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# Assessing public perception and willingness to pay for renewable energy in Pakistan through the theory of planned behavior

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With growing urbanization and increasing world population, energy demand also increases. A significant portion of the world's energy comes from fossil fuels, and these sources of energy are declining rapidly at the current consumption rate. There are also growing environmental concerns on the use of fossil fuels increasing greenhouse gas emissions. In this regard, renewable energy (RE) shows promising solutions which are both sustainable and environmentally friendly. Developed countries and leading organizations are investing heavily in the RE sector. However, the developing world has anxieties over social acceptability and people's willingness to pay for renewable energy. This study is conducted in Pakistan to understand the public perception and willingness to pay. The Theory of Planned Behavior (TPB) was utilized with background factors such as awareness, perceived advantages, perceived challenges, and moral obligations to examine its influence on people's willingness to pay. In addition to this, the study also assessed the indirect effects of background factors (awareness, perceived advantages, and perceived challenges) on willingness to pay through public attitude. Furthermore, the indirect relationship between background factors (awareness and moral obligation) and willingness to pay through subjective norms was also examined. A total of 512 samples were gathered from participants and were analyzed through partial least square–structural equation modeling (PLS-SEM) and SPSS. The study findings are very interesting and back up our hypotheses that the background factors (awareness, perceived advantages, and perceived challenges) are positively associated with public attitude and have an indirect effect on willingness to pay through public attitude. Similarly, variables such as awareness and moral obligation are negatively and positively associated with subjective norms, respectively. However, the variables, awareness and moral obligation, have no indirect relationship with willingness to pay through subjective norms. Additionally, the study reveals that the components (attitude and perceived behavior control) of TPB have a significantly positive effect on willingness to

pay. The study also concludes that the participants having formal education and knowledge about climate change and renewable energy are inclined toward green energy and are willing to pay, and they are hardly influenced by others' opinions. Furthermore, the study also provides insights for policymakers, suggestions, and recommendations for the future.

#### KEYWORDS

renewable energy, public perception, willingness to pay, theory of planned behavior, PLS-SEM

## 1 Introduction

Environmental quality and accessibility to natural resources have a direct impact on life. The fundamental requirement for sustaining life is to maintain the ecosystem in equilibrium. The Earth's atmosphere is a very precious resource, but it is fragile too and has to be protected. Contrarily, the unwanted influxes into the environment by human activities can disturb this equilibrium and also have negative effects on lives (Mariani et al., 2010). Human interventions intensify day by day due to large-scale manufacturing, agriculture, and urbanization, which lead to more demands for fossil fuels and a high consumption of transportation and energy (Van Gent and Rietveld, 1993; Lam et al., 2011; Ockenden et al., 2014). As reported by the International Energy Agency (IEA), the world's primary energy consumption has increased 2.5 times from 1971–2014, from 5.5 GTOE to 13.7 GTOE (International Energy Agency I, 2017). A 150% increase in the total primary consumption. Similarly, during the same time, CO<sub>2</sub> emission has also increased twofold (Bell et al., 2011).

Climate change poses very serious threats, such as environmental, social, and economic threats. Global warming is directly linked to increases in carbon emissions associated with human intervention. During the past century, CO<sub>2</sub> emission has increased significantly in comparison to the pre-industrial level (Canadell et al., 2007). One of the major contributors of CO<sub>2</sub> emission is fossil fuels. Burning fossil fuels around the world adds  $5 \times 10^9$  tons of CO<sub>2</sub> to the atmosphere annually, a significant portion of which remains in the atmosphere (Dyson, 1977). Similarly, the continuous increase in population, urbanization, growing energy consumption, and economic activities are also among the major contributors to global warming. Recent studies have shown that the world average temperature is in excess of 2°C (IPCC, 2014). Although it has been consented in the Paris Agreement that the world's major countries would keep the world's average temperature below 1.5°C by 2050 (Bach, 1979), it is estimated that the average global temperature may exceed 3°C by 2050.

The growing energy demands are increasing the burden on the environment, thus attracting the attention of academia and researchers in the field of energy management and RE. In the developed countries, a significant transition has occurred toward green energy due to their commitment to the Kyoto Protocol and Paris Agreement, as a result of public access to information relevant to the environment and RE (Vasseur and Kemp, 2015; The Paris Agreement, 2018). In order to meet the goals of the Paris Agreement of limiting the average temperature increase to 1.5°C, large-scale RE adoption is required. In recent years, green investment in RE has

greatly increased to achieve sustainable growth. However, most developing countries still use fossil fuels for energy generation. Fossil fuels can no longer be used as the primary energy source due to their high price and potential environmental threat. Fossil fuels' unsustainability and potential environmental threat led governments and policymakers to shift to green energy and minimize fossil fuel usage. However, the investment ratio is meager due to their poor infrastructure, poor economies, and related social and cultural issues.

The social acceptability of green energy (renewable energy sources and renewable energy technologies) is to monitor at both the national and international levels. It has also been observed that public attitude varies not only between countries but also between different regions within the same country (Eiser et al., 2010; Walter, 2014; Gallup, 2015). Active ecological awareness has been observed in South Korea, where the majority of South Koreans support policies that promote renewable energy sources (most of them are state owned) (Mroczek and Donata, 2014). The US government is also motivating and encouraging US citizens to use renewable energy resources such as solar energy systems by giving them incentives (Kowalczyk-Juśko and Bogdan, 2015). Similarly, Portugal has a favorable attitude toward investing in renewable energy sources, especially hydropower and solar energy (Dmochowska-Dudek and Bednarek-Szczepańska, 2018). Germany, Italy, the United States, China, Japan, Spain, France, Bulgaria, Australia, and the Czech Republic are countries with the most installed photovoltaic-rated power. Most of these countries' energy policies are on generated kilowatt-hour, low-interest loans, national renewable energy sources, solar development goals, and lower taxations, which attract the masses toward RE (Borges Neto et al., 2010). The local authorities and volunteers have played a very important role and made advancements in technology and large-scale applicability of photovoltaics (Bajpai and Vaishalee, 2012).

Contrarily, the major impediments to the wider adoption of renewable energy sources and renewable energy technologies, except costly infrastructure, are of not sharing relevant information with the public and the behavior of the public against advancements in renewable energy sources and renewable energy technologies (Kaya et al., 2019), where the latter has been more pronounced and observed in developing countries, while the former is in the context of people living in the rural, suburban, and urban regions of China. (Rahman et al., 2014). Another study was conducted in Malaysia (Muhammad-Sukki et al., 2011) about the public views and perceptions on solar energy and photovoltaic installation, which concluded that Malaysians have been very hesitant to invest in photovoltaics since they hardly comprehend the incentives and

significant socioeconomic benefits. Furthermore, there has been social opposition to renewable energy sources and renewable energy technologies in the Middle East and North Africa (Florkowski et al., 2018). A study on the societal acceptance of small hydropower plants (SHPs) in India has found that these projects are difficult to implement in certain regions (Florkowski et al., 2018).

Apart from the social acceptance of, behavior toward, and perception of renewable energy sources and renewable energy technologies, studies have also focused on the economics aspect where the public readiness to pay for expensive renewable energy in their locality and the place of residency, also known as the “willingness to pay” (WTP), was studied (Klepacka et al., 2018). WTP was further investigated by arranged discussions with the public through a questionnaire to record their preferences (Devine-Wright, 2008). A positive relationship has always been noted among WTP, income, and the level of public information (Ekins, 2004; Wüstenhagen et al., 2007). A study on attitude toward renewable energy sources and renewable energy technologies has observed that tourists from Australia are willing to pay more (about 1%–5%) for existing renewable energy sources and renewable energy technologies in accommodation sites (Miranda et al., 2011). In the case of Sweden, it has been reported that renewable energy source acceptance increases with the level of environmental awareness (Wooldridge, 2015). A Chinese study had examined that household income, knowledge about RE, renewable energy technologies (RET), and education were positively associated with WTP, whereas variables like age and neighborhood were negatively associated with WTP (Eurobarometer, 2014).

Pakistan is a developing country, the fifth most populous country with a population of 224.78 million (Pakistan Economic Survey, 2022). Like other developing countries, Pakistan is also facing huge challenges in achieving sustainable green development. The rapid increase in population and urbanization have increased the country’s energy demand. In the past 15 years, the total energy consumption has increased by 53.61% (887.4 GWh to 1,363.2 GWh) (Pakistan Economic Survey, 2022). A significant portion of this energy comes from fossil fuels (non-renewable fuels such as oil, gas, and coal). According to the Pakistan Economic Survey 2021–2022 (Pakistan Economic Survey, 2022), a significant portion of the total energy comes from fossil fuels. However, the share of renewable energy sources (other than hydropower) amounts to only 3% (Pakistan Economic Survey, 2022). The country has developed an Alternative and Renewable Energy Policy in 2019, which includes some ambitious goals such as to increase the portion of renewable energy sources (other than hydropower) by 20% by 2025 and 30% by 2030 in the total energy mix (Ministry of Energy, 2019). However, social acceptance is the key factor which will play a key role in achieving this ambitious goal. Social acceptance is the willingness of people to accept renewable energy investment in their communities and countries at large (Liu et al., 2013; Caporale and de Lucia, 2015). According to Rosso-Cerón and Kafarov (2015), social acceptance defines people’s positive and negative attitudes toward various green energy resources and technologies. In Pakistan, various studies have been conducted on renewable energy sources and renewable energy technologies (Bhutto et al., 2011; Bhutto et al., 2013; Kamran, 2018; Zafar et al., 2018; Ali et al., 2019; Kashif et al., 2020; Bhutto et al., 2021; Uddin et al., 2021), but no study has been reported on public perception about RE sources, technology, and WTP.

The scope of this article is to investigate the public perception about the environment, climate change, and renewable energy technology, as well as their awareness and willingness to pay for renewable energy. This study also investigates how various variables such as perceived advantages, perceived challenges, and moral obligations effect their willingness to pay for renewable energy. To study all these parameters, the Theory of Planned Behavior (TPB) is utilized. This study provides researchers and policy makers with an understanding of the public perception about renewable energy and factors those affect their attitudes toward renewable energy, as well as their willingness to pay for it and aid in improving their existing models or policies.

## 2 Literature review

### 2.1 Theoretical background

Earlier studies have shown that customers’ decision-making process is dynamic. Researchers have used models such as self-efficacy, reasoned action theory, and TPB to examine purchasers’ purchase intentions. The TPB states that behavioral intentions control behavior. People consider the consequences before doing, which leads to their intended result. Individuals’ attitudes are shaped by their strong beliefs and predictions of behavior results (Ajzen, 1991). The TPB offers a framework for looking at the factors those influence behaviors. The TPB contends that individual conduct is the result of behavioral intentions, where intentions are a result of one’s attitude toward the action, i.e., one’s perception of behavioral control and one’s subjective norm. In essence, the TPB states that the greater one’s behavioral intentions are, the greater will be one’s likelihood of carrying out that behavior. Intentions are further explained by variables like attitude (AT), subjective norms (SNs), and perceived behavior control (PBC) (Ajzen, 2012). The TPB has played an important role in various research areas. Various studies have utilized the TPB for ascertaining consumption and willingness to pay (Al Mamun et al., 2018; Sreen et al., 2018; Kaffashi and Shamsudin, 2019; Bhutto et al., 2021; Masrahi et al., 2021; Nazir and Tian, 2022). Apart from significant support, the TPB also faces criticism. A major criticism is the need to add some additional variables that would improve its predictive and explanatory power. Ajzen (1991); Ajzen (2020) acknowledges that the TPB allows additional variables if it adds significance to the model’s predictive and explanatory power. Thus, several researchers have suggested the addition of new variables to the TPB to enhance its predictive and explanatory power. This study expands the TPB by adding variables such as awareness, perceived advantages, perceived challenges, and moral obligations to improve the model’s predictive power for assessing public perception and willingness to pay for renewable energy. The study conceptualizes and validates the model in the context of Pakistan.

### 2.2 Hypotheses

#### 2.2.1 Awareness

Environmental awareness has a direct impact on customers’ attitudes and their willingness to pay for goods, and this is related to

buying behavior both directly and indirectly. Eco-label awareness has been found to have a good link with both product knowledge and consumers' propensity to buy environmentally friendly products in studies (Devi et al., 2012). Similarly, increasing people's environmental awareness and encouraging them to buy green or ecologically friendly products might help them make better decisions (Laroche et al., 1996). Customers who are eco-literate are more likely to make rational, rather than irrational, purchases because they understand the problems regarding environmental concerns. The increased ecoliteracy will generally lead to stronger purchasing intentions for green energy, because it suggests a better awareness of environmental symbols, concepts, benefits, and consequences. As a result, attitude's explanatory ability will be improved. However, the explanatory value of attitude is diminished when consumers lack eco-literacy and instead rely on subjective feelings while making purchases. So overall, eco-literacy plays a key role in consumers' attitude and their willingness to pay for renewable energy and technologies.

**Hypothesis 1a:** Public awareness will have a positive impact on their attitude toward renewable energy.

**Hypothesis 1b:** Public awareness will also have a positive and indirect effect on their willingness to pay for renewable energy through AT.

### 2.2.2 Attitude

The term "attitude" refers to a person's mental state of preparedness, which they can develop and plan as a result of their experiences with things, people, and scenarios to which they can connect (Ivancevich et al., 2008). According to the TPB model, a person's behavioral attitude relates to the degree to which they see the activity—positively or negatively (Fishbein and Ajzen, 1975). According to Ajzen (1991), people are more likely to engage in action if they have a good attitude toward it. Positive or negative attitudes toward ecologically friendly items have been documented in the literature with regard to supporting the environment, according to Wang et al. (2016). There is no need for intentions to impact green purchasing and recycling practices according to the findings of Gadenne et al. (2011). Consumers' everyday energy-saving habits may be influenced by their views toward energy conservation, which in turn can help them become more involved in the cause for energy conservation and in using green energy (Egmond et al., 2005; Lopes et al., 2019).

**Hypothesis 2:** Public attitude positively affects their willingness to pay for renewable energy.

### 2.2.3 Advantages

Emotional rewards that might result from pure altruistic activity, such as giving to others, are described by economists in the warm-glow hypothesis (Andreoni, 1989; Andreoni, 1990). A "helper's high" is conceptually connected to a warm-glow effect (James Baraz, 2010). Furthermore, a previous study has revealed that consumers may experience a feeling of personal pleasure when they devote themselves not just to charitable acts but also to environmental awareness (Ritov and Kahneman, 1997). Altruism in the context of sustainability has been examined in a number of

research studies. It has been shown that those motivated by a strong feeling of dedication and generosity are more likely to utilize environmentally friendly goods and services than those who do not feel the same way (Sánchez-Fernández et al., 2009). Research has revealed that consumers' willingness to pay a higher price for green energy is influenced much more by the expectation of warm-glow advantages than by the perceived decrease in environmental impact (Wüstenhagen and Bilharz, 2006). According to Andreoni (1990), "pure altruism," i.e., an intrinsic purpose without reciprocal expectations, produces a pleasant glow that is idealistic. "Impure altruism," i.e., an extrinsic drive with reciprocal expectations, is the most common source of the warm-glow feeling (Gneezy and Rustichini, 2000). However, a previous study has shown that both altruism and warm-glow effects have considerable influence on customer sentiments toward green energy products (Hartmann and Apaolaza-Ibáñez, 2012; D'Amato et al., 2014; Carrington et al., 2010). In other words, attitudes are influenced by perceptions of warm-glow advantages. Thus,

**Hypothesis 3a:** The perceived advantages will also have a positive impact on public attitude toward renewable energy.

**Hypothesis 3b:** The perceived advantage will also have a positive and indirect effect on public willingness to pay for renewable energy through AT.

### 2.2.4 Perceived challenges and risks

Risk perception is the term used to describe an individual's capacity to evaluate the level of risk that is connected with a certain behavior or activity (Ajzen, 2002). In the context of renewable energy, this means a person's assessment of how they feel about the risks of using renewable energy technologies. This introduces a new concept: risk tolerance. An individual's perception of danger, as well as his or her risk tolerance level, plays a key role in accepting a particular technology. If a person thinks that using renewable energy is less dangerous than using other sources of energy, he or she is more likely to use renewable energy (Aman et al., 2012). Trust is when a person or group is willing to be open to the actions of another person or group in the hope that the other person or group will act in the best interests of the trusting person or group (Zainudin et al., 2014). In the context of renewable energy, confidence in renewable energy refers to an individual's anticipation that employing renewable energy resources will result in acceptable favorable outcomes in terms of benefits (Nguyen, 2018). Trust is a crucial factor in determining the current scenario, which includes the hazards involved and vulnerability of the trusted person. Trust has been viewed as a motivator in adopting new technology and completing transactions involving the provision of services in the hopes of a beneficial exchange relationship between the parties concerned. Thus

**Hypothesis 4a:** The perceived challenges and risks will negatively affect public attitude toward renewable energy.

**Hypothesis 4b:** The perceived challenges and risks will also have a negative and indirect effect on public willingness to pay for renewable energy.

## 2.2.5 Awareness and subjective norms

Subjective norms are determined by a set of cultural beliefs that represent the perceived social pressures that an individual feels to engage in specific types of conduct (Minton et al., 2017). Individuals in modern civilization are inextricably linked to society, and this influences their pro-environmental conduct (Zhang et al., 2019). The majority culture in Pakistan is collectivist, and social results have a part in consumers' purchase decisions (Zhang et al., 2019). Environmentally conscious and literate consumers are more inclined to make purchasing decisions on their own rather than seek recommendations from friends, family, co-workers, and other reference groups. As a result, we believe that growing consumer awareness will lower the explanatory power of subjective norms. Due to their lack of confidence, consumers with less eco-knowledge (eco-literacy) are more likely to rely on social input when making decisions. As a result, we believe that a low level of customer knowledge will boost the strength of subjective standards to explain purchase intent.

**Hypothesis 5a:** Awareness will have a negative impact on the subjective norm.

**Hypothesis 5b:** Public awareness will also have a positive and indirect effect on their willingness to pay for renewable energy through SN.

## 2.2.6 Moral obligations

The term "moral duty" refers to a person's sentiments of accountability, which leads them to perform or avoid certain actions (Beck and Ajzen, 1991). Having moral duties shows that the person has accepted a commitment to perform actions in an environmentally conscientious way (Stern, 2000; Bamberg et al., 2007). Empirical data have substantially supported the positive association between moral duty and environment-friendly intentions in prior investigations (Stern, 2000; Onwezen et al., 2013; Hwang and Lee, 2017). The desire to acquire RE might be sparked by a person's moral duty to preserve natural resources and enhance the environment. In many cases, people who have a strong sense of moral obligation to act in a way that is beneficial to the environment will act in accordance with an internal normative standard that they have established for themselves (Bamberg et al., 2007; Hwang, 2016). Previous research have experimentally examined the link between moral responsibilities and subjective standards (Mamun et al., 2018; Al Mamun et al., 2019; Fatoki, 2020). The relationship between moral duty and the subjective norm was largely neglected by academics in impoverished nations like Pakistan. Consequently, our research implies that moral duty might have a favorable impact on subjective standards for adopting RE. Because of this, this research suggests

**Hypothesis 6a:** Moral obligations will have a positive effect on subjective norms.

**Hypothesis 6b:** Moral obligations will also have a positive and indirect effect on public willingness to pay for renewable energy through SN.

## 2.2.7 Subjective norms

Subjective norms refer to how much people, society, or others approve or disapprove of a specific behavior (Sultan et al., 2020). As

defined by the TPB framework, a subjective norm relates to the extent to which people feel that the other person should do (Finlay et al., 1999). It relates to the "social pressure" that people feel and how they interpret the actions of others in their social circles, such as family, friends, or co-workers, which are both parts of the concept. Consumers' ideas of what is and is not acceptable are shaped by these many facets of perception. In the present sustainability movement, behaviors such as adopting new energy sources and using eco-friendly products may be viewed more favorably.

This psychological process has been extensively studied in the context of energy-saving behavior. In the words of Black et al. (1985), customers' ideas about the advantages of energy savings may encourage them to save energy. A similar finding was reported in studies conducted in South Korea and China (Zhao et al., 2014; Ha and Janda, 2017). Subjective norms were demonstrated to have a beneficial influence on Korean customers' purchase intentions for energy-efficient appliances in a recent study performed in South Korea (Park and Kwon, 2017). Energy-efficient appliance purchase intentions were shown to be negatively affected (Wang et al., 2019). Additional research in Asia has bolstered these results (Ajzen, 1991; Zainudin et al., 2014; Tan et al., 2017). However, in a study on Pakistani consumers, subjective standards and energy-saving objectives were not linked (Ali et al., 2019). In addition, Tan et al. (2017) observed that energy-efficient appliance purchase intention did not have a substantially positive association with SNs, which shows that customers may not be readily affected by other people's views. By contrast, Wang et al. (2019) found a stronger influence of social norms on intentions to buy in South Asian collectivistic societies. Thus,

**Hypothesis 7:** Subjective norms will positively affect public intention to pay for renewable energy.

## 2.2.8 Perceived behavior control

Perceived behavior control is a measure of how much control a person believes they have over their behavior (Ajzen, 1991). PBC has been studied as a key factor in determining behavioral intentions in the context of green consumption and willingness to pay for renewable energy (Chen and Tung, 2014; Wu and Chen, 2014). Consumers are more likely to engage in the desired activity if they have more control over their actions (Ajzen, 1991). Perceived difficulty or ease of executing a given conduct has also been classified as PBC in the pro-environmental literature (Bamberg, 2003).

Wang et al. (2019) hypothesized that behavioral control has a detrimental effect on customers' willingness to pay for renewable energy, which is counterintuitive. The justification for this is that it is challenging for consumers to obtain relevant energy consumption information or to fully understand energy-efficient rating information when purchasing energy-saving products, which in turn hinders their ability to make educated decisions and feel secure when purchasing renewable energy or green energy products. On the contrary, the results did not back up this theory, but instead indicated that PBC had a significant impact on whether people planned to pay for renewable energy even when controlling for factors like informational details. Thus,

**Hypothesis 8:** Perceived behavior control positively affects the willingness to pay for renewable energy.

**TABLE 1** Demographic information of the participants ( $n = 512$ ).

Components	Categorization	Enumeration	
		Frequency	%
Gender	Male	289	56.45
	Female	223	43.55
	Transgender	—	—
Age	Under 25	187	36.52
	25–35	274	53.52
	36–45	35	6.84
	45+	16	3.13
Province	Baluchistan	123	24.02
	Khyber Pakhtunkhwa	145	28.32
	Punjab	131	25.59
	Sindh	113	22.07
Qualification	Undergraduate	83	16.21
	Master/MS/MPhil	270	52.73
	PhD	109	21.29
	Others	50	9.77

## 3 Materials and methods

### 3.1 Participants and sampling procedure

This study utilized a quantitative method to analyze the suggested model. The data were acquired through questionnaires distributed among the inhabitants of four provinces in Pakistan: Baluchistan, Khyber Pakhtunkhwa, Punjab, and Sindh. The questionnaires were distributed among the participants from July to September 2021 at times when there was a smart lockdown imposed in several cities. All the participants were briefed before filling out this questionnaire and signed a written consent. An instruction document was also provided to inform the participants of the aim of the study to avoid any biases. Due to COVID-19, a smart lockdown was imposed in various cities and provinces, so an online sampling technique was applied to reach the maximum number of participants in the study. To ensure a non-biased sample and strictly follow the standard operating procedure (SOPs) during the pandemic, questionnaires were spread with the aid of different social media platforms, such as WhatsApp, WeChat, and QQ through Google Forms (online data collection software), where every respondent had the opportunity of being selected. The target provinces and regions completed a total of 512 usable questionnaires where the participation of each respondent was voluntary.

The demographic information of the participants in the study is given in [Table 1](#). All the respondents belonged to the four different abovementioned provinces in Pakistan. According to the survey's gender breakdown, 56.45% and 43.55% of the respondents were male and female, respectively. In total, 36.52, 53.52, 6.84, and 3.13%

of the respondents were from the age groups of under-25, 25–35, 36–45, and 45-plus years, respectively. Based on the qualification of the respondents, 16.21% were undergraduates, 52.73% were Master/MS/MPhils, 21.29% were PhDs, and 9.77% were others (which included post-doctorate or any other level of qualification). Furthermore, among the respondents, 24.02, 28.32, 25.59, and 22.07% belonged to the province of Baluchistan, Khyber Pakhtunkhwa (KPK), Punjab, and Sindh, respectively.

### 3.2 Measures

The measures of the TPB construct utilized in the present study are those used by prior researchers in various settings, which is consistent with the TPB questionnaire's criteria and structure. [Figure 1](#) shows all the TPB model components and background components that are considered latent variables. The data collection questionnaire comprised two parts. The participant's demographic data were included in the first section, while the second section included questions related to the public perception and WTP for RE, which was measured on the basis of TPB.

The perceived advantages of renewable energy (AD), perceived challenges of renewable energy (CH), and willingness to pay (WTP) were measured by seven, six, and two items, respectively, as proposed by [Ntanos et al. \(2018\)](#) and [Buchmayr et al. \(2021\)](#), whereas the subjective norm (SN), moral obligation (MO), and perceived behavior control (PBC) were measured by two items each proposed by [Bhutto et al. \(2021\)](#). The items reflecting awareness (AW) were adapted from the study by [Djurisic et al. \(2020\)](#); similarly, the items reflecting attitude (AT) were adapted from the studies of [Ntanos et al. \(2018\)](#); [Kaya et al. \(2019\)](#). A Likert scale with a maximum of five points, from “strongly disagree” (1) to “strongly agree” (5), was used to measure the aforementioned items. The questionnaire structure and the proposed model reliability were tested by a pilot test with 50 respondents.

### 3.3 Common method variance

The data of both the dependent and independent variables in this study were recorded and obtained from the same participants. So, there is a possibility of method bias. The possible method bias was reduced by properly guiding and briefing the participants before attempting the questionnaire (an instruction document containing the aims of the study was also provided with the questionnaire), which helped the participants to better understand the questionnaire before attempting it. To check for any bias in the study, the variance inflation factor (VIF) and tolerance (TOL) tests were used (the most commonly used test for checking biases). [Table 2](#) shows that there is no collinearity problem with the research since all TOL values are larger than 0.1 and all VIF values are less than 10.

### 3.4 Model assessment

The current study's research model was transformed into structural equation modeling (SEM) for additional investigation (such as outer and inner models). For PLS-SEM, the PLS

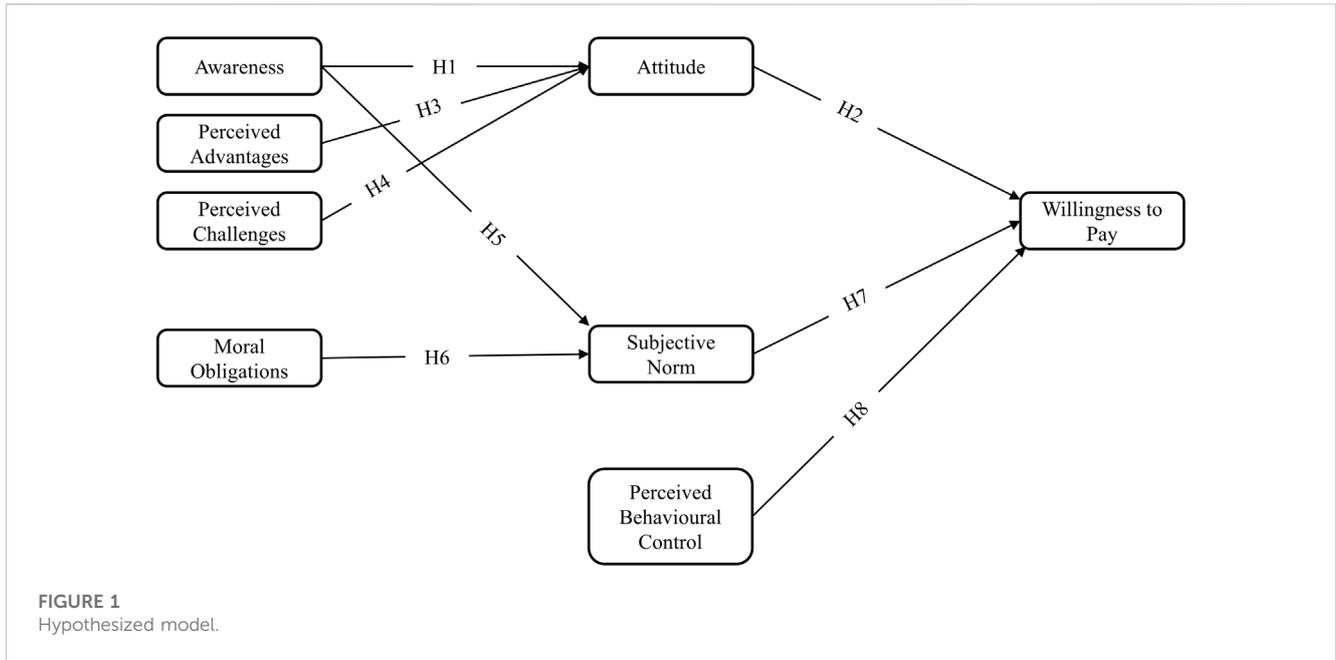


TABLE 2 Collinearity assessment.

IVs	Tolerance	VIF
AW	0.218	4.596
AD	0.163	6.14
CH	0.211	4.731
AT	0.108	9.238
MO	0.491	2.035
SN	0.477	2.098
PBC	0.784	1.276

IVs, independent variables; AT, attitude; SN, subjective norm; PBC, perceived behavior control; AW, awareness; AD, perceived advantages; CH, perceived challenges; MO, moral obligation; VIF, variance inflation factor (Latan and Noonan, 2017).

3.0 software was used. The study utilized PLS-SEM, which is normally used to analyze complicated models and comprehend their multidimensional relationships. In the realm of management, PLS-SEM is considered a helpful multivariate analytical approach. Furthermore, the model’s adaptability and suitability for analyzing numerous interactions between variables have been acknowledged in prior studies (Sarstedt et al., 2014).

## 4 Results

### 4.1 Partial least square–structural equation modeling

To evaluate the model, the study utilized a two-step approach: first, the validity and reliability of the scale employed and customized for the study were evaluated using an outer model or a measurement model; second, the model’s efficacy and the proposed relationship between the proposed variables were tested

using an inner model or a structural model; the (PLS-SEM) PLS-3 was utilized to assess both the inner and outer models.

### 4.2 Measurement model

The convergent and discriminant validity analyses were conducted for evaluating the reflective model; the results are given in Tables 3, 4. The convergent validity assessment presumes a high degree of correlation between items measuring the same construct (Hair et al., 2019) and this can be assessed from factor loading (CL), composite reliability (CR), and average variance extracted (AVE). Where the values of CL fall in the range of 0.761–0.951, the value of CL >0.5 is considered satisfactory and to fall in the acceptable range. Similarly, the values of CR that fall between 0.906 and 0.951 are considered acceptable if the values are >0.7, representing good internal consistency. After examining both CL and CR, the AVE values are also calculated. The results show that all the constructs have

**TABLE 3** Constructs validity evaluation (*n* = 512).

Constructs and statements	Items	(CL)	(CR)	(AVE)	(C $\alpha$ )
<b>Awareness</b>					
I am fully aware of climate change.	AW1	0.915	0.917	0.786	0.863
I am fully aware of environmental problems.	AW2	0.892			
I know what is RE.	AW3	0.850			
<b>Perceived advantages</b>					
RE improves life quality.	AD1	0.910	0.956	0.758	0.947
RE can protect the environment.	AD2	0.873			
RE is a source of green development.	AD3	0.869			
RE is a source of economic development.	AD4	0.846			
RE will reduce fossil fuel dependency.	AD5	0.840			
RE will create new job opportunities.	AD6	0.857			
RE will give energy independence.	AD7	0.897			
<b>Perceived challenges</b>					
RE has a high installation cost.	CH1	0.854	0.924	0.670	0.901
RE has low reliability.	CH2	0.769			
RE technologies have complex installation.	CH3	0.809			
RE systems are hazardous.	CH4	0.761			
RE systems have high maintenance costs.	CH5	0.845			
I do not have enough information about RE challenges.	CH6	0.866			
<b>Attitude</b>					
I am concerned about climate change.	AT1	0.900	0.940	0.758	0.920
I like to try new technologies.	AT2	0.839			
Energy-saving/conservation is important.	AT3	0.896			
The govt should set targets for increasing RE.	AT4	0.833			
I will cooperate with the govt for public awareness in my community.	AT5	0.883			
<b>Moral obligations</b>					
I feel it is our moral obligation to save our environment.	MO1	0.938	0.930	0.870	0.851
I feel it is our moral obligation to use clean energy.	MO2	0.928			
<b>Subjective norms</b>					
Most of the people important to me buy and use green energy.	SN1	0.913	0.908	0.832	0.798
Most of the people whose opinion I respect would buy green energy.	SN2	0.911			
<b>Perceived behavior control</b>					
I am confident that I would buy RE instead of conventional energy.	PBC1	0.951	0.950	0.904	0.894
I have the tools, skills, and knowledge to use RE.	PBC2	0.950			
<b>Willingness to pay</b>					
I would like to buy RE.	WP1	0.947	0.946	0.898	0.886

(Continued on following page)

**TABLE 3 (Continued) Constructs validity evaluation (n = 512).**

Constructs and statements	Items	(CL)	(CR)	(AVE)	(Cα)
Awareness					
I would like to pay more for RE.	WP2	0.948			

CL, cross-loadings; CR, composite reliability; AVE, average variance extracted; Cα, Cronbach’s alpha; AW, awareness; AD, perceived advantages; CH, perceived advantages; AT, attitude; MO, moral obligation; SN, subjective norm; PBC, perceived behavior control; WTP, willingness to pay for renewable energy.

**TABLE 4 Discriminant validity evaluation (n = 512).**

Heterotrait–monotrait ratio (HTMT)							
AD							
AT	0.780						
AW	0.824	0.832					
CH	0.830	0.810	0.820				
MO	0.103	0.064	0.102	0.094			
PBC	0.409	0.417	0.380	0.455	0.209		
SN	0.246	0.158	0.229	0.259	0.846	0.087	
WTP	0.700	0.666	0.662	0.671	0.055	0.415	0.197

The heterotrait–monotrait (HTMT) criterion was used to estimate the results (Al Mamun et al., 2019).

an average value between 0.670 and 0.904, which means that all the constructs’ values are above 0.5, which represents that all the items in the construct have a variation of more than 50% (Hair et al., 2017). Additionally, Cronbach’s alpha (Cα) was calculated to examine internal reliability. The Cα values fall between 0.798 and 0.947, surpassing the minimum threshold value of 0.70, which validates the data reliability (Table 3).

Furthermore, the discriminant validity of the construct was examined through the heterotrait–monotrait (HTMT) ratio (Henseler et al., 2015), as given in Table 4. According to Henseler et al. (2015), the resulting values are <0.85, representing good discriminant validity of all the constructs of the proposed model.

### 4.3 Structural model assessment

The structural model assessment was performed after confirming that the structural model had no collinearity issues. The model collinearity assessment was performed by assessing the VIF and TOL values. Table 2 shows the results representing both VIF and TOL in the acceptable range (VIF values <10 and TOL values >0.1), confirming that the model had no collinearity issue and was ready for the structural model assessment.

To evaluate the suggested structural model, a comparison of the path coefficient dimensions and values with other relevant R<sup>2</sup> in t statistics calculation is considered important. The path coefficient and relevant importance of the proposed model are measured by utilizing the bootstrapping technique (to 5,000 resamples). The effect size f<sup>2</sup> measurement is also taken into account for the proposed study (Hair et al., 2017). Furthermore, Stone–Geisser’s Q<sup>2</sup> was also considered in the study to measure the model’s predictive ability.

Table 5 illustrates the bootstrapping results of the β-coefficient, t-statistics, and f<sup>2</sup> values for all the proposed structural paths. Except for one proposed structural path or relationship, all others were deemed to be significant (with a 99% confidence level). Factors affecting attitude, such as awareness (AW-AT, β = 0.36, t = 3.643, LL = 0.196, UL = 0.52, p ≤ 0.01), perceived advantages (AD-AT, β = 0.37, t = 2.771, LL = 0.182, UL = 0.617, p ≤ 0.01), and perceived challenges (CH-AT, β = 0.28, t = 2.794, LL = 0.103, UL = 0.437, p ≤ 0.01), had a substantial favorable effect on attitude. In the case of subjective norms, both awareness (AW-SN, β = 0.13, t = 1.865, LL = -0.244, UL = -0.016, p ≤ 0.01) and moral obligations (MO-SN, β = 0.69, t = 12.474, LL = 0.593, UL = 0.773, p ≤ 0.01) had a substantial favorable effect on subjective norms. Regarding the components of TPB, and based on the data set findings, this study found that the attitude (AT-WTP, β = 0.52, t = 5.778, LL = 0.367, UL = 0.661, p ≤ 0.01) and perceived behavior control (PBC-WTP, β = 0.18, t = 1.956, LL = 0.035, UL = 0.333, p ≤ 0.01) had a substantial favorable effect on the willingness to pay, however subjective norm (SN-WTP, β = 0.10, t = 1.544, LL = -0.22, UL = 0.005, p ≤ 0.01) had no significant effect on WTP for RE. So, overall, the hypotheses H1a, H2, H3a, H4a, H5a, H6, and H8 were accepted, while H7 was rejected. The path coefficient and degree of influence of the proposed model are shown in Figure 2.

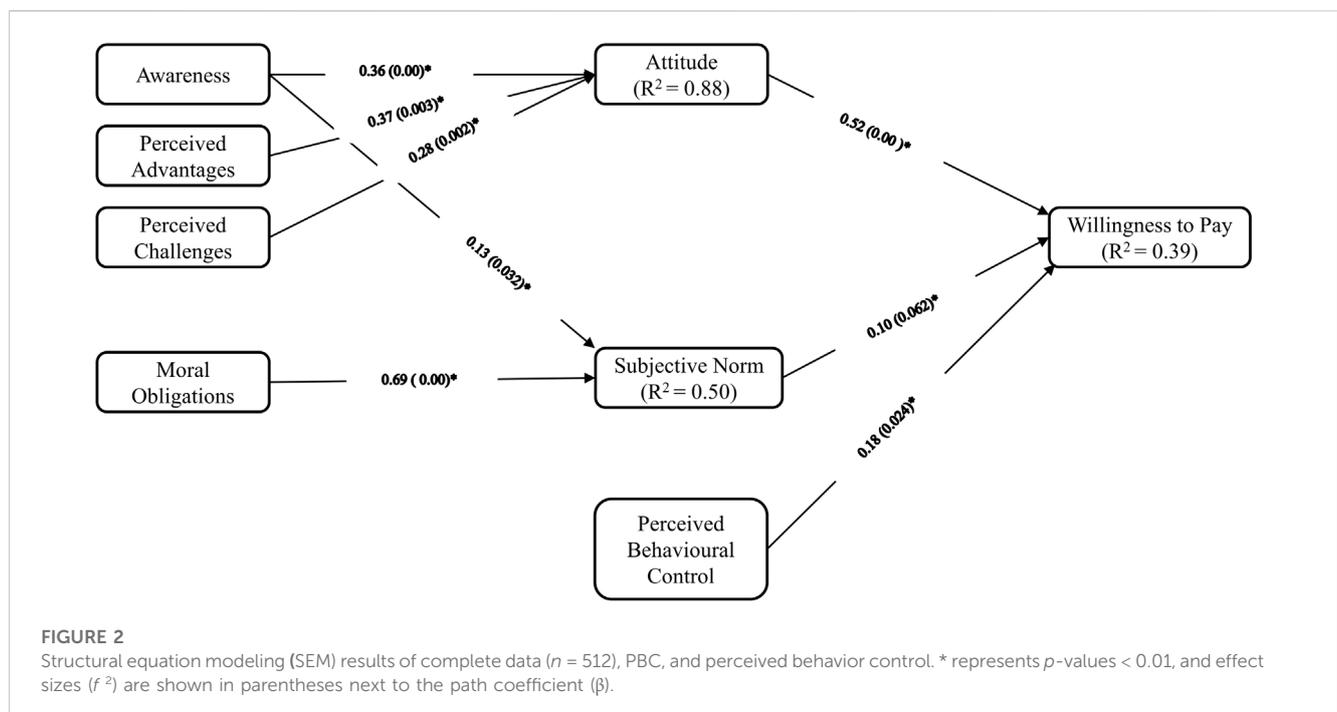
To measure the effect size (f<sup>2</sup>), the Cohen (1970) criteria were adopted, such as 0.02 for small-, 0.35 for medium-, and ≥0.8 for large-sized effects. All variables, except for one, were greater than the minimal threshold criterion of (0.02), demonstrating that they had an impact on the dependent variable, as shown in Table 5. SN showed no noticeable impact on the WTP for RE.

Additionally, the study also determined the coefficient of determination (R<sup>2</sup>) and predictive relevance (Q<sup>2</sup>) of variables

**TABLE 5** Structural paths evaluation (hypothesis testing).

Structural paths	$\beta$ -Value	$t$ -Value	$f^2$	LL	UL	Results
AD—AT	0.37	2.771	0.251	0.182	0.617	Accepted
AT-WTP	0.52	5.778	0.373	0.367	0.661	Accepted
AW-AT	0.36	3.643	0.363	0.196	0.52	Accepted
AW-SN	0.13	1.865	0.034	-0.244	-0.016	Accepted
CH-AT	0.28	2.794	0.184	0.103	0.437	Accepted
MO-SN	0.69	12.474	0.946	0.593	0.773	Accepted
PBC-WTP	0.18	1.956	0.044	0.035	0.333	Accepted
SN-WTP	0.10	1.544	0.018	-0.22	0.005	Rejected

\*\*Significance at  $p \leq 0.01$ . AT, attitude; AD, perceived advantages; AW, awareness; CH, perceived challenges; SN, subjective norm; MO, moral obligation; PBC, perceived behavior control; WTP, willingness to pay for renewable energy; LL, lower limit; UL, upper limit at 99% confidence interval.



(independent with respect to dependent). The computed  $R^2$  value for the dependent variable WTP is 0.39, which indicates that the study’s overall independent variables, AT, SN, and PBC, collectively account for 39% of the variance in the dependent variable. The  $R^2$  for the dependent variable AT and SN is 0.88 and 0.50, respectively. It is an indication that variables such as AW, AD, and perceived challenges (CH) explain a variance of 88% in the dependent variable AT, similarly variables such as AW and MO explain a variance of 50% in the dependent variable SN.

Furthermore, the study also performed PLS prediction by adopting the Shmueli et al. (2019) procedures. The predictive validity was evaluated using cross-validation with holdout sampling, and the overall findings are shown in Table 6. During the assessment, first the  $Q^2$  values were measured and the corresponding values for AT, SN, and WTP were 0.870, 0.481, and 0.404, respectively, representing the promising predictive

performance of the suggested model. In addition to this, the linear regression (LM) model was also used for the prediction assessment (Shmueli et al., 2019). The results of both LM and PLS were compared, which showed that the LM had a lower mean absolute (MAE) and mean square error (RMSE) than did the PLS, indicating a significant predictive ability of the proposed model.

#### 4.4 Mediation effect of TPB components among background factors of behavioral intention

The proposed model presumed that TPB components will mediate the existing factors (such as AW, AD, CH, and MO) and people’s WTP for RE. The mediation effect of the proposed

**TABLE 6 PLS prediction evaluation.**

Summary									
AT		0.870							
SN		0.481							
WTP		0.404							
PLS prediction summary									
	PLS			LM			PLS-LM		
	RMSE	MAE	Q <sup>2</sup> Predict	RMSE	MAE	Q <sup>2</sup> Predict	RMSE	MAE	Q <sup>2</sup> Predict
AT1	0.724	0.585	0.709	0.828	0.665	0.620	-0.104	-0.080	0.089
AT2	0.803	0.670	0.629	0.886	0.713	0.549	-0.083	-0.043	0.080
AT3	0.773	0.651	0.644	0.850	0.680	0.569	-0.077	-0.029	0.075
AT4	0.756	0.591	0.598	0.862	0.653	0.477	-0.106	-0.062	0.121
AT5	0.836	0.682	0.696	0.903	0.711	0.645	-0.067	-0.029	0.051
SN1	1.019	0.827	0.387	1.152	0.908	0.217	-0.133	-0.081	0.170
SN2	0.942	0.741	0.408	1.072	0.836	0.234	-0.130	-0.095	0.174
WTP1	1.023	0.770	0.359	1.135	0.870	0.210	-0.112	-0.100	0.149
WTP2	1.042	0.816	0.368	1.128	0.867	0.259	-0.086	-0.051	0.109

AT, attitude; SN, subjective norm; WTP, willingness to pay for renewable energy; LM, linear regression model; RMSE, root mean square error; MAE, mean absolute error.

**TABLE 7 Mediation effect.**

Structural paths	$\beta$ -value	t-value	p-values	LL	UL	Results
AW-AT-WTP	0.186	3.204	0.001	0.093	0.284	Supported
CH-AT-WTP	0.146	2.439	0.007	0.048	0.246	Supported
MO-SN-WTP	0.073	1.543	0.061	-0.151	0.003	Not-supported
AD-AT-WTP	0.190	2.472	0.007	0.087	0.341	Supported
AW-SN-WTP	0.013	1.118	0.136	-0.002	0.037	Not-supported

\*\*Significance at  $p \leq 0.01$ . AT, attitude; SN, subjective norm; PBC, perceived behavior control; WTP, willingness to pay for renewable energy; AW, awareness; MO, moral obligation; LL, lower limit; UL, upper limit at 99% confidence interval.

model was assessed by the bootstrapping technique as mentioned in Section 4.3. The results of the mediation effect such as the specific indirect effect and significance values ( $p$ -values) with 95% confidence level (bias-corrected) are given in Table 7. The results reveal that the indirect effect of awareness, perceived challenges, and perceived advantages on people’s willingness to pay for renewable energy through the mediation effect AT was significant ( $\beta = 0.186$ , LL = 0.093, UL = 0.284,  $p \leq 0.001$ ;  $\beta = 0.146$ , LL = 0.048, UL = 0.246,  $p \leq 0.007$ ; and  $\beta = 0.190$ , LL = 0.087, UL = 0.341,  $p \leq 0.007$ , respectively). Nevertheless, the indirect effect of awareness and moral obligation on people’s willingness to pay for renewable energy through SN turned out to be insignificant ( $\beta = 0.013$ , LL = -0.002, UL = 0.037,  $p \leq 0.136$  and  $\beta = 0.073$ , LL = -0.151, UL = 0.003,  $p \leq 0.061$ , respectively). Based on the above results, we conclude that the effect of awareness, perceived advantages, and perceived challenges on WTP is

mediated by AT, whereas SN does not mediate the relationship. So overall, Hypothesis 1b, Hypothesis 3b, and Hypothesis 4b are supported, whereas Hypothesis 5b and Hypothesis 6b are not supported.

## 5 Discussion

Growing energy demand and global warming concerns have changed the priorities of governments and regions, particularly in countries that are facing serious climate change problems. Countries around the globe, especially the developed countries, are continuously taking serious measures to avoid the negative impacts of climate change and continue to invest in green energy. They also discourage the use of energy from non-renewable sources. Developed countries can afford investing in renewable energy sources, and the people there are capable

of buying energy even by paying relatively high amounts. On the contrary, third-world countries (the developing countries) such as Pakistan have serious energy crises (where the governments are trying to meet the energy demand by any means); apart from this, poor infrastructure and economic restrictions do not provide any provision to invest in renewable energy. Also, due to inherited social and cultural issues along with financial limitations, people are reluctant to switch to renewable energy. Several studies have been conducted to check public perception, awareness, attitude, and willingness to pay for RE across the world but not in Pakistan. This study is conducted to investigate these aspects within the context of Pakistan. A highly significant social theoretical framework, TPB, along with factors such as awareness, perceived challenges, perceived advantages, and willingness to pay, was investigated.

The results show that the TPB has a significant explanatory power and is a useful framework for comprehending the intended investigational behavior. To be precise, the relationship between AT, PBC, and WTP are found to be significant and hence supports our proposed [Hypothesis 2](#) and [Hypothesis 8](#). Similar results have been noticed in studies relevant to environmentally friendly purchasing (Roe et al., 2000; Zarnikau, 2003). However, there is no significant relationship between SN and WTP for RE and hence [Hypothesis 7](#) is rejected. First, by directly examining the relationship between the TPB components, it is noted that people's attitude toward WTP for RE predicts intention and indirect behavior. Furthermore, this study presumes that people who have positive opinions and attitudes toward renewable energy are more inclined to use renewable energy and are willing to pay for it. As reported by Ajzen (2020), people are more inclined to act if they have a positive attitude toward it. The results also reflect that eco-literate people are hardly influenced by others' opinions or views. The study found pro-environmental behavior that might be due to people's level of understanding and information about environmental issues, climate change, and renewable energy sources. Variables such as perceived advantages, challenges, and awareness about renewable energy resources have a substantial positive effect on their attitude toward renewable energy and hence support our proposed [Hypothesis 3a](#), [Hypothesis 4a](#), and [Hypothesis 1a](#). The abovementioned results are in line with those of previous studies (Nazir and Tian, 2022), and we conclude that all these variables shape people's opinion and attitude. In order to promote renewable energy, the positive aspects should be highlighted further. To effectively inform consumers about environmental challenges and renewable energy technologies, more information is needed. Second, the findings show that awareness (AW) is negatively associated with subjective norms (SNs) and hence support our proposed [Hypothesis 5a](#). Furthermore, this study shows that SNs have no significant impact on public WTP for RE and hence reject [Hypothesis 7](#). It is presumed that those who have proper education and knowledge about climate change and RE will hardly be influenced by others as they have their own say. A similar conclusion is also drawn in a study relevant to check consumers' buying intentions (Zhang et al., 2019). However, moral obligation has been positively associated with the subjective norm and hence supports our proposed [Hypothesis H6a](#). We presume those who are educated and have knowledge about their responsibilities have a sense of moral obligations and act as responsible citizens. Furthermore, the study found that AT is a mediation effect between the variables (AW, AD, and CH) and WTP for RE, hence

validating our proposed [Hypothesis 1b](#), [Hypothesis 3b](#), and [Hypothesis 4b](#). The same conclusion had also been drawn in previous studies (Hartmann and Apaolaza-Ibáñez, 2012; Allison et al., 2013; Ntanos et al., 2018). We presume that awareness, perceived challenges, and perceived advantages can affect people's attitudes and behavior toward their willingness to pay. The more they learn about environmental issues and renewable technologies, as well as their benefits, the more likely they are to purchase renewable energy. It indicates that people are willing to pay more for green energy. On the contrary, awareness and moral obligation have no significant indirect effect on willingness to pay for renewable energy through SN and hence [Hypothesis 5b](#) and [Hypothesis 6b](#) are rejected. This means that those who have knowledge about climate change and renewable energy are hardly influenced by society, and they have their own opinion based on their understanding. Similar results have also been noticed in a study based on consumers' intention to buy energy-efficient appliances (Bhutto et al., 2021).

It is concluded that the relationship between AT, PBC, and WTP was significant. However, the relationship between SN and WTP was found to be insignificant. Similarly, the results indicate that the relationship between all the variables except for one was significant. This is a positive indication that those who have a formal education (also a relatively young population of the country) have a clear understanding of the environmental challenges, climate change, and renewable energy technologies, resulting in favor of renewable energy resources. This means that education and the right information about new technologies and their advantages are the key factors that intensify public intention toward their willingness to pay for renewable energy. Educating the masses with the right information and promoting the advantages of green energy/renewable energy will positively affect public perception toward RE. Additionally, RE plays a vital role in supporting energy security by safeguarding continuous energy provisions without interruption. The possible source of disruption can be natural (flood, heavy rainfall, etc.), technological, human interventions, cyber attitudes, and geopolitics. The International Energy Agency (IEA) defines energy security as continuous supply at affordable prices. The US Department of Energy defines it as access to various energy sources, routes, and supplies. Energy supply is essential for industries (almost all modern industries), such as food, healthcare, telecommunication, water, and sanitation. As mentioned in previous sections, Pakistan primarily depends on imported fossil fuels for energy generation. This high dependency on imported fossil fuels puts energy security at risk and puts pressure on the country's poor economy in the form of large import bills. The country has abundant RE sources such as solar, wind, biomass, geothermal, and hydro energy. The country has plenty of RE sources, which when tapped effectively can satisfy the its energy needs. By shifting to RE, the country can reduce high import bills and get energy independence and clean energy. Furthermore, it can help avoid climate change and consequences like global warming, floods (which destroy all the infrastructure), etc. So, a policy shift is required in this regard.

## 6 Policy implications

The findings of the study have significant implications for policymakers and relevant organizations. The study's findings

suggest that awareness and information about renewable energy play an essential role in consumers' purchase intentions. The policymakers and energy sector should formulate such policies that increase public awareness and educate the public about environmental issues, climate change, and renewable energy. Similarly, the energy sector and relevant organizations should educate the masses, provide relevant information about renewable energy technologies, and highlight the potential benefits of RE on print, electronic, and social media. This will increase customers' understanding of environmental challenges and renewable energy technologies. Giving more information about renewable energy sources and technologies will reduce the mass skepticism toward it. This will further lead consumers to purchase renewable energy (environmentally friendly and sustainable energy sources).

This study proposed that perceived challenges and advantages affect public attitude toward renewable energy. The perceived challenges and associated risks negatively affect public attitude toward renewable energy, reducing people's intentions to purchase it. Policymakers have to formulate relevant policies to facilitate energy sectors (such as waiving tax on importing relevant technologies and attracting multinational companies to invest) and give incentives to end consumption. This will encourage investors to invest in the energy sector and help reduce renewable energy costs, hence more people will purchase renewable energy. Also, the relevant companies and organizations should focus on reducing the challenges to a minimum (by improving the technology), making the installation simple and reducing installation and maintenance costs. An effective advertisement is required to attract the public to purchase renewable energy.

Similarly, the perceived advantages and warm-glow benefits positively affect public attitude and increase purchase intentions and renewable energy adoption. Policymakers should formulate policies that indicate renewable energy's importance and implement renewable energy advantages. Similarly, marketing organizations should promote the benefits of using renewable energy such as improving the quality of life, creating job opportunities, reducing fossil fuel consumption, promoting energy independence, and most importantly, protecting the environment by reducing the carbon footprints and adverse effects of climate change. This study gives new insights into public perception and willingness to pay for RE in developing countries like Pakistan. It will not only help the local policy maker and energy sectors but also aid the international market in understanding local consumers and the potential of the green energy market in the country. Further results will also help the policymaker and energy sector understand the factors that shape public perception and willingness to pay for RE.

## 7 Conclusion, limitations, and recommendations

Global energy demand is increasing tremendously and is mainly dependent on fossil fuels, which are exhausted rapidly and pose environmental concerns. These unsustainability and environmental concerns have changed regions' and countries' priorities from fossil fuels to green energy. This transition from non-renewable to renewable energy is more prominent in developed countries.

However, developing countries face challenges, and their pace is relatively slow. The study is conducted in Pakistan to understand public perception and willingness to pay for RE. The results of the study are pretty interesting. The study reveals that public attitude and perceived behavior control are positively associated with the public's willingness to purchase renewable energy.

Additionally, the study also finds that a change to background factors such as awareness, perceived challenges, and perceived advantages has a significant positive effect on public attitude and willingness to pay for RE through the mediation effect of attitude. This means that the public will be more inclined and attracted toward renewable energy when they are aware and have the information about the environment, climate change, and renewable energy. Furthermore, the warm-glow benefits will also positively affect the public's purchase intentions. So, it is suggested that the public be educated to minimize their concerns and advertise the warm-glow benefits of renewable energy to attract the public in utilizing RE. Furthermore, the study reveals that subjective norms have no significant effect on willingness to pay for RE, and the background factors (awareness and moral obligations) have no significance on willingness to pay through subjective norms. This indicates that society, friends, and colleagues hardly influence eco-literate people who have their own opinions. So, it is necessary to attract people by equipping them with pertinent information. It will increase public understanding of renewable energy and motivate them to purchase it.

The following are some limitations of this study and recommendations for future research. First, this study only considers the four provinces of Pakistan and does not account for other regions such as Gilgit Baltistan, Azad Kashmir, and Ex-FATA (federally administered tribal areas). So, it is recommended that the study be extended throughout the country to investigate better and more accurate public perception. Second, due to time and resource constraints, the study's sample size was small and may not reflect the entire population. So, it is recommended that in future studies, the sample size should be increased to get a true representation. Third, this study was only based on a questionnaire survey. It is highly recommended that interviews be conducted with the participants. Fourth, the study only represented the educated section of the society (having formal education), which may not represent the complete spectrum of the public. It is recommended to spread out future studies to cover different segments of the society. Fifth, the study does not take subcultural factors into account, so it is highly recommended that future studies should incorporate them into their model to see how it affects public perception and purchase intentions. Finally, this study was conducted in the context of Pakistan only, so in the future, it can be extended to other regions and countries for comparative analysis.

## Data availability statement

The raw data supporting the conclusion of this article will be made available by the authors, without undue reservation.

## Author contributions

SD: Conceptualization, Formal analysis, Software, Writing—original draft; RW, ME, XL: Supervision, Writing—review, and editing; FN, DG, ZM, and MA: Writing, review, and editing; TA: Funding, Writing—review, and editing. All the authors discussed the results and contributed to the final manuscript.

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