



# Consumers' intention-based influence factors of renewable energy adoption in Pakistan: a structural equation modeling approach

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## Abstract

As the adoption of renewable energy (RE) is a complex and intricate procedure affected by a wide range of factors, it prompts traction among researchers to examine these influence factors. The aim of this study is to scrutinize the factors affecting consumers' intention to adopt RE for household use in Pakistan. The current research has contributed through expanding the structural framework of the theory of planned behavior by incorporating three novel factors (perception of self-effectiveness, perception of neighbor's participation, and belief about RE benefits) to have a deep insight into the factors that motivate or inhibit consumers to adopt RE. Outcomes are based on the primary data compiled from 353 households in the five main cities of Pakistan accompanying an inclusive survey. The state-of-the-art structural equation modeling was utilized to test and analyze the proposed hypotheses. The results signify that the influencing factors such as perception of self-effectiveness, awareness of RE, and perception of neighbor's participation impart a positive effect on consumers' intention to adopt RE, whereas cost of RE generation has an opposite effect. Interestingly, environmental concern and belief about RE benefits found to have neutral effects. Research results emphasize the need to enhance public awareness, reform policy structure, transform social norms, and highlight the benefits that RE provides, all through an integrative and coherent way.

**Keywords** Renewable energy · Influence factors · Consumers · Structural equation modeling · Pakistan

## Abbreviations

ARE Awareness of RE  
BREB Belief about RE benefits  
BREC Belief about renewable energy cost  
CRE Cost of renewable energy generation  
IAD Intention to adopt renewable energy

PNP Perception of neighbor's participation  
PSE Perception of self-effectiveness  
RETs Renewable energy technologies  
TPB Theory of planned behavior

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## Introduction

Environmental concerns and changes in climate have attained the prime consideration in economic and political debates during the recent years (Grafakos et al. 2020). Renewable energy (RE) is considered a promising way to mitigate climate changes and solve environmental problems (Rasheed et al. 2020). Governments all over the world are uplifting the growth of renewable technologies (Irfan et al. 2019a). The shift from conventional ways of producing electricity to renewable sources is since there is a demand for green energy generation and consumption from civil society and regulatory organizations (Irfan et al. 2020a). The demand for energy is at its peak due to the growing population and economic development (Etokakpan et al. 2020; Sarkodie and Adams 2020), which has led policymakers to think about alternative ways of

energy generation and reduce carbon footprints by depending less on fossil fuels (Ahmad et al. 2019).

Several initiatives have been taken by different countries to utilize energy resources efficiently and increase the share of RE in their energy portfolio (Merino et al. 2019; Valdés and Leon 2019). It is believed that RE projects improve the life quality of local dwellers in many ways. Firstly, RE sources have the potential to minimize greenhouse gas (GHG) emissions and air pollution (Solangi et al. 2019), which in turn, improve the health conditions of people. Secondly, the penetration of RE creates new jobs for local people, directly supporting the national economy. And finally, it provides affordable electricity and will stabilize electricity prices in the future (Kaygusuz 2012; Caspary 2009).

Irfan et al. (2019b) reported that RE can meet the energy needs of a growing population in a sustainable way. By knowing residents' attitudes towards RE, we will be in a better position to penetrate RE quickly. Numerous studies have focused on examining the consumers' intention to adopt RE in developed countries. Survey results showed moderate to strong social acceptance for RE technologies (Krohn and Damborg 1999; Wolsink 2000). Some researchers have focused on the institutional capacity behind the public acceptance of RE, as economic incentives, robust policies, effective regulations, and support mechanisms were turned out to be the key determinants (Molnarova et al. 2012; Sauter and Watson 2007). Others have focused on individual behavior with a psychological point of view (Huijts et al. 2012), and these studies widely used quantitative analysis and environmental activism (Tanner and Wölfing Kast 2003). Consumers' intention to adopt RE is assessed as the contemplation of inhabitants' attitudes (Zografakis et al. 2010). It means that residents' attitude determines the extent of utilizing RE. Subsequent studies examined the determinants and factors which affect social acceptance. Hansla et al. (2008) showed that consumers' intention increases with having a positive attitude about RE, that it alleviates environmental problems, and decreases with the rise in electricity prices. These results are consistent with Bang et al. (2000). Similarly, income, family size (Hansla et al. 2008), education, age (Ek 2005), personal experience (Batley et al. 2000), and social status (Irfan et al. 2020b) are also major influencing factors.

Previous researches were mostly conducted in countries where governments have clear policy targets to mitigate GHG emissions. More specifically, researchers have discussed the gap between public acceptance and the national goals of increasing RE share in the total energy mix. They specified that low social acceptance is hindering RE penetration and restricting to achieve the national goals, indicating that the role of social acceptance is crucial in RE development (Stigka et al. 2014). Recently, some researchers have studied the consumers' intention to adopt RE technologies in developing countries as well. For instance, Pollmann et al. (2014)

examined consumers' intentions in developing Africa and reported that people have a high intention to use RE, especially biomass energy. Patel and Rao (2016) conducted a survey to examine the social acceptance of solar energy in India. Survey results revealed that 91% of the respondents are in favor of installing solar panels at rooftops to fulfill energy needs. On the other hand, Seetharaman et al. (2019) found that several barriers are hindering the public acceptance of RE, including technological, social, regulatory and economic barriers. Mosly and Makki (2018) studied the intention to adopt RE in Saudi Arabia. Research findings indicated that several factors affect consumers' intention, including age and economic conditions of the respondents. In another study, Düşteğör et al. (2015) revealed that government subsidies and policies are the major factors that influence residents to adopt RE in Saudi Arabia.

Limited research has done on the Pakistani perspective to find out consumers' intention of adopting renewable energy generation technologies (RETs). For instance, Shakeel et al. (2016) exposed that the country is suffering from acute energy crises. Negligence, poor planning, and mismanagement of government are the root causes of these crises. Chaudhry et al. (2009) examined the prospects and challenges of RE technologies in Pakistan and found out that RE sources can tackle the energy shortage problems of the country in a short period of time. Farooqui (2014) explored the availability and future projections of different renewable sources in Pakistan and reported that the country has enormous RE potential and will install 30 GW from hydel and 50 GW from wind sources by 2030. Shah and Solangi et al. (2019) offered policy recommendations for 100% RE deployment in the country. Meanwhile, Talpur et al. (2017) studied the householders' perceptions of RE in Sindh province. The research findings show that there is a high level of social acceptance of solar energy technology.

In contrast with ambitious national goals, RE penetration is at a preliminary stage in Pakistan. Contrary to former studies, the present study has contemplated all the factors from the perspective of considering RETs market. In this regard, the main contributions of this study are threefold. First, the research gaps motivated us to contribute to the existing body of literature by examining consumers' intention to adopt RE, households' energy stipulation, and potential factors that may motivate or discourage Pakistani consumers to adopt RE. Second, we have expanded the planned behavior theory by introducing three novel constructs (perception of self-effectiveness, perception of neighbor's participation, and belief about RE benefits). A questionnaire survey was performed in the five main cities of Pakistan to derive the research outcomes. A total of 353 valid responses were collected from households and structural equation modeling (SEM) was utilized for data analysis.

Third, concerning the relevance of the outcomes, though a particular country (Pakistan) was selected to derive the findings, however, the implications of these outcomes indicated the phenomenon of consumers' intention-based impelling factors to adopt and utilize RE. In this situation, the outcomes are not restricted to one specific country or region. Besides, the novel factors may prevail in all developing states. Thus, the findings are not case-specific, yet highlight the effect of accompanying factors on RE adoption and the case of Pakistan would be considered as a representative model to pinpoint the phenomenon. Additionally, SEM is the most appropriate methodological option to examine the relationship among all the factors that have been used in the model.

The rest of the paper has been structured as follows: the "Theoretical framework" section explains the theoretical framework. The "Formulation of hypotheses" section explicates the formulation of the hypothesis. Section 4 illustrates the research design. The "Results and analysis" section presents results and analysis. The "Discussions" section includes discussions on research findings. The "Conclusions and recommendations" section concludes the study and offer policy recommendations. Finally, the "Limitations and future work" section discusses research limitations and future work.

## Theoretical framework

Buyers' purchase decision is a complicated process that involves a bunch of factors. Ample studies have been done to examine the public acceptance of RE in various dimensions including self-efficacy theory, social cognitive theory, the theory of reasoned action, and the theory of planned behavior (Ajzen and Fishbein 1970; Ajzen and Fishbein 1977). Different from contextual studies, the focus was on consumers' behavior in this research. The theory of planned behavior (TPB) was adopted to establish a theoretical framework. According to this theory, an individual's behavioral intention determines the behavior. Before performing a specific behavior, individuals first think about its consequences and then perform that behavior which directs them to a desirable result (Ajzen 1991). A person's striking beliefs and result estimations related to a particular behavior form an individual's attitude.

TBP describes and forecasts consumers' behavior and has been widely used in different situations (McBride et al. 2020). The theory has been applied by scholars in different consumers' research aspects, including e-commerce, organizational settings, green behavior, and identifies that the theory successfully examines consumers' behavior. Researchers have the opinion that a variety of factors affects the acceptance of any particular technology in economic, regulatory, and social aspects. However, TBP only deals with normative, behavioral, and control beliefs to determine consumers' intention to

engage in a specific behavior and overlook additional factors that might influence their intention. Moreover, as the RE is not much developed in Pakistan, therefore people have concerns regarding social norms, environment, and cost comparison of utilizing modern technology. Therefore, the TBP was expanded by including three new variables, i.e., perception of self-effectiveness, perception of neighbor's participation, and belief about RE benefits. Perception of self-effectiveness influences an individual's intention directly and behavior indirectly. Perception of neighbor's participation is defined as the influence of neighbors in buying or consuming a particular product, while belief about RE benefits is considered as an individual's evaluation of the positive outcomes of consuming RE in the form of climate mitigation, reducing air pollution and improving the health conditions of people.

The authors assessed the public attitude towards RE by evaluating their intention to involve in the behavior of adopting green electricity. Figure 1 shows the analytical framework of this research. Combined with existing and new factors, the analytical framework has become comprehensive enough which will assist to examine consumers' intention for RE adoption.

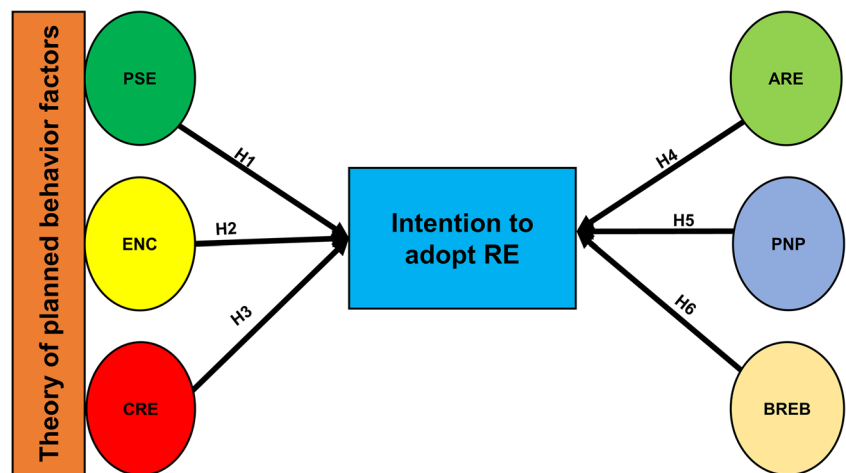
## Formulation of hypotheses

An extensive piece of literature has been consulted, i.e., research papers, policy documents, and official statistics for the formulation of hypotheses.

### Perception of self-effectiveness

If an individual does not exhibit the ability to perform a behavior, the conforming intentions would not happen. In the perspective of consumers' intention to adopt RE, perception of self-effectiveness (PSE) is linked with the comfort or struggle; consumers exhibit to adopt RE. One attribute that might influence consumers' PSE is the struggle associated with the adoption of the technology. Individuals should have access to the essential resources for the adoption, installation, and utilization of RE, (Korcaj et al. 2015). Former researches indicated that buyers' intentions for energy preservation have been positively influenced by PSE (Ham et al. 2015; Alam et al. 2014). For instance, Wang et al. (2017) reported that consumers' intention to choose vehicles are influenced by PSE. Consumers' intentions concerning energy-efficient devices were examined by Tan et al. (2017). It was found that PSE significantly influences their intention to buy these devices. Likewise, consumers' intention related to the adoption of bioenergy was studied by Halder et al. (2016). The outcomes revealed that PSE plays a critical role in buyers' decisions to adopt bioenergy. We formulated the first hypothesis by considering these research findings as:

**Fig. 1** The research framework of consumers' intention-based influence factors of renewable energy utilization. Notes: PSE, perception of self-effectiveness; ENC, environmental concern; CRE, cost of RE generation; ARE, awareness of RE; PNP, perception of neighbor's participation; BREB, belief about RE benefits



- H1: Perception of self-effectiveness positively influences consumers' intention to adopt renewable energy.

**Environmental concern**

Environmental concern (ECN) is defined as the level to which households have knowledge about environmental dilemmas and are committed to solving them. Globally, consumers are becoming aware of their daily consumption routines, and the level to which the environment is being affected by these activities (Canova et al. 2020). Consumers who possess this kind of behavior also demonstrate an optimistic attitude towards green technologies and make efforts for environmental protection (Tan 2011). ECN and the effect it has on consumers' choices to buy green products recently got the consideration of researchers. ECN is the major factor of consumers' intention that influence the adoption and consumption of RE (Dienes 2015). Residents with a positive ECN cautiously observe their energy utilization routines and possess positive behavior towards RE adoption (Lin and Syrgabayeva 2016). They anticipate energy preservations as a self-declared responsibility (Zhang et al. 2015) and comprehend it progressively (Komendantova and Yazdanpanah 2017). Liu et al. (2013) reported that the intention to adopt green energy might be influenced by consumers' awareness of climate change glitches. In another study, Kowalska-Pyzalska (2018) found the consequence of ECN on buyers' intention of energy conservation. By taking into consideration the above findings, it is likely that buyers' intention to adopt RE is positively affected by ECN and formulated as:

- H2: Environmental concern has a positive effect on consumers' intention to adopt renewable energy.

**Cost of renewable energy generation**

Consumers consider cost information to determine the economic losses linked with the buying procedure (Al-Marri et al. 2018). RE projects require high costs as they are capital intensive (Irfan et al. 2019c). Ghosh and Ghosh (2018) stated that cost is the major hurdle in the adoption of RE. Though the cost of RETs has declined significantly during the last decade (Chu et al. 2017), it is still higher than traditional electricity, and to remain competitive, the cost needs to reduce further (Shakeel et al. 2016). The outcome of several studies indicates that there exists a negative link between cost and consumers' intention of buying RE. Huh et al. (2014) reported that buyers' intention to accept RE decreases as the cost of RETs increases. In similar research, it was uncovered that high costs lower individuals' intention of RE adoption (Hansla et al. 2008). Similarly, Traber and Kemfert (2009) scrutinize that high cost is a key barrier in the acceptance of RE. Recently, it was exposed that the capital cost is the main obstacle of RE adoption (Eder et al. 2015). These results led to the formulation of the third hypothesis as:

- H3: There is a negative effect of cost on consumers' intention to adopt renewable energy.

**Awareness**

A major aspect in the minds of consumers while accepting new technology is awareness (Merikle et al. 2001). From the perspective of RE, awareness is considered residents' knowledge about RE technology and understanding about its cost, efficiency, and similar concerns (Komendantova and Yazdanpanah 2017). Awareness plays a crucial role during the consumers' decision process of adopting RE (Zografakis et al. 2010). Alam et al. (2014) conducted a study in Malaysia and found that consumers' intention to accept RE is positively



associated with awareness. In another study, Ek (2005) reported that individuals who have the awareness that utilizing green energy will lead to mitigating carbon emissions may take substantial actions to alter their current way of living and adopt RE to support the carbon-free environment. However, sometimes consumers remain unaware of the important issues of environment protection and energy-saving due to the lack of understanding and poor education (Wang et al. 2014) which is the leading cause of negative influence on consumers' intention to adopt RE. Based on the above findings, we hypothesized that

- H4: Awareness positively influences consumers' intention to adopt renewable energy.

### Perception of neighbor's participation

There is always a perceived societal pressure of executing a specific behavior (Ajzen 1991). Former studies revealed that the adoption of RE is affected by social norms. Perception of neighbor's participation is considered as the impact of neighbors to use RE. It was reported that perception of neighbor's participation is a leading factor influencing consumers' intention related to energy and energy preservation. A significant association was found between perception of neighbor's participation and residential energy preservation attitudes (Lopes et al. 2019). It was examined that households' behavior of mitigating GHG emissions and energy conservation is significantly linked with perception of neighbor's participation (Chen 2016). Rogers et al. (2012) reported that the realization of public green technology schemes is significantly affected by cultivating new social norms for energy generation. Gadenne et al. (2011) showed a positive relationship between perception of neighbor's participation and consumers' intentions concerning energy conservation and the environment. Ozaki (2011) uncovered that perception of neighbor's participation is a major motivational factor that encourages households to adopt RETs. Liu et al. (2013) reported that the purchasing intentions of consumers are mostly driven by neighbors, as the actions of neighbors inspire consumers to execute similar actions. A recent study indicated that households' intention of buying solar PV is significantly affected by the action of neighbors (Jayaraman et al. 2017). Overall, the neighbor's attitude and actions have a major influence on buyers' purchase intentions. Consequently, it has been assumed that the same may hold true in our study as well and hypothesized as:

- H5: Perception of neighbor's participation positively influences consumers' intention to adopt renewable energy.

### Belief about RE benefits

The belief about the benefits associated with green energy consumption is considered as residents' understating and knowledge of the advantages that RETs offers in terms of environmental mitigation, energy security, and energy efficiency (Komendantova and Yazdanpanah 2017). Individuals match the performance of RETs with traditional energy sources and make decisions based on the socio-economical point of view (Colmenares-Quintero et al. 2020). Thus, it is crucial to make efforts of expanding consumers' knowledge about the benefits related to green electricity consumption, i.e., improving air quality, minimizing GHG emissions, and make them aware of the negative consequences of consuming traditional electricity (Islam 2014). We devised the sixth hypothesis, considering the above arguments as:

- H6: Belief about RE benefits positively influences consumers' intention to adopt renewable energy.

## Research design

### Questionnaire development

With the ever-increasing population and growing industrial needs, energy shortage has become a major challenge in the way of sustainable development in Pakistan. A questionnaire survey was conducted in the five main cities of Pakistan namely Lahore, Karachi, Peshawar, Faisalabad, and Islamabad during August, September, and October in 2019 (Pasha 2015). In terms of economic structure, these cities demonstrate the distinctive characteristics of the country. In each city, we selected respondents by using convenient random sampling technique (Elfil and Negida 2017). To obtain accuracy, every aspect of the questionnaire was explained in detail to the respondents. A total of 353 valid responses were collected.

### Measures and collection of data

The scale items for determining awareness (ARE) were obtained from the work of (Alam et al. 2014). To assess perception of self-effectiveness (PSE) and perception of neighbor's participation (PNP), scale items were taken from (Liu et al. 2013). Scale items related to environmental concern (ENC) were obtained from the study of (Bang et al. 2000; Hartmann and Apaolaza-Ibáñez 2012). Scale items for measuring residents' belief about RE benefits (BREB) and the cost of RE generation (CRE) were taken from (Liu et al. 2013; Hartmann and Apaolaza-Ibáñez 2012). Scale items associated with consumers' intention to adopt (IAD) RE were consulted from the study of (Chou et al. 2015). All items

were evaluated on a 5-point Likert scale, as 1 being “strongly disagree” to 5 “strongly agree.”

### Analysis of data

SPSS (26.0) and AMOS (26.0) software were utilized for the analysis of data. Propositions were analyzed using SEM. The technique is robust to examine the relationship between different constructs. Due to robustness and efficiency, SEM provides accurate and meaningful outcomes (Steenkamp and Baumgartner 2000). Compared with other techniques, it allows to create several indicator variables per construct, which do not require split analysis and yield valid and clear inferences (Lei and Wu 2007). It considers measurement error by computing the measurement error sections of examined variables. Therefore, the results of the relationship among variables are reliable and neutral (Neale et al. 2016). In addition, it has the capability to scrutinize complicated associations and a variety of hypotheses instantly incorporating mean structures and group estimations which are very difficult to be done in other prototypes and techniques (Al-Gahtani 2016).

## Results and analysis

### Attributes of the respondents

Table 1 listed the demographic features of individuals. The largest share of respondents belongs to the middle age group (158, 44.8%) whose age was between 36 and 55 years, followed by young people (112, 31.7%) having age between 18 and 35. The third age group was old people (83, 23.5%) having age more than 55 years. The majority of the respondents were male (201, 56.9%). A total of 131 respondents (37.1%) belong to an upper-middle-income class with an income between Pakistani rupees (PKR) 31,000 and 40,000 per month, followed by middle-income class (96, 27.2%) having an income between PKR 21,000 and 30,000 per month. Besides, we categorized respondents into various education levels. Most of the respondents (119, 33.7%) have a college degree. The second largest group (91, 25.8%) has attended middle school in their lives. In our survey, 179 (50.7%) of the respondents belong to the technical occupation.

### Descriptive statistics and discriminant validity analysis

Descriptive statistics of the sample has been examined by utilizing mean and standard deviation. The interrelationships among constructs have been checked by using Pearson’s correlation test, which generated statistically significant correlations. The discriminant validity issue has been examined by using the square root of the average variance extracted (AVE).

**Table 1** Demographic characteristics of the sample

Characteristics	Classifications	N	Percentage (%)
Age	18–35	112	31.7
	36–55	158	44.8
	Above 55	83	23.5
Gender	Male	201	56.9
	Female	152	43.1
Income (PKR)	< 10,000	19	5.4
	10,000–20,000	66	18.7
	21,000–30,000	96	27.2
	31,000–40,000	131	37.1
	41,000–50,000	29	8.2
Education	> 50,000	12	3.4
	Illiterate	16	4.5
	Primary	64	18.1
	Middle	91	25.8
	College degree	119	33.7
Occupation	Graduate	63	17.8
	Government job	18	5.1
	Technical personnel	179	50.7
	Own business	73	20.7
	Farmer	59	16.7
	Other	24	6.8

The purpose of performing discriminant validity is to realize the extent to which factors’ items are theoretically not interrelated. It is noticed that the data do not have any discriminant validity issue, as the value of the square root of AVE is higher than its correlation with other constructs, verifying the absence of discriminant validity (Kline 2005) (see Table 2).

### Testing the fit of the model

Exploratory factor analysis (EFA) was conducted to know the contributing design structure. We performed Bartlett’s test of

**Table 2** Factor correlations and discriminant validity

Factors	ENC	PNP	BREB	ARE	PSE	CRE	IAD
ENC	[0.712]						
PNP	0.327	[0.825]					
BREB	0.270	0.488	[0.822]				
ARE	0.353	0.376	0.525	[0.754]			
PSE	0.339	0.252	0.175	0.328	[0.835]		
CRE	0.170	0.544	0.416	0.305	0.221	[0.781]	
IAD	0.296	0.569	0.506	0.418	0.236	0.724	[0.738]

Notes: Values in brackets [] indicate the square root of AVEs  
IAD, intention to adopt renewable energy

sphericity (BTS) and Kaiser-Meyer-Olkin (KMO) analysis before conducting EFA to calculate the suitability of data. The condition of EFA fulfilled, as the value of BTS was 9982.878 ( $p < 0.001$ ). The KMO value was 0.919, indicating that the sample is suitable for factor analysis as recommended by Kaiser (1974). Composite reliability (CR) test was performed to examine the consistency of all constructs' items. To realize the level to which the items are theoretically associated with each other, we performed the convergent validity test by utilizing AVE and loadings of the items (Anderson and Gerbing 1988). Results reveal that AVE values surpass 0.50 for all constructs, specifying that latent constructs detained a minimum of 50% of the variance.

The reliability of the samples was examined by conducting a reliability analysis test. Nunnally (1978) recommended that the reliability coefficient must not be less than 0.70. Our results indicate that the values of CR and Cronbach's alpha exceed 0.70 for all constructs (Table 3). Therefore, the outcomes of the measurement model verify the validity and reliability of the data. Next, confirmatory factor analysis (CFA) was performed to verify the adequacy of the data for the proposed model. Several fitness checks (CMIN/df = 1.627, GFI = 0.865, NFI = 0.894, RFI = 0.884, IFI = 0.956, TLI = 0.952, CFI = 0.956, and RMSEA = 0.042) were executed that produced values, as recommended by Kline (2005), Thompson (2004), and Byrne (1994).

**Table 3** Factor loadings and convergent validity results

Constructs	Items	Standard loadings	AVE	CR	Cronbach's alpha
Awareness of RE			0.569	0.902	0.904
ARE1	I know that RE-based solutions are available in the market	0.556			
ARE2	I am aware of the benefits of RE utilization	0.828			
Perception of self-effectiveness			0.697	0.920	0.892
PSE1	I possess the required knowledge to adopt RE	0.879			
PSE2	I possess full control of consuming RE	0.967			
PSE3	I possess all resources of consuming RE	0.710			
Environmental concern			0.507	0.804	0.804
ENC1	I am anxious about pollution	0.729			
ENC2	I am anxious of environmental problems	0.744			
ENC3	I am anxious of climate change	0.686			
ENC4	Utilization of RE can improve the environment	0.677			
Cost of RE generation			0.609	0.886	0.919
CRE1	Generation of RE cause extra cost	0.730			
CRE2	Renewable electricity is expensive as the RE projects need a heavy initial investment	0.806			
CRE3	RE consumption need high installation cost	0.904			
Perception of neighbor's participation			0.681	0.937	0.938
PNP1	Participation of neighbors in buying green energy influence me to adopt RE	0.777			
PNP2	Participation of neighbors in buying green energy motivates me to adopt RE	0.804			
Belief about RE benefits			0.676	0.936	0.937
BBEB1	Utilization of RE reduces carbon emissions and improve energy structure	0.644			
BBEB2	Utilization of RE would improve public surroundings	0.839			
BBEB3	Energy supply would become improved with the utilization of RE	0.807			
BREB4	Employment opportunities will be increased with the installation of new RE projects	0.860			
Intention to adopt RE			0.544	0.827	0.823
IAD1	I have the intention to adopt RE	0.677			
IAD2	Energy-saving behavior encourage me to adopt RE	0.708			
IAD3	I have the intention to spend more on RE than other sources of energy	0.665			
IAD4	I strongly recommend others to adopt RE	0.601			

Notes: Rotation technique: Promax; extraction technique: maximum likelihood; total variance elucidated: 63.77%; Bartlett's test of sphericity:  $\chi^2 = 9982.878$ ; Kaiser-Meyer-Olkin measure of sampling adequacy: 0.919; Sig: 0.000

### Valuation of structural equation and hypothesis testing

We estimated the structural model and analyzed the hypothesized relationships after attaining the validity and reliability of the measures. As an important step, the value of  $R^2$  was calculated to measure the amount of change in the dependent variable explained by independent variables. The  $R^2$  value (0.73) implies substantial interpretation as it exceeds the minimum accepted value of 0.35 recommended by Cohen (1988). Curve estimation was performed for all the relationships in the model and the covariance-based SEM algorithm was tested which yielded a strong  $F$ -value, indicating that all relationships are linear. To develop the model as good as possible, we performed the collinearity diagnostic test among all variables. The analysis shows that there is no multicollinearity issue in our model, as the Variance Inflation Factor (VIF) did not exceed the threshold value of 10 for all variables, as suggested by Field (2009) and is consistent with the results of Strupeit and Palm (2016). (see Table 4).

Figure 2 shows the path analysis of the structural model. After controlling the demographic variables, we calculated the goodness-of-fit indices for the structural model. Fit index values (CMIN/df = 1.380, GFI = 0.981, NFI = 0.967, RFI = 0.927, IFI = 0.991, TLI = 0.979, CFI = 0.990, PCLOSE = 0.885, and RMSEA = 0.033) surpass the threshold value, signifying that the model satisfactorily incorporated the data (Kline 2005; Thompson 2004; Byrne 1994). The path coefficient of the variable “perception of self-effectiveness” H1 ( $b = 0.66, p < 0.001$ ) indicates that consumers’ perception of self-effectiveness has a positive and significant effect on their intention to adopt RE. Therefore, we accepted hypothesis 1. It was noticed that consumers’ intention to adopt RE negatively affected by the variable “cost of RE generation” H3 ( $b = -0.01, p < 0.001$ ), as consumers’ intention decreases with an increase in RE cost. Thus, hypothesis 3 was accepted. Similarly, the path coefficients supported the hypotheses H4 ( $b = 0.09, p < 0.05$ ), and H5 ( $b = 0.11, p < 0.01$ ), and we accepted the hypotheses that “awareness of RE” and “perception of neighbor’s participation”, positively and significantly influence consumers’ intention to adopt RE.

Meanwhile, the path coefficients failed to validate the hypotheses H2 ( $b = 0.10$ ), and H6 ( $b = 0.08$ ), as the hypotheses “environmental concern,” and “belief about RE benefits” did not impart a significant effect on consumers’ intention to adopt RE and were rejected. The hypothesized paths and validity of the hypotheses have been shown in Table 4 and Fig. 2.

### Discussions

#### Association between perception of self-effectiveness and intention to adopt RE

Research results disclose that PSE has a positive impact on consumers’ intention to adopt RE and is in line with the findings of (Alam et al. 2014; Tan et al. 2017). The possible factors which motivate consumers to accept RETs include energy-saving, energy-security, and environment-friendly nature of RE. Besides, the utilization of photovoltaics for household purposes is more user friendly, easy to install, and has a more average life span than the existing sources of energy generation including uninterruptible power supplies (UPSs) and power generators. Consumers’ assessment of the technology and the knowledge of its utilization will assist as important dynamics to develop trust in green power technologies in the future.

#### Association between environmental concern and intention to adopt RE

Due to the clean nature, the consumption of green electricity aid in climate change mitigation by reducing carbon footprints. Zhang et al. (2015) and Liu et al. (2013) reported that consumers’ intention to adopt RE is affected by ECN. In light of previous research outcomes, the authors expected that the same results would happen in the Pakistani market. However, the outcomes of the current research did not realize a significant effect. One possible reason may be linked with the urge for which individuals purchase these energy generating systems. Contrary to the economies in which governments give importance to climate mitigation, reducing air pollution and anticipate that technology is a true substitute of lowering electricity costs, gain long-lasting environmental paybacks, and participate progressively towards the betterment of the environment, Pakistani buyers give less importance to climate change mitigation and pollution snags while making buying decisions. One main reason for this behavior is the lack of a robust policy structure. The government hardly attempts to allow residents aware of the environmental glitches and the dynamic role they could play to foster the environment.

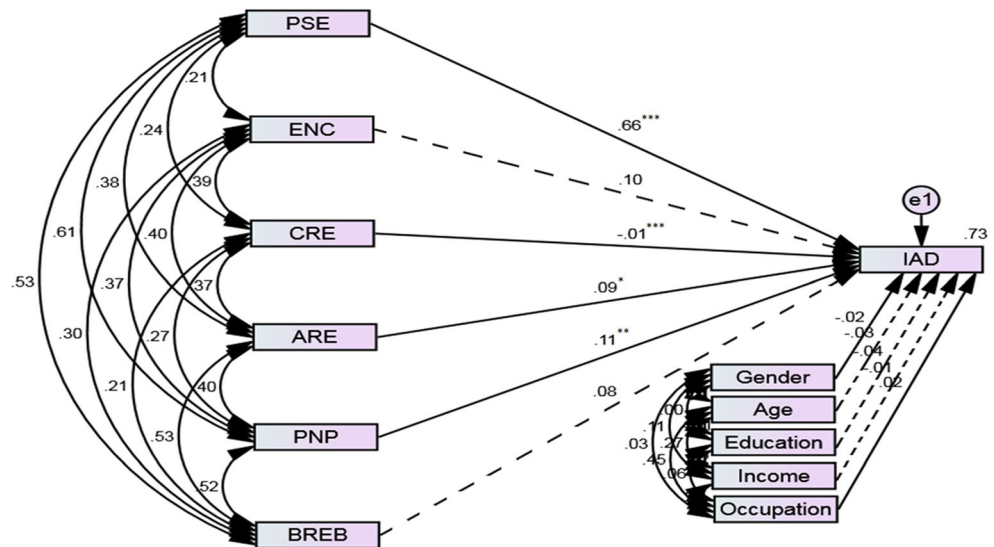
**Table 4** Result of the hypothesis and diagnostic tests

Hypothesis	Hypothesized paths	b value <sup>a</sup>	Accept	VIF	$R^2$
H1	PSE → IAD	0.66***	Yes	1.803	0.73
H2	ENC → IAD	0.10	No	1.379	
H3	CRE → IAD	-0.01***	Yes	1.285	
H4	ARE → IAD	0.09*	Yes	1.629	
H5	PNP → IAD	0.11**	Yes	1.864	
H6	BREB → IAD	0.08	No	1.780	

Notes: <sup>a</sup> Significance level (\*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$ )



**Fig. 2** Structural equation modeling. Continuous lines indicate significant paths and dashed lines show insignificant paths. Significance level (\*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$ )



### Association between cost and intention to adopt RE

The likelihood of consumers’ intention to adopt RE would decrease by having a positive belief about the extra cost associated with renewable electricity generation. Research findings supported this hypothesis, as cost negatively affects buyers’ intention to adopt RE. The research outcomes of previous studies are consistent with our findings, as Luthra et al. (2015) and Kardooni et al. (2016) stated that cost negatively influences consumers’ intention to adopt RE, stipulating that cost performs a critical part and is a primary impediment of RE acceptance. Similarly, Yaqoot et al. (2016) found that high cost significantly affects individuals’ intention and obstruct them from using RE. The traditional electricity is five to six times cheaper than renewable-based electricity in the Pakistani energy market. A middle-class family cannot bear such expenses and refrain from buying RE solutions.

### Association between awareness and intention to adopt RE

Research outcomes supported the hypothesis that awareness positively influences consumers’ intention to adopt RE, which indicates that individuals who are well familiar with RE tend to have a positive attitude towards it and are more likely to consume green electricity. The study of Moula et al. (2017) revealed that awareness has an encouraging effect on buyers’ intention to adopt RE which is in line with our research findings. On the contrary, the former study of Yasmin and Grundmann (2019) highlighted that awareness does not play a crucial role, as the individuals might not have enough knowledge about the benefits of RE. Due to the present energy problems of the country, the majority of consumers are acknowledging that the consumption of RE can overcome these

problems and help to solve the energy dilemma. The understanding of RE markets, technology, and installation services is growing rapidly that will be helpful in the future.

### Association between perception of neighbor’s participation and intention to adopt RE

Research results indicated that PNP has a significant impact on consumers’ intention to adopt RE. The results are in accordance with the previous studies of Chen (2016) and Jayaraman et al. (2017), as they stated that consumers’ intentions to adopt RE have been significantly influenced by subjective norms. Pakistan has an integrated social system and the actions of society and neighbors have a great impact on the minds of people. The previous understanding of peers of utilizing RE might influence buyers’ behavior in such a fashion that good experience allows the acceptance of RE. On the other hand, negative experience has opposite effects. Thus, PNP performs a dominant role during the decision process.

### Association between belief about RE benefits and intention to adopt RE

Hypothesis results indicate that consumers’ belief about RE benefits does not have a significant effect on their intention to adopt RE. These findings are contrary to former studies in which it was exposed that the buying preferences of consumers are based on the positive belief about the benefits of a specific product which they intend to buy. Consumers adopt RE if they know the perceived benefits associated with RE utilization (Abdul Rahman and Elinda 2016). One major reason is that the government did not advertise the comprehensive benefits of RE during its deployment in Pakistan and people

still favor traditional sources of energy as they are cheap compared with RE sources. Besides, buyers' belief in green energy technologies is limited.

## Conclusions and recommendations

In this paper, we analyze the factors influencing consumers' intention to adopt RE in Pakistan. The possible factors which might motivate or prohibit individuals to use RE were identified. We expanded the conceptual framework of TPB by incorporating three novel constructs. Based on an inclusive study of literature, it was recognized that the factors such as consumers' perception of self-effectiveness, environmental concern, cost of RE generation, awareness of RE, perception of neighbor's participation, and belief about RE benefits might affect their intention to adopt RE. A comprehensive survey was organized in the five main cities of Pakistan and SEM was used for the analysis of data. Research outcomes reveal that perception of self-effectiveness, awareness of RE, and perception of neighbor's participation have a positive influence on consumers' intention to adopt RE. The cost of RE generation was found to have a negative influence, whereas environmental concern and belief about RE benefits did not impart significant effects on consumers' intention.

With a focus to examine the social acceptance of RE adoption, the current study provides useful insights for stakeholders, organizations, and the government sectors associated with enhancing the deployment of RETs by realizing the relationship among all the factors influencing the acceptance and rejection of RE. The economy of Pakistan has been deeply affected due to colossal energy predicaments. The investment in RE is increasing all over the world and has earned global recognition due to falling costs and technological advancements (Khan et al. 2012). Still following the conventional

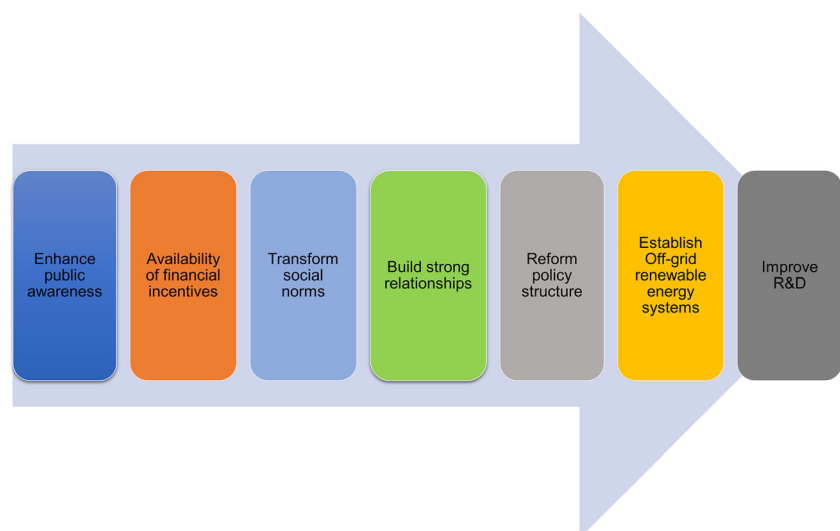
policy of depending on fossil fuels will put the country in a disastrous stage (Irfan et al. 2019d).

According to research outcomes, we have sorted four major motivations that endorse the importance of utilizing RE in Pakistan. Firstly, the country primarily relies on thermal sources for electricity generation. The import of expensive fossil fuels for power generation has put a heavy encumbrance on the national economy. The feeble Pakistani economy is inept to bear such a burden. Consequently, the future fossil supply of the country is under high risk. Secondly, the conventional policy of depending on fossil fuels for energy production did not generate the required results to manage the energy scarcity problem and failed desperately (Shah and Solangi 2019). Thirdly, Pakistan is a climate-vulnerable country in the world. Continuous reliance on fossil fuels would leash Pakistan into an undesirable state of climate change. Finally, the country has enormous RE potential. If exploited efficiently, the country can trounce the prevailing energy crises (Ghori 2012). In addition, the sustainability of RE depends on a country's policy and policy instrument which successively influences the cost and technological advancements. Besides, the technological advancements influence the cost of RETs, leading to market failures and low patronization of RETs (Owusu and Asumadu-Sarkodie 2016).

The subsequent policy recommendations have been advised for the Pakistani government to increase consumers' intention of adopting RE and gradually uplift RE's share in the country. Figure 3 illustrates the policy recommendations.

**Enhance public awareness** There is an urgent need to highlight the importance of minimizing carbon emissions, energy conservation, and adopting environment-friendly options of energy generation. All stakeholders including government, non-government organizations (NGOs), and enterprises should increase residents' awareness about environmental

**Fig. 3** Policy recommendations



issues and the benefits that RE offers to solve these problems. The process can be speeded up by launching environmental awareness campaigns and seminars at the national level.

**Availability of financial incentives** RE projects are capital intensive and require a high upfront cost. Therefore, the government should provide easy and long-term financing to developers and local dwellers. Banks and other financial institutions should be advised to allocate a special loan quota for RE projects. The interest rate for renewable projects should be reduced to motivate local and foreign developers to invest in RE projects. The research results indicate that the residents' belief of RE cost generation negatively affect their intention to adopt RE. Therefore, the Pakistani government should launch subsidy programs to motivate domestic users to adopt RE.

**Transform social norms** Pakistani society is integrated and the opinions of peers, relatives, neighbors, and society deeply impact the minds of local dwellers. Thus, social norms should be transformed by allowing consumers to select RE over traditional electricity.

**Build strong relationships** There is a need to build strong relationships between industry and government to validate that the government policy commandments of incorporating RE in the total energy mix of the country are producing the required results. Organizations involved with RE deployment should replace old strategies with innovative business models to completely commercialize RETs. For example, the small upfront cost of these technologies will be beneficial in this respect.

**Reform policy structure** An effective policy structure is critical in enhancing residents' intention to adopt RE and winning public support from a long-term perspective. The government should reform the old policy structure which is usually meant for conventional energy sources and formulate new and transparent policies for the quick deployment of RE in the country. Besides, the sustainability of RE depends on the energy policies of the government. This is because the major barriers in the adoption of renewables are the high cost of RETs, technological advancements, and market failures. These barriers could be addressed by the government through policy instruments. However, apart from government policies, consumers' psychology is associated with so many other aspects like awareness about new technology, societal norms, and so on. Therefore, an active and robust RE policy should involve consumers and consider the interconnection of factors influencing RE supplies and sustainability.

**Establish off-grid renewable energy systems** The off-grid RE system is a suitable and convenient technology, especially solar PV (Xu et al. 2019). Residents can be benefited from the off-grid RE system, as the power outage in the summer

season lasts from 8 to 10 h in the urban areas and 14 to 18 h in the rural areas of Pakistan (Iqbal et al. 2018).

**Improve R&D** R&D is a vital value-adding element of the renewable industry. Local production facilities should be improved by continuous R&D activities in order to reduce operating costs and dependence on foreign countries.

## Limitations and future work

Though the research results are in harmony with theoretical predictions, however, the current research is not without limitations. Firstly, there was a small sample size chosen which affect the generalizability of the outcomes. Secondly, the data was collected from urban areas and did not consider the rural areas of the country. The socio-economic features including awareness, income, and education might differ in urban and rural regions. Forthcoming studies should tackle this limitation by performing research in the countryside. Thirdly, the authors did not perform the levelized cost of energy (LCE) and cost-benefit evaluation. This critical aspect may be considered in future studies to supplement the existing body of literature from the Pakistani perspective. Lastly, a variety of factors affect the RE industry, however, only the most crucial factors were analyzed. This limitation could be overcome by assessing the impact of other possible factors including risk perception, trust in RETs, and moral obligations.

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