.7% females; 58.3% male). In general, in studies conducted in Pakistan, females normally participate less relative to males (Ali et al., 2019). A total of 13 respondents (2.3%) were younger than 20 years, 205 (36.8%) were aged between 31 and 40 years, 36 (6.4%) were aged over 40 years, and the majority (302; 54.3%) were aged between 21 and 30 years. This age distribution is consistent with that of Irfan et al. (2021). Regarding education, 84 respondents (15.1%) were educated to an undergraduate level, 129 (23.2%) had a diploma or PhD level education, and nearly two-thirds (343; 61.69%) had a Master's degree, indicating that they have a rich educational background and understand the environment's positive and negative effects. This distribution is consistent with many prior studies in

Table 1 Sample demographics ($n = 556$)	Demographics		Frequency	Percentage
	Gender	Female	232	41.727
		Male	324	58.273
	Age (years)	<20	13	2.338
		21–30	302	54.316
		31–40	205	36.87
		>40	36	6.475
	Education level	Undergraduate	84	15.108
		Master's	343	61.690
		Other (diploma or PhD)	129	23.201
	Area	Rural	233	41.906
		Urban	323	58.093
	Ownership of house	Self-owned	424	76.259
		Rented	132	23.741
	Income (Pakistani rupees)	<50,000	337	60.611
		50,001–100,000	134	24.100
		>100,000	85	15.287
	Family members	<5	191	34.352
		5–10	237	42.626
		>10	128	23.021

which most respondents had Master's level education (Ali et al., 2019; Lee et al., 2021). Regarding the area, 323 (58%) lived in urban areas and 41.9% lived in rural areas. However, in general, the majority of the population is living in rural areas (Pakistan Bureau of Statistics, 2022), while, in our study, most of the participants were living in urban areas. This could be because only those having access to the internet participated and most households in rural areas lack access to the internet (Ali et al., 2021). Regarding home ownership, over three-quarters had their own home, while 23.7% lived in rented accommodation. Most respondents (c. 61%) had a monthly income of less than 50,000 Pakistani rupees, which indicates that they are in the early stage of employment. In general, however, people in Pakistan have an income greater than 50,000 Pakistani rupees. This discrepancy may be due to impact of COVID-19, with many individuals experiencing job loss or a decrease in their salaries (Nasar et al., 2021). Furthermore, the majority of respondents had five to 10 family members in the household. Among them, in general, women (especially housewives) spent more time in the house and performed daily routine activities (i.e., cooking, cleaning, washing, watching TV). However, due to COVID-19, some household members not usually in employment may have had a job, while household energy consumption may have been increased due to performing office work from home, and attending online classes, etc.

Measurements

This study administered an online survey incorporating three sections (general overview of the research, demographic questions, and questions regarding the variables). All the latent variables used in this study were adopted from existing studies and measured using a 5-point Likert scale (1 = strongly agree to 5 = strongly disagree). Three questions adopted from Wan et al. (2014) were used to measure the

household's attitude. Subjective norms were assessed using two items adopted from Nie et al. (2019). Perceived behavior control was assessed using three items adopted from Wan and Shen (2015). Descriptive norms were measured using three items adopted from Gao et al. (2017). Moral responsibility was assessed with four items adopted from Chen (2016). Households' intention to save energy was measured with four items adopted from Gao et al. (2017) and Neves and Oliveira (2021). Finally, households' energy-saving behavior was assessed using three items adopted from Y. Wang et al., (2021a, 2021b). Details regarding each construct's items are detailed later in Section "Assessment of the measurement model" (in Table 3).

We used the Kaiser–Meyer–Olkin (KMO) test to measure the sampling adequacy for each variable in the model and for the complete model. If Bartlett's test of sphericity's significance is less than 0.5, this means that the data has good construct validity, while if the KMO value is at least 0.50, the sample is adequate, with KMO values closer to 1 representing greater adequacy (Antony & Visweswara Rao, 2007). The results are shown in Table 2. The KMO values are greater than 0.7, and the F value of Bartlett's test of sphericity is equal to 0.000, which means that the sample data are adequate and have good construct validity, hence being suitable for analysis.

Common method bias (CMB)

This study used the full collinearity approach proposed by Hair et al. (2019) to ensure the data were free from CMB issues. The full collinearity test is a more comprehensive method for the simultaneous evaluation both of lateral (predictor–criterion collinearity) and vertical collinearity (predictor–predictor collinearity) (Kock & Lynn, 2012). Using the PLS-SEM approach proposed by Hair et al. (2019) led to using the variance inflation factor (VIF) for the full collinearity test. A VIF value ≥ 5 is indicative of collinearity issues among the variables. Ideally, it should be close to but less than 3.3 (Hair et al.,

Table 2 KMO and Bartlett's test

Kaiser–Meyer–Olkin measure of sampling adequacy		0.951
Bartlett's test of sphericity	Approx. chi-square	10,989.819
	df	231
	Sig	0.000

Table 3 Results of measurement model

Construct	Item code	Loading	CA	CR	AVE
Attitude (ATT)	*Household energy saving* ATT1: in my daily life is useful to protect the environment	0.947	0.942	0.963	0.896
	ATT2: is a wise action to reduce carbon emission	0.946			
	ATT3: is valuable to alleviate energy shortage issues	0.946			
Subjective norms (SN)	SN1: My families think that I should save energy at home	0.951	0.893	0.949	0.903
	SN2: People whose opinions I value would prefer my energy-saving behaviors at home	0.95			
Perceived behavior control (PBC)	PBC1: I am confident that I have the knowledge and time for household energy-saving behavior	0.943	0.93	0.955	0.877
	PBC2: It is difficult for me to perform household energy-saving behavior	0.932			
	PBC3: It is completely up to me whether I save energy at home	0.935			
Descriptive norms (DN)	DN1: My parents have taken actions to save energy in our home	0.912	0.893	0.933	0.823
	DN2: My families have participated in energy saving behavior	0.904			
	DN3: Others who are important to me have participated in energy saving behavior	0.906			
Moral responsibility (MR)	MR1: I would feel guilty about not saving energy at home	0.835	0.871	0.912	0.721
	MR2: It is my moral obligation to save energy at home	0.828			
	MR3: It is my moral obligation to close electrical appliance not in use for saving energy	0.874			
	MR4: It is my moral obligation to perform energy-saving behavior at home	0.857			
Intention to save energy (ITSE)	ITSE1: I am willing to engage in energy-saving behaviors at home	0.907	0.926	0.947	0.817
	ITSE2: I am willing to follow the suggestions and rules of the community energy- saving scheme	0.91			
	ITSE3: I intend to make an effort to save energy at home	0.893			
	ITSE4: I intend to change my habits and activities to save energy	0.906			
Energy-saving behavior (ESB)	ESB1: I often participate in household energy saving related activities	0.893	0.86	0.915	0.781
	ESB2: I often closed lights in daytime and when there is of no use in night	0.891			
	ESB3: I often recommend others to save energy	0.868			

2019). In the present study, all of the constructs' VIF values were < 3.3, i.e., well within the acceptable threshold (Hair et al., 2019) (see Section "Assessment of the structural model," Table 6). Thus, we can conclude that the data are free from collinearity issues and that CMB is not a problem in the proposed model.

Data analysis

The present study used the Statistical Package for Social Science (SPSS) software package for the descriptive statistics and PLS-SEM techniques using SmartPLS 3.3

to test the relationships. PLS-SEM is usually employed when the model is complex and includes dense relationships, encompassing direct, indirect, or intervening and causal mechanisms (i.e., mediation and moderation). In addition, PLS-SEM is widely accepted across the social sciences discipline (e.g., hospitality management, strategic management, international business research, accounting management, marketing management, human resource management, and pro-environmental behavior studies) (Hair et al., 2019; Qalati et al., 2021; Tang et al., 2019). Furthermore, Dash and Paul (2021) recently compared covariance-based structural equation modeling (CB-SEM) and PLS-SEM, identifying

two major differences: PLS-SEM can be used for both explanation and prediction, whereas CB-SEM is limited to explanation; and PLS-SEM specifies both formative and reflective measurement models, whereas CB-SEM is limited to reflective models only. These authors also argued that PLS-SEM techniques are popular among the research community because of their variance-based relationship, as opposed to covariance-based. Therefore, we used the PLS-SEM approach to run the analysis and test the hypothesized relationships.

Assessment of the measurement model

The measurement model was assessed using internal consistency, reliability, and convergent and discriminant validity tests. Cronbach's alpha (CA) and composite reliability (CR) illustrate the internal consistency and reliability of the items. The constructs' values, both for CA and CR, should be > 0.70 (Hair et al., 2019). In the present study, the CA values were between 0.871 and 0.942, and the CR values were between 0.912 and 0.963, i.e., within the acceptable threshold. Convergent validity is used to assess the correlation between distinct items within the same category. For this, two values are commonly used: the factor loading of the items; and the average variance extracted (AVE). Factor loading reveals the correlation coefficient among the latent and observed constructs; the factor loading value for each construct item should be > 0.70 (Hair et al., 2019), and all values in the present study were within the acceptable threshold (see Table 3). On the other hand, to establish that the items of the same construct have an adequate correlation, the AVE values should be > 0.5 (Hair et al., 2019); in this present study, the AVE values were between 0.721 and 0.903 (see Table 3).

The discriminant validity test aims to test whether a particular construct is different from others. According to Neves and Oliveira (2021), there are two ways to analyze discriminant validity. First, Fornell and Larcker (1981) specified that the square root of the AVE of each variable must be greater than the correlation between them (see Table 4). Second, the heterotrait-monotrait (HTMT) ratio of a construct must be less than 0.9 (Hair et al., 2019) (see Table 5). In both cases, the values were within the acceptable thresholds.

This study's descriptive statistics results for the seven constructs are shown in Table 4, encompassing the mean, standard deviation (SD), minimum value, maximum value, kurtosis, and skewness. According to Abd Razak et al. (2016), statistical analysis on kurtosis and skewness presents the verification of the normality of the data. Bryman (2012) argued that skewness values between -2 and $+2$ and kurtosis values between -7 and $+7$ are considered normal. This study's skewness and kurtosis values follow the normal distribution.

Assessment of the structural model

Hair et al. (2019) proposed that the assessment of the structural model should be performed using three measures: assessment of the coefficient of determination (R^2) values (using PLS algorithm techniques); assessment of predictive relevance (Q^2) (using blindfolding techniques); and hypothesis testing (using the bootstrapping technique). The R^2 value assesses the model's explanatory power (Hair et al., 2019). The R^2 values obtained for the structural model reveal that the factors (attitude, subjective norms, perceived behavior control, descriptive norms, and moral responsibility) explain 70.5% variance in households' intention to save energy (see Table 6). In addition, perceived behavior control, moral responsibility, and households' intention to save energy explain 63.1% of variance in households' energy-saving behavior. R^2 values of 0.60, 0.33, and 0.19 are considered substantial, moderate, and weak, respectively; however, an R^2 value of 0.10 is also acceptable and satisfactory in some disciplines (Raithel et al., 2012). In the present study, the R^2 values were substantial as they were found to be > 0.60.

Q^2 is the second measure used to assess the models' predictive accuracy (Stone, 1974). This measure not only assesses the out-of-sample prediction but also combines both out-of-sample and in-sample explanatory power. Hair et al. (2019) suggested that Q^2 values should be > 0 for a specific endogenous variable to determine the predictive accuracy of the structural model for that variable. Q^2 values of 0.50, 0.25, and > 0 are considered to have large, medium, and small predictive relevance, respectively. The outcomes of the present study revealed the model to be satisfactory (for households' intention to save energy) and medium (for households' energy-saving behavior) (see Table 6). Regarding the assessment of the model fit, Hair et al. (2019) proposed that the value for the standardized root mean square residual

Table 4 Descriptive statistics and discriminant validity (Fornell–Larcker criterion)

Construct	Mean	SD	Min	Max	Kurtosis	Skewness	ATT	ESB	DN	ITSE	MR	PBC	SN
Attitude (ATT)	3.725	1.254	1	5	−0.368	−0.825	**0.946**						
Energy-saving behavior (ESB)	3.639	1.023	1	5	0.135	−0.723	0.655	**0.884**					
Descriptive norms (DN)	3.46	1.171	1	5	−0.635	−0.494	0.498	0.566	**0.907**				
Intention to save energy (ITSE)	3.72	1.152	1	5	−0.604	−0.665	0.681	0.739	0.715	**0.904**			
Moral responsibility (MR)	3.83	1.078	1	5	0.225	−0.896	0.521	0.601	0.376	0.503	**0.849**		
Perceived behavior control (PBC)	3.62	3.727	1	5	−0.523	−0.707	0.764	0.642	0.536	0.725	0.537	**0.937**	
Subjective norms (SN)	3.70	1.165	1	5	−0.361	−0.718	0.728	0.606	0.538	0.683	0.447	0.738	**0.95**

(SRMR) should be less than 0.08. In the present study, the SRMR value was 0.034, which is far below the acceptable threshold of 0.08 (see Table 6). The hypothesis testing was a third means to assess the structural model. The bootstrapping technique was employed with 5000 resamples to obtain the correlations between the latent constructs (see Fig. 2).

Mediation analysis was also performed using the bootstrapping technique, which produced results for the total, direct, and indirect effects. There are two ways to assess mediation: the effect sizes (f^2); and the variance accounted for (VAF) (Hair et al., 2019). Notably, using PLS-SEM, several studies have suggested the VAF approach for the mediation analysis (Carrión et al., 2017; Nitzl et al., 2016; Rasoolimanesh et al., 2021). The VAF values for the present study are as follows:

$$VAF_{ATT} = \frac{\text{Indirect effect}}{\text{Total effect}} = \frac{0.059}{0.238} = 0.248 = 24.8\%$$

$$VAF_{SN} = \frac{\text{Indirect effect}}{\text{Total effect}} = \frac{0.057}{0.083} = 0.686 = 68.6\%$$

$$VAF_{PBC} = \frac{\text{Indirect effect}}{\text{Total effect}} = \frac{0.106}{0.146} = 0.7260 = 72.6\%$$

As guidelines, values of <20, 20–80, and >80% reflect no, partial, and full mediation, respectively (Hair et al., 2019; Qalati et al., 2021). In the present research, the VAF values for attitude and subjective norms were 24.8% and 68.6%, respectively, demonstrating partial mediation. For perceived behavior control, the VAF was 72.6%, demonstrating full mediation.

Regarding the moderation effect, this study evidenced that moral responsibility positively moderates the perceived-behavior-control–households'-energy-saving-behavior relationship. These findings infer that when a household's moral responsibility is higher, perceived behavior control and households' energy-saving behavior have a more positive relationship, relative to households with lower moral responsibility (see Fig. 3).

Discussion

Table 6 and Fig. 2 illustrate the structural modeling results, revealing that all the hypotheses were supported (p-value<0.05, t-value>1.96). This study evidenced that, in terms of R^2, the difference in the explanatory power

Table 5 Discriminant validity (HTMT ratio)

Construct	ATT	ESB	DN	ITSE	MR	PBC	SN
Attitude (ATT)							
Energy-saving behavior (ESB)	0.727						
Descriptive norms (DN)	0.544	0.645					
Intention to save energy (ITSE)	0.729	0.828	0.786				
Moral responsibility (MR)	0.574	0.694	0.425	0.56			
Perceived behavior control (PBC)	0.816	0.717	0.588	0.781	0.595		
Subjective norms (SN)	0.793	0.691	0.603	0.751	0.506	0.81	

Table 6 Results of the structural model, common method bias, and model fit

Hypothesis	Relationship	Path coefficient	SD	t-value	p-value	Decision	f^2	VIF
Total effect								
	ATT→ESB	0.238	0.054	4.372	0.000	Supported		
	SN→ESB	0.083	0.051	3.781	0.001	Supported		
	PBC→ESB	0.146	0.052	2.816	0.005	Supported		
Direct effect								
H1	ATT→ITSE	0.143	0.051	2.804*	0.003	Supported	0.024	2.904
H2	SN→ITSE	0.138	0.046	3.000*	0.002	Supported	0.023	2.675
H3(a)	PBC→ITSE	0.257	0.052	4.968*	0.000	Supported	0.072	3.121
H3(b)	PBC→ESB	0.149	0.054	2.761*	0.003	Supported	0.025	2.402
H4	DN→ITSE	0.403	0.043	9.423*	0.000	Supported	0.362	1.518
H5(a)	MR→ITSE	0.078	0.033	2.335*	0.021	Supported	0.029	1.479
H5(b)	MR→ESB	0.328	0.040	8.226*	0.000	Supported	0.165	1.770
H6	ITSE→ESB	0.502	0.045	11.215*	0.000	Supported	0.310	2.205
Indirect effect								
H7	ATT→ITSE→ESB	0.059	0.022	2.691*	0.007	Supported		
	SN→ITSE→ESB	0.057	0.019	3.014	0.003	Supported		
	PBC→ITSE→ESB	0.106	0.026	4.140*	0.000	Supported		
Moderation effect								
H8	PBC×MR→ESB	0.094	0.035	2.684*	0.008	Supported	0.021	1.506

Critical values. *t-value > 1.96 ($p < 0.05$)

TPM model (attitude, subjective norms, and perceived behavior control) $R^2 = 0.589$

Extended TPB model (attitude, subjective norms, perceived behavior control, descriptive norms, and moral responsibility) $R^2 = 0.705$

R^2 (ESB) = 0.631

Q^2 (ITSE) = 0.541; and Q^2 (ESB) = 0.464

Goodness of fit indices: SRMR = 0.034

between the TPB model ($R^2 = 58.9\%$) and the extended model ($R^2 = 70.5\%$) is higher than 11.6%. This finding is consistent with previous results of Chen (2016), who stated that the inclusion of moral obligation increased the proportion of explained variation of intention to save energy by 1–9%. This R^2 difference reflects that the extended model is more appropriate to explain households' intention to save energy and engage in energy-saving behavior.

The present study evidenced a positive and significant effect of TPB factors, namely attitude ($\beta = 0.143$, $p = 0.003$), subjective norms ($\beta = 0.138$, $p = 0.002$), and perceived behavior control ($\beta = 0.257$, $p = 0.000$) on household's intention to save energy; therefore, *H1*, *H2*, and *H3(a)* are supported. These findings imply that households with strong positive attitudes, social pressure, and perceived behavior control have more
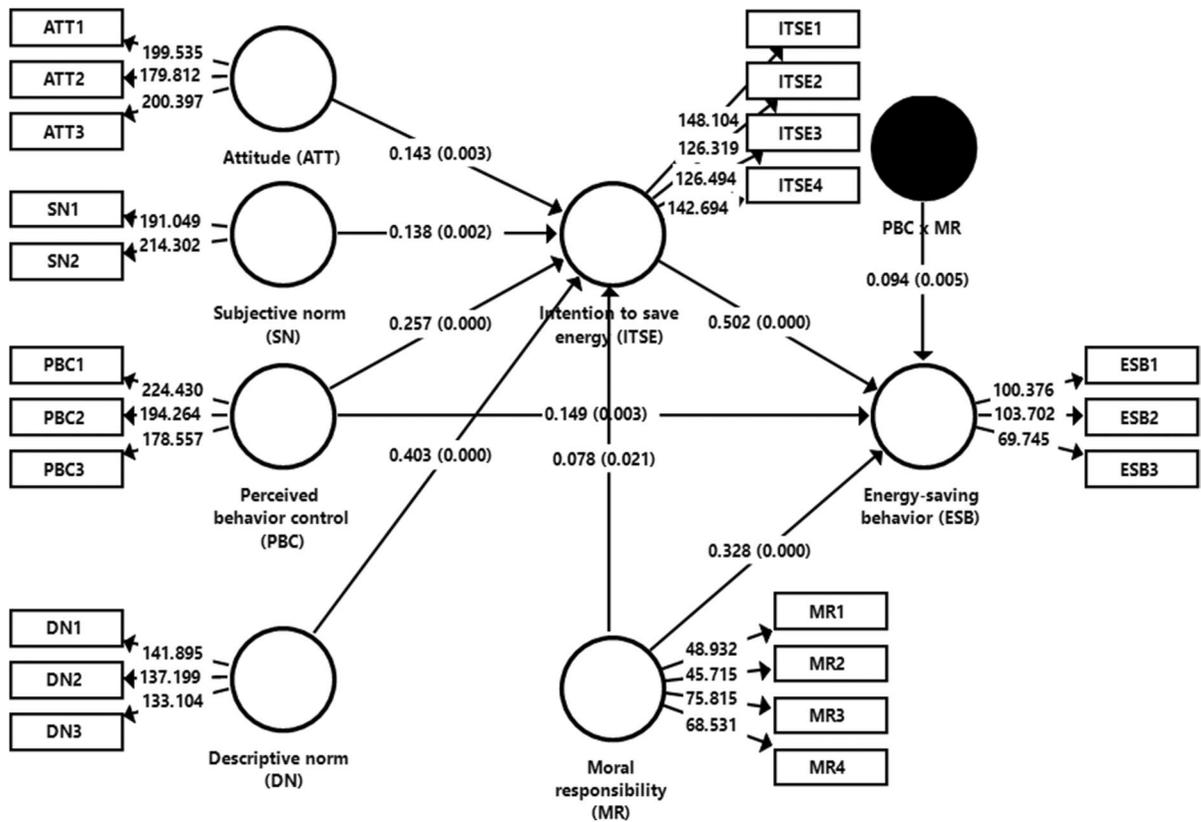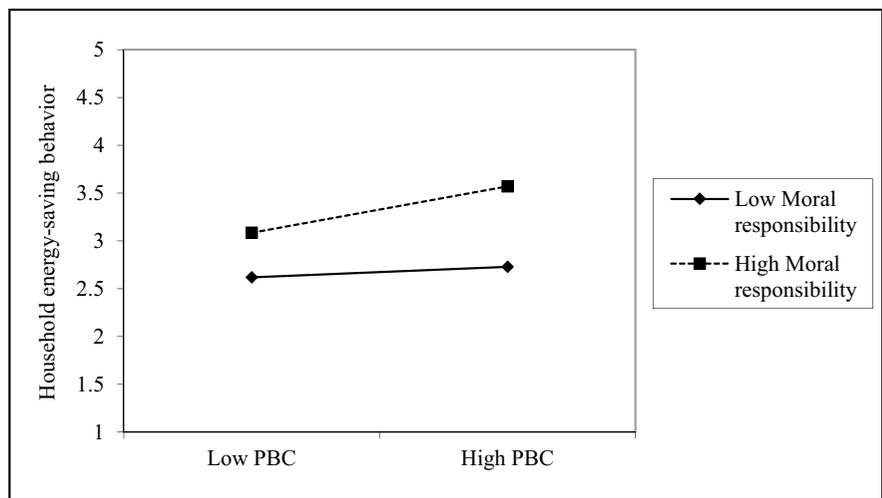
Fig. 2 Structural equation modeling

Fig. 3 Moderating effect of moral responsibility on the relationship between perceived behavior control and households' energy-saving behavior

intention to save energy. *H3(b)* was also supported as perceived behavior control was found to have a significant influence on energy-saving behavior ($\beta = 0.149$, $p = 0.003$). These results are in line with previous work (Gao et al., 2017; Liu & Tsaur, 2020; Ru et al., 2018; Wang et al., 2014, 2020a, 2020b, 2021a, b) that has also evidenced the significant effect of TPB factors on pro-environmental intention and behavior.

Furthermore, we found a significant effect of the extended factor of descriptive norms ($\beta=0.403$, $p=0.000$) on the intention to save energy; thus, *H4* is supported. This study's results evidenced that descriptive norms have the strongest impact on households' energy-saving intentions. This may be because households are more likely to classify themselves to a particular group and replicate the behavior that others in the family have performed to avoid being isolated from other households. In addition, another reason could be that most employees in companies adopt a wait-and-see approach, following others rather than acting first. When someone else performs that behavior first, they then replicate it. Therefore, in the household setting, if parents or educated family member have taken action to save energy, other members will also perform energy-saving behavior. This result also confirms previous findings for descriptive norms affecting pro-environmental behavior (Gao et al., 2017).

In addition, we confirmed a significant effect of another extended factor, i.e., moral responsibility ($\beta=0.078$, $p=0.021$), on households' intention to save energy and engage in energy-saving behavior ($\beta=0.328$, $p=0.000$); therefore, *H5(a)* and *H5(b)* are supported. These results suggest that a single unit change in moral responsibility leads to 7.8% and 32.8% of changes in intention to save energy and energy-saving behavior, respectively. This result implies that when a household has moral responsibility to reduce its effect on climate change and global warning, it is significantly more likely to have an intention to save energy and engage in energy-saving behavior. These findings are consistent with prior work (Chen, 2016; Gao et al., 2017; Ru et al., 2018; Wan et al., 2014) that has highlighted the importance of moral responsibility, evidenced its significant effect, and called for further studies.

In addition, the present study evidenced the significant effect of intention to save energy on energy-saving behavior ($\beta=0.502$, $p=0.000$); thus, *H6* is supported. This outcome suggests that intention to save energy, individually, is responsible for over 50% of variance. This result implies that households intending to change their habits participate in energy-saving activities, as well as suggesting that others should perform energy-saving behavior. This finding is in line with previous studies (He et al., 2021; Liao et al., 2020; Liu et al., 2021; Wang et al., 2020a, 2020b) that have confirmed the influencing role of pro-environmental intention on behavior.

Table 6 shows that households' intention to save energy positively and significantly mediates the relationship between TPB factors and energy-saving behavior;

thus, *H7* is accepted. This result suggests that TPB factors influence households' intention to save energy, which in turn improves energy-saving behavior. This finding supports previous work (Mafabi et al., 2017; Thorhauge et al., 2019) showing that pro-environmental intentions can mediate these relationships. The present study also evidenced the positive and significant moderating role of moral responsibility on the relationship between perceived behavior control and energy-saving behavior ($\beta=0.094$, $p=0.005$); thus, *H8* is supported. This result suggests that it is important for policy-makers to improve households' moral responsibility in relation to saving energy when they advertise energy-saving products. This finding is consistent with the recent work of Wang et al., (2021a, 2021b). The present study's model explains 70.5% of variation in household's intention and 63.1% in energy-saving behavior.

Theoretical implications

This study has several theoretical implications. First, many studies have extended the TPB framework in the context of pro-environmental behavior (e.g., bike-sharing, waste sorting, energy-saving appliances, and individuals' intentions in the workplace) using several factors, such as personality (Big Five traits), demographic characteristics (e.g. age, gender, education level), and personal norms (Gao et al., 2017; Liao et al., 2020; Si et al., 2020; Wang et al., 2021a, 2021b). However, there is limited literature regarding the relationship between households' intention to save energy and energy-saving behavior (Wang et al., 2021a, 2021b). Our research is the first study to extend the TPB model by adding two factors (descriptive norms and moral responsibility) in the context of households' intention to save energy during the COVID-19 pandemic.

Second, there have been calls for further research concerning how households' intention can lead to actual energy-saving behavior (Gao et al., 2017). The present empirical study was thus conducted to provide a more comprehensive understanding of the factors influencing not only intention but also actual behavior in relation to saving energy. Our research evidences that, among the five factors of the extended TPB model (i.e., attitude, subjective norms, perceived behavior control, descriptive norms, and moral responsibility), descriptive norms have a strong influence on households' intention to

save energy. Among three factors of the TPB model (i.e., perceived behavior control, intention to save-energy, and moral responsibility), households' intention to save-energy has the strongest influence on households' energy-saving behavior.

Finally, this study contributes by furthering understanding of the mediating role of a household's intention to save energy, as well as the moderating role of moral responsibility. These findings imply that TPB factors, and the extended factors used in the study, are enough to improve a household's intention and behavior in relation to saving energy. The present research results confirm that intention to save energy both has direct and indirect effects on energy-saving behavior. In addition, moral responsibility significantly moderates the link between perceived behavior control and actual energy-saving behavior.

Practical implications

This study also offers several implications for policy-makers and governmental and environmental agencies to encourage households to reduce energy consumption. First, considering the significance of TPB factors (attitude, subjective norms, and perceived behavior control) and its extended factors (descriptive norms and moral responsibility), several public advertisements, campaigns, and messages must be launched, both in cities and rural areas, to protect the environment and reduce energy consumption during and after the COVID-19 pandemic. These measures can make households realize the significance of saving energy, improve awareness, and strengthen positive attitudes to saving energy and moral responsibility for protecting the environment by reducing energy consumption. Furthermore, these measures can help households to save energy not only at home, but also in the workplace, at college, and while at university, by making them realize that they have the responsibility, ability, and obligation to save energy, reduce energy consumption, and protect the environment.

Second, since this study has evidenced the significant effect of descriptive norms on households' intention to save energy, role models, both within families and among managers in companies, must come forward and exhibit energy-saving behavior. Finally, since moral responsibility positively and significantly moderates the relationship between perceived behavior control and energy-saving behavior, environment caretakers (i.e., policy-makers and government and

non-government agencies) need to add content relevant to moral responsibility in their promotional campaigns as this will lead to the effective promotion of energy-saving behavior.

Limitations

Although this study utilized and extended the TPB model, there are some of limitations, all of which suggest future research opportunities. First, this research explored households' intention and behavior in relation to saving energy during the COVID-19 pandemic, which may be considered one of the limitations of the study. Second, data being collected using an online survey due to the COVID-19 pandemic may be considered another limitation of the study. This led to those without internet access (especially the rural population) not being included, as well as to most respondents having a high level of education (most of participants held a Masters' degree). Third, this study was conducted in a single developing country. Since each country has different levels of education and internet access, as well as different cultures, this restricts the generalizability of the research findings to other developing countries (Al Mamun et al., 2018). Fourth, this research tested only the indirect effect of three factors (perceived behavior control, intention to save energy, and moral responsibility) on households' energy-saving behavior; descriptive norms and moral responsibility may also have an indirect effect on households' energy-saving behavior. Fifth, the present study tested the mediating role of intention to save energy only between the TPB model and energy-saving behavior. Finally, this study tested the moderating role of moral responsibility on the link between perceived behavior control and energy-saving behavior. However, it may also play a moderating role between TPB, the extended factors, and intention to save energy.

Future research directions

Since the pandemic has affected almost all industries, future studies could explore individuals' intention and energy-saving behavior in different sectors, including education, manufacturing, telecommunication, etc. In addition, future studies could perform a comparative analysis of individuals' intention and energy-saving behavior, considering the pre- vs post-pandemic period, as well as rural vs urban life. Second, future research should collect data from different developing countries to

conduct comparative studies as the culture, educational level, and other socio-economics factors vary. Third, future studies should test the mediating role of intention to save energy between all of the proposed independent and dependent variables (household energy-saving behavior). Finally, the mediating and moderating role of intention and moral responsibility can be tested in the context of different pro-environmental behavior, including recycling, waste sorting, and consumption.

Conclusion

Increasing households' energy-saving intention is beneficial in relation to environmental sustainability. However, extant studies on individuals' intention to save energy have mainly focused on companies or were conducted before the COVID-19 pandemic, and little research has focused on households' intention to save energy in the context of developing countries, especially in Pakistan and India, which are among the countries most severely affected by the COVID-19 pandemic. This study is one of the first attempts, in several respects, to examine this phenomenon in the context of Pakistan, or any developing country, following the COVID-19 pandemic. In the present study, we constructed an extended TPB model to explore the factors influencing households' intention and behavior in relation to saving energy. This research analyzed 556 households in Pakistan using the PLS-SEM technique. The research findings have evidenced the importance and usefulness of descriptive norms and moral responsibility, thus successfully extending the TPB model in relation to households' intention to save energy. Moreover, the findings of the present study reflect that several factors (attitude, subjective norms, perceived behavior control, descriptive norms, and moral responsibility) have a positive and significant influence on households' intention to save energy. Furthermore, perceived behavior control, moral responsibility, and households' intention to save energy significantly affect households' energy-saving behavior. Apart from the direct effect, households' intention to save energy partially mediates the relationship between attitude and subjective norms and households' energy-saving behavior, and fully mediates the relationship between perceived behavior control and household energy-saving behavior. In addition, moral responsibility significantly moderates the relationship between perceived behavior control and households' energy-saving behavior. Thus, we can conclude that moral responsibility plays a key role in households' energy-saving behavior.

Declarations

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