Assessment of public acceptance and utilization of renewable energy in Pakistan

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Abstract

Since the acceptance of renewable energy technologies is a complicated and multifaceted process influenced by a broad range of factors, it allows researchers to investigate these influencing factors. Therefore, this study aims to examine the factors influencing the intention of consumers to utilize renewable energy (RE). The current research led to a deeper understanding of the factors that encourage or discourage consumers to utilize RE by expanding the structural context of planned behaviour theory by the integration of three new considerations (perception of self-effectiveness, belief about the benefits of RE, and perception about neighbour's participation). The data used for analysis, collected from 351 households in Pakistan's four big cities such as Rawalpindi, Lahore, Gujranwala, and Faisalabad accompanying an inclusive survey. The propositions are scrutinized by utilising structural equation modelling (SEM). The results reveal that the driving factors such as perception of self-effectiveness, awareness, and perception about neighbour's participation have significant and positive effects on the intention of consumers to utilise RE. Whereas,

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RE cost utilisation belief has a negative effect. More interestingly, it was observed that the belief about the benefits of RE and environmental concern have insignificant effects. This study provides Based on research findings, essential and useful policy guidelines have been proposed in this research.

Keywords: Public acceptance; renewable energy; consumers; environmental concern; Pakistan

1. Introduction

Due to the recent economic growth and growing population, energy demand has increased enormously. Many developing countries, including Pakistan, still rely on fossil fuels for energy generation. Nonetheless, due to high prices and adverse environmental effects, fossil fuels can no longer be depended on as primary energy options (Iqbal et al., 2018). Governments are seeking economical and sustainable sources to resolve the existing energy crises and monitor the current economic situation (Merino et al., 2020). The change from traditional forms of energy generation to sustainable sources is due to the need for RE production and consumption by the public sector and regulatory bodies (Liu et al. 2013). Environmental concerns and climate changes have led policymakers to realise the other possible methods of energy production and minimise fossil fuel-based carbon footprints (Irfan et al. 2019a).

Various countries have taken initiatives to increase RE share in their energy proposition (Ikram et al., 2020). RE is considered as a true alternative to traditional energy sources due to falling costs throughout the world (Shah et al, 2019). RE programs are believed to enhance residents' quality of life in various ways. First, RE sources are likely to reduce emissions from air pollution and greenhouse gas (GHG) (Khan et al. 2019; Rehman et al., 2020), thus enhancing people's health. Second, RE penetration creates new jobs in the local population and directly promotes the domestic economy (Ram et al., 2020). Some RE sources are a little costly, as in the case of photovoltaics, the cost of energy generation is higher than other RE and non-RE sources (hydropower and coal). PV panels lose efficiency due to dust and pollution. The regular cleaning of PV panels, in turn, demands substantial cost (Sharma et al., 2012). However, due to resource scarcity and increasing rate of fossil fuel consumption, thermal energy (generated from coal, oil, and natural gas) is becoming more expensive (Kåberger, 2018). Shah et al. (2018) assessed the economic feasibility of off-grid PV solution for the rural regions of Pakistan and found that the energy generated using off-grid PV system only costs Pakistani rupees (PKR) 7.98/kWh that is very economical than the traditional energy which costs PKR 20.79/kWh. Finally, due to technological advancements and cost reduction potential, RE is outcompeting non-RE sources and would provide affordable energy and stabilise energy costs in the future (Kaygusuz, 2012; Caspary, 2009).

RE meet the growing population's energy requirements in a sustainable way (Irfan et al., 2019b). RE development would be expanded by understanding consumer's behaviour towards RE. Several researches examined the intention of consumers to use RE in developed countries. The results of their studies revealed mild to strong public acceptance of RE technologies (Hamilton et al., 2018; McGowan and Sauter, 2005). Some scholars concentrated on the structural capacities behind public acceptance of RE because the key determinants were economic motivation, efficient policies, and support programs (Paravantis et al., 2018, Musall and Kuik, 2011). Others have examined the psychologically oriented consumer behaviour (Huijts et al., 2012), and utilised quantitative assessments and environmental activism in large measure (Kaufmann et al., 2012). The intention to use RE is measured as a perception of residents' attitudes (Zografakis et al., 2010), specifying that the attitudes of people determine the degree to which RE is used. The contributing factors that influence public acceptance of RE were investigated in successive researches. Wüstenhagen et al. (2007) found that the intention of consumers rises with positive behaviour towards RE, that it will lessen environmental issues and decrease as the cost of energy increases. These findings are in line with Bang et al. (2000).

Likewise, the size of family, income (Hansla et al., 2008), social status (Batley et al., 2001), awareness, personal experience, education (Batley et al., 2000) are other important impelling factors. Other factors include location and urban vs. rural users. Devine-Wright (2005) reported that location is a significant factor that influences the social acceptance of wind farms. Shakeel and Rahman (2018) found that the social acceptance rate of RE is very high among urban residents of Pakistan. Liu et al. (2013) conducted a survey in the rural areas of China and found that rural dwellers are willing to pay for RE.

The rest of the paper is as follows. The section 2 presents the literature review. Methods, research design along with hypothesis formulation are presented in section 3. Section 4 presented the results and discussions. Finally, the conclusion remarks, policy implication and limitation of study is presented in last section of paper.

2. Literature review

Currently, some scholars have analyzed the intention of consumers in developing countries to use RE technologies. Hosseini et al. (2018) compared the consumers' intention of using different RE technologies by using the social acceptance pyramid. Research findings revealed that wind energy has a higher level of social acceptance as compared to geothermal and solar energy technologies. Alam et al. (2014) scrutinised intention of consumers to utilise RE in Malaysia and found that several factors such as perceived behavioural control, simplicity to use, relative advantage price reduction, and awareness significantly influence the intention to use RE. Vand et al., (2019) led a survey to investigate the attitude of consumers to support RE in China. Survey findings indicated that low awareness and income

are the major barriers in the way of RE utilisation. 97% of the respondents showed willingness to alter their sources of energy generation completely or partly by making them aware of the bad consequences of using fossil fuel-based energy. Majhi and Banarjee (2019) conducted research in India to find out consumer acceptance of RE transition. The research outcomes exposed that consumers demonstrated significant interests in RE adoption and are worried about environmental threats caused by fossil fuels. Düştegör et al. (2015) conducted a study in Saudi Arabia and found that the major influencing factors of RE adoption are financial incentives and government subsidy programs.

There have been few studies directed in Pakistan to examine the intention of residents to accept and utilize renewable energy generation technologies (RETs). Irfan et al. (2019c) highlighted that Pakistan is struggling with severe energy crises and the off-grid solar power is the best possible solution to overcome the prevailing energy crises of the country. Wang et al. (2020) assessed various RE sources of the country to diversify the energy generation from fossil fuels to RE. They found that there is an enormous potential of wind, solar, and biomass energy in the country. Akhtar et al. (2018) scrutinized the supply and future growth of various RE sources in the country and uncovered that Pakistan has the potential to generate 150,000MW of wind energy, 56,000MW of hydroelectricity, and 50,000MW of solar energy. Raza et al. (2020) proposed policy guidelines to develop RETs in Pakistan's rural regions. Mirza (2015) documented the residents' perceptions of and satisfaction with different RETs. Research results specify that local dwellers have a high acceptance of solar energy. Abdullah et al. (2017) conducted a survey to find the public willingness of accepting solar home system (SHS). The outcomes results indicated that 81% participants exhibit high willingness to pay for SHS. However, there also exist barriers which hinder residents from using SHS such as low awareness, risk, and the high price of solar panels.

Several scholars have contributed to the theory of planned behaviour, as some have focused on “environmental concern” to find out the knowledge of consumers about environmental problems and their motivation to solve these problems (Čábelková et al., 2020; Kim and Choi, 2005), while some have focused on the “cost of RE” and how it affects consumers' decisions (Shakeel and Rahman, 2018; Irfan et al., 2020). Some have focused on “awareness of RE” (Sarin et al, 2018), whereas, others have focused on “attitude towards RE” (Jabeen et al., 2019; Dalton et al., 2008). The society in Pakistan is integrated, stipulating that the acts of peers, family, and neighbours have a huge influence on people's minds. Therefore, people have concerns regarding self-effectiveness, neighbour's participation, and the benefits of RE. However, none of the previous studies have been identified to focus on examining these novel factors which this research has introduced in any respect before.

Contrary to former studies, the current research has anticipated all these factors from the viewpoint of considering RE. In this way, this research has contributed to the current knowledge base by bridging all these research gaps. In order to examine the proposed

hypothesis, the results are based on the primary data gathered from 351 households in the four big cities (Rawalpindi, Lahore, Gujranwala, and Faisalabad) of Pakistan by accompanying questionnaire survey. The state-of art-structural equation modelling (SEM) technique has been used for data analysis purposes.

This study provides three-fold contributions. Firstly, the research gaps inspired us to contribute to the current pool of knowledge by identifying and analysing the intention of consumers to utilise RE, domestic energy provision, and the possible factors encouraging or restricting Pakistani households to use RE. Secondly, the behavioural framework of planned behaviour theory has been expanded by incorporating three additional factors. Those factors are (perception of self-effectiveness, belief about the benefits of RE, and perception about neighbour's participation). Furthermore, the current study has extended research results different from the former studies. For example, as mentioned before, these novel factors have never been taken into consideration as the possible influencing factors of RE utilisation. Along these lines, perception of self-effectiveness is evidenced to be an important driver in the way of utilising RETs. Likewise, perception about neighbour's participation also persisted a significant addition to the behavioural framework of planned behaviour theory. On the contrary, belief about the benefits of RE found to has an insignificant role in the utilisation of RETs. We intend to focus on the general character of RE technologies in this study, as it has a positive environmental impact but demand higher participation cost compared with conventional sources of energy (Liu et al., 2013). To sum up, the present study conserves the novel research outcomes compared to the previous body of knowledge.

Finally, concerning the relevance of the results, though the findings are based on a questionnaire survey conducted in a specific geographical location (Pakistan), however, the implications of these results indicated the phenomenon of consumers' intention-based impelling factors to accept and use RE. The findings are beyond a specific region or territory in this respect. Pakistan has an abundance of RE sources in the form of solar, wind, biomass, geothermal, and hydroelectric power. Such abundant RE sources if used effectively, the country can meet its current and future energy demand by 100%. However, Pakistan is not particularly known for its support of RE due to several challenges and barriers including economical, policy, technological, and social barriers (Irfan et al., 2019b). Pakistan is a developing country and primarily depends on fossil fuels for energy generation. The national economy has been heavily burdened with imported costly fossil fuels to generate energy. Pakistan's weak economy cannot withstand such a burden. Consequently, the country is going through severe energy crises (Solangi, et al., 2019). It is anticipated that the other developing countries may also have the same energy dilemmas. Therefore, these novel factors (presented in the current research) may prevail in other developing countries or states as well. In this case, the research results are not case-specific, yet transferrable to other countries and

emphasize the importance of accompanying factors on RE utilization and for other countries to recognize this trend, Pakistan would be seen as a representative model.

3. Methods

3.1. Modeling framework

Former studies indicated that customers' decision-making process is based on a dynamic series of processes. Scholars have suggested different conceptual models to analyse the complicated essence of buyers' purchasing intentions (Moula et al., 2013). For instance, self-efficacy theory, reasoned action theory, and the theory of planned behaviour (Procter et al., 2019; Parkinson et al., 2017; Liu et al, 2013). However, the theory of planned behaviour (TPB) has been most widely employed by researchers in many consumers' research domains to describes and forecasts consumers' behaviour (Si et al., 2020). For example, e-commerce, organizational design, and green behaviour. Researchers have identified that compared with other models, TPB successfully examines consumers' behaviour in different settings. Different from contextual studies, we have focused on consumers' behaviour in this research. Therefore, TPB has been utilised to establish the modelling framework.

According to this theory, the behavioural intentions of an individual regulate the behaviour. Before doing a certain behaviour, individuals first weigh their implications and then execute that behaviour, which leads them to a needed outcome. The striking beliefs of an individual and the forecasts of the outcomes associated with a given behaviour form the attitude of an individual (Ajzen, 1991). In terms of economic, political, and social characteristics, scholars believe that several elements affect the approval of a specific technology. But TPB only discusses cultural, behavioural, and management views to assess the intention of consumers to partake in a certain behaviour and excludes certain considerations that may affect their intentions. As, the RE in Pakistan is not quite developed, residents are worried about social standards, the environment and the benefits of using RETs.

To fill this research gap, we have expanded the TPB by including integral factors such as perception of self-effectiveness, belief about the benefits of RE, and perception about neighbour's participation. Perception of self-effectiveness is defined as “one's ability to effectively perform a certain action/behaviour and this particular action/behaviour will be appreciated by the society”. The intention and behaviour of a person are directly and indirectly affected by perception of self-effectiveness. Belief about the benefits of RE is defined 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”. While perception about neighbour's participation implies that “the consumers' intentions and how they are shaped by what a neighbour does”.

We have assessed consumers' behaviour by assessing their intentions to participate in the behaviour of utilising RE. The modelling framework of this study has been illustrated in

Fig. 1. The analytical framework in accordance with existing and new variables would assist to examine consumers' intention to utilise RE.

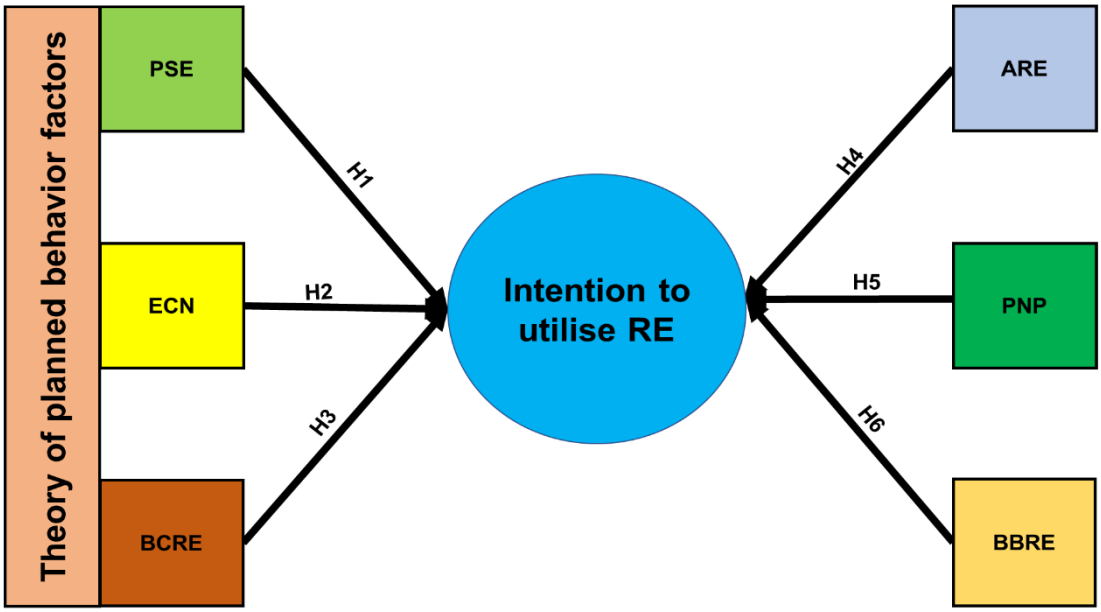

Fig. 1. Modelling framework indicating the influence factors of consumers' intention to utilise RE.

Notes: PSE: Perception of self-effectiveness; **ARE:** Awareness; **ECN:** Environmental concern; **PNP:** Perception about neighbour's participation; **BCRE:** Belief about the cost of RE utilization; **BBRE:** Belief about the benefits of RE.

3.2. Formulation of hypothesis

3.2.1. Perception of self-effectiveness

The pertaining actions would not exist if individuals are unable to exhibit a certain behaviour. Perception of self-effectiveness (PSE) directly influence intention of consumers and indirectly influence behaviour. In view of the intention of consumers to use RE, PSE is related to ease or difficulty, they possess to use RE. One major challenge that may affect the PSE of individuals is the struggle linked with technology acceptance. For the acceptance, installation, and utilisation of RE, the key resources should be available to consumers (Yun and Lee, 2015). Previous studies have shown that the intentions of consumers to accept RETs are positively shaped by PSE. For instance, Wojuola and Alant (2017) conducted a study in Nigeria and showed that the PSE is the main driver behind the acceptance of RETs. Hegan and Pijawka (2015) studied public perceptions regarding climate change and support for RE in North America. The research results specified that people are worried about environmental problems caused by fossil fuel burning and possess high support towards RE. Moreover, their support for RE is significantly influenced by PSE. Similarly, the intentions of consumers regarding the intake of biofuels have been examined by (Zhang et al., 2011). The results showed that PSE is a critical factor in consumers' decisions on biofuel use. By considering these research findings, the first hypothesis is formulated as:

H1: *There is a positive relationship between PSE and intention of consumers to utilise RE.*

3.2.2. Environmental concern

The degree to which citizens are aware of the environmental issues and are interested in solving them is known as environmental concern (ECN) (Ndebele, 2020). On a global scale, people are conscious of their regular practices of consumption and of the level at which their consumption practices impact the environment (Yue et al., 2020). Individuals who exhibit such behaviour often display a positive approach towards RETs and attempts to safeguard the environment (Kalkbrenner and Roosen, 2016). ECN and its impact on the choice of buyers to purchase green products (solar water heaters, solar lights, solar cookers, solar tube wells, biomass stoves, biomass boilers), recently got the consideration of researchers. Some studies specify that environmental concerns are less important than the desire to use less energy to lower the cost of buying energy by households (Shakeel and Rahman, 2018). Neither concerns about the environment nor the desire to pay less for energy may matter to households that do not have access to energy or suffer from the chronic disruption of energy supply. Such households may be inclined to utilise RE sources if they can afford it (Jabeen at al., 2019). On the contrary, some researchers consider that ECN is a significant element that affects the intention of consumers to accept and use RE. Consumers who possess positive ECN, track the use of energy carefully and have an optimistic attitude towards RETs (Karlstrøm and Ryghaug, 2014). They consider resource management a self-declared responsibility (Chen and Knight, 2013). Wang et al. (2018) claimed that consumers' knowledge of climate change vulnerabilities could affect their decision to use RE. A further study reports the impact of ECN on the intention of consumers to preserve energy (Hartmann and Apaolaza-Ibáñez, 2012). Considering these results, the choice of buyers to use RE is likely to be influenced positively by ECN and devised as:

H2: *There is a positive relationship between ECN and intention of consumers to utilise RE.*

3.2.3. Belief about the cost of renewable energy

Lee and Heo, (2019) reported that individuals take into account cost information in order to assess the losses linked to the purchasing procedure. Saving on energy costs and subsidies for the purchase of equipment that utilise RE are primary motives in utilising some RE sources (Klepacka, 2019; Klepacka et al., 2018). High cost is the biggest barrier for RE acceptance as reported by (Iskin et al. (2013). Whilst RETs cost has decreased considerably over the past years (Mohandes et al., 2019), it is still expensive than the fossil fuel-based conventional energy. RE ventures need massive costs as they escalate investments (Irfan et al., 2019d). Here, cost refers to both monetary and non-monetary costs. The results of various researches imply that a negative connection exists between cost and the intention of consumers to purchase RE. Sardianou and Genoudi (2013) assessed the determinants of

consumers' willingness to adopt RETs. It was turned out that cost is the main obstacle to RE adoption. Kostakis and Sardianou (2012) revealed that consumers' intention decreases as the cost of RETs increases. Moula et al. (2017) also exposed that high costs constitute a major barrier to the adoption of RE. Capital cost has recently been shown to be the main barrier of RE acceptance (Komendantova and Yazdanpanah, 2017). Based on these arguments, the third hypothesis was devised as:

H3: *There is a positive relationship between BCRE and intention of consumers to utilise RE.*

3.2.4. Awareness

Awareness is an important element in residents' minds while adopting new technology (Gordon, 2010). From the RE point of view, awareness is regarded as consumers' knowledge about RE in terms of cost, capability, and other related issues (Khambalkar et al., 2010). Awareness plays an important role in the process of consumer decision-making to accept and utilise RE (Ali et al., 2019). Al-Marri et al. (2018) led a research in Qatar and found that the intention of consumers to consume RE is positively linked with awareness. Abdullah et al. (2017) conducted a research in Pakistan and reported that people who are conscious that using RE contributes to carbon mitigation may take significant actions (shift their routines from traditional room/water heating to RE-based room/water heating i.e., solar room/water heaters and move from conventional ways of electrifying the house to solar home systems) to promote an environment free of pollution. Yet, consumers often remain unaware of the significant environmental and energy conservation concerns because of low awareness (Lopes et al., 2019) which is the major reason for the adverse impact on the intention of consumers to use RE. The fourth hypothesis was formulated on the basis of these claims:

H4: *There is a positive relationship between ARE and intention of consumers to utilise RE.*

3.2.5. Perception about neighbour's participation

Studies have shown that social norms influence the acceptance of RE. Society's pressure to exercise a specific conduct is always perceived (Steg et al., 2015). Perception about neighbour's participation is regarded as the influence on RE use by neighbours. It has been reported as the main influencer for consumers' energy conservation intentions. Opiyo et al. (2019) found a positive association between perception about neighbour's participation and residential attitudes towards SHS. Kosugi et al. (2019) has investigated the influence of neighbourhood on the diffusion of residential PV systems in Japan and found that neighbours have a significant effect on consumers' minds which shape their decisions regarding the adoption of PV systems. Palm (2017) examined the influence of peers on the acceptance of small PV systems among Swedish users. The results uncovered that the opinion of neighbours, friends, and family means a lot to consumers while adopting PV systems for household purposes. Rai et al. (2016) found positive links between neighbour's involvement

and the intention of consumers regarding preservation of energy and the environment. Perception about neighbour's participation has been unveiled by Qureshi et al. (2017) as an important motivating factor for residents to accept RETs. It is expected that the same could be true in this research and hypothesised as:

H5: *There is a positive relationship between PNP and intention of consumers to utilise RE.*

3.2.6. Belief about the benefits of RE

Consumers' understanding of the advantages offered by RETs usage in the form of carbon mitigation, the security of resources, and energy efficiency is termed as belief about the befits of RE (Süsser and Kannen, 2017). Consumers compare the benefits of RETs with conventional sources energy and took actions considering the socio-economic perspectives (Aitken, 2010). Consequently, efforts should be made to increase the knowledge of consumers about the advantages associated with the consumption of RE (improvement in air quality, reduction in carbon footprints) and inform them about the adverse impact of thermal energy consumption (Islam, 2014; Mohsin et al., 2019). Stigka et al. (2014) examined the social acceptance of RE sources as an alternate solution to fossil fuel-based energy generation and found that consumers give importance to use RE sources due to the perceived benefits and their contribution in achieving sustainability. The sixth hypothesis has been devised considering these findings as:

H6: *There is a positive relationship between BBRE and intention of consumers to utilise RE.*

3.3. Research design

3.3.1. Sample size, characteristics, and selection criteria

The study covers the four big cities of Pakistan such as Rawalpindi, Lahore, Gujranwala, and Faisalabad due to highest population density, equipped with modern facilities, and show the country's distinctive economic growth characteristics. A well-structured survey was administered in these cities during May June, and July of 2019 based on a comprehensive questionnaire. The detail of the questionnaire has been provided in the Appendix A1. The questionnaire was tested by conducting a pilot survey on a smaller sample size before the start of the actual survey to obtain accuracy and generate more meaningful results (Awadh et al., 2014). An in-depth explanation was provided to participants about every element of the questionnaire in this context. The authors approached the respondents in-person to conduct the survey. Later, for the actual survey, a convenient random sampling technique was used to select the respondents (Etikan et al., 2016) to ensure that all members of the population have an equal opportunity to be selected in the survey. This in turn, indicates that the sample is representative of the population. A total of 400 respondents were approached and 351 valid responses (the questionnaires whose all questions were filled by the respondents) were

collected, showing a response rate of (87.70%). Incomplete questionnaires were not entertained in the data analysis and considered invalid. The composition of the sample in the context of the total and urban population of Pakistan is 351: 221,483,664[1]: 77,437,729. The sample presents a balanced proportion from each sector of life, as respondents were selected from all categories of age, income, education and occupation. Osborne and Costello (2004) recommended that no specific criterion has been followed for deciding sample size in behavioural studies, as one-sixth of the researches applied a 2:1 subject-to-item ratio and 20% of the researches applied less than a 5:1 subject-to-item ratio. Our sample size (351 respondents) is even more than a 5:1 subject-to-item ratio, which is good enough for performing the data analysis. Two types of questions were incorporated in the questionnaire (i) questions regarding the demographic characteristics of the respondents and (ii) questions regarding influencing factors and residents' intention to utilise renewable energy. The description of the data collected is provided in Table 1.

Table 1: Survey information.

Study parameters	Value
Time	May, June, and July (2019)
Location	Rawalpindi, Lahore, Gujranwala, and Faisalabad
Sample size	400
Valid responses	351
Rate of response	87.70%

3.3.2. Measures and collection of data

The study of Liu et al. (2013) was consulted to take the scale items for measuring perception of self-effectiveness. The work of Kaldellis et al., (2012) was considered to extract the scale items associated with environmental concern. The research of Moula (2013) was chosen to obtain the scale items linked with RE cost and RE benefits. The study of Alam et al. (2014) was consulted to derive the scale items for evaluating awareness of RE. The research of Kalkbrenner and Roosen (2016) was considered to obtain the scale items for measuring perception about neighbour's participation. Finally, the work of Shakeel and Rahman (2018) was selected to collect the scale items related to consumers' intention. A five-point Likert scale was used to scrutinise all items, as 1 indicates “strongly disagree” and 5 indicates “strongly agree”. An aggregated result of all scale items was then considered as the projected value of these variables.

3.3.3. Data analysis

[1] The data of urban and total population of Pakistan has been obtained from Worldometers website. Available at: https://www.worldometers.info/world-population/pakistan-population/

The data analysis was conducted using SPSS (V. 26) and AMOS (V. 26) software packages. Hypotheses were tested by employing structural equation modelling. SEM is a robust technique to examine the association among different variables and has three major advantages over conventional multivariate methods. (i) clear estimation of measurement errors, (ii) calculation of latent (unobserved) constructs by observed constructs, and (iii) model testing for the implementation and evaluation of a structure in compliance with data. Much of the multivariate methods implicitly ignore measurement error by not directly measuring it. However, the SEM models measure both independent and dependent variables with these error variance factors (Novikova et al., 2013). The technique delivers precise and meaningful results due to its robustness and reliability (Hair et al., 2014). Consequently, we have utilised SEM, because it is the most suitable methodological choice for investigating the association among all the variables used in the study.

4. Results

4.1. Characteristics of the sample

Table 2 compiled the demographic profile of participants. Most of the participants were male (57.3%). The highest proportion of participants is from the middle ages (44%) with the age of 36-55 years followed by young (31.9%) and old people (23.6%) respectively. 37.3% of the participants have per month income between PKR 31,000-40,000 and categorised as upper middle-income class followed by middle-income class (27.4%) with a per month income between PKR 21,000-30,000. 34.2% of them have been graduated from college, whereas, 25.4% of them have middle school education. Technical personnel (51.6%) constitute the largest part of the sample followed by "own business" group (20.8%).

Table 2: Demographic profile of participants.

Features	Range	Frequency	(%)
Gender	Male	201	57.3
	Female	150	42.7
Age			
	18-35	112	31.9
	36-55	156	44.4
	Above 55	83	23.6
Income (PKR)			
	< 10,000	19	5.4
	10,000-20,000	66	18.8
	21,000-30,000	96	27.4
	31,000-40,000	131	37.3
	41,000-50,000	27	7.7
	> 50,000	12	3.4
Education			
	Uneducated	16	4.6

	Primary pass	66	18.8
	Middle pass	89	25.4
	College pass	120	34.2
	Graduate	60	17.1
Occupation			
	Technical personnel	181	51.6
	Government servant	16	4.60
	Own business	73	20.8
	Farmer	58	16.5
	Others	23	6.6

Notes: Technical personnel are those people certified in the use and operation of electric power equipment.

4.2. Summary statistics and test of discriminant validity

Summary statistics of the data are analysed using mean and standard deviation. Through using the Pearson correlation test, significant correlations have been found among variables. The issue of discriminant validity is tested by utilising the square root of the average variance extracted (AVE) with an objective to determine the degree to which the elements of the variables theoretically are not Interconnected. It was confirmed that there is no discriminant validity problem because the square root value of AVE is more than its correlation to other variables (Irfan et al., 2020) (see Table 3).

Table 3: Correlation matrix and discriminant validity findings.

Variables	M	SD	ECN	PNP	BBRE	ARE	BCRE	PSE	IURE
ECN	4.26	.755	**[0.713]**						
PNP	2.99	.946	0.329	**[0.826]**					
BBRE	3.79	1.22	0.274	0.485	**[0.822]**				
ARE	2.39	.937	0.354	0.375	0.523	**[0.755]**			
BCRE	2.41	1.10	0.172	0.543	0.413	0.303	**[0.782]**		
PSE	4.10	.594	0.346	0.248	0.171	0.329	0.220	**[0.838]**	
IURE	3.53	.441	0.295	0.568	0.507	0.418	0.723	0.233	**[0.743]**

Notes: The square root of AVEs is shown in brackets []; **M:** Mean; **SD:** Standard deviation; **IURE:** Intention to utilise renewable energy.

4.3. Validity and reliability

By calculating Cronbach's alpha, the items' internal reliability was checked. The Cronbach's alpha values surpass the threshold value of 0.70 for each variable, as suggested by (Nunnally, 1978), indicating that the data is valid and reliable (see Table 4).

4.4. Content validity

Content validity reflects the adequacy of which an individual content domain has been tested, i.e., whether an instrument is really an inclusive measure of the studied area. It is subjective and judgmental in its determination (Nunnally, 1978). Fig. 2 verify the content validity of the model because each item was loaded on the corresponding structure.

4.5. Composite Reliability and convergent validity test

The test of composite reliability (CR) was executed to evaluate the accuracy of each variables' items. Table 4 shows that the values of CR for all variables exceed the minimum accepted value, as recommended by Nunnally (1978). The test of convergent validity was conducted by using the AVE and items' loadings to determine the degree to which the items are theoretically related (Wong, 2013). The outcomes show that the values of AVE surpass 0.50, highlighting that the latent variables retained at least 50% variance.

4.6. Factor analysis

To determine the contribution structure, exploratory factor analysis (EFA) was performed. Kaiser-Meyer-Olkin (KMO) test and Bartlett's Test of Sphericity (BTS) were conducted to find the sampling adequacy of the data. The results uncover that the value of KMO is 0.919, specifying that data factor analysis can be performed (Kaiser, 1974). On the other hand, the BTS value was significant as well (9958.990), which satisfied the requirements of EFA (see Table 5). Next, confirmatory Factor analysis (CFA) has been carried out to check the data adequacy of the suggested model.

Table 4: Factor loadings along with the results of convergent validity.

Variables	Statements	Standard loadings	AVE	Composite reliability	Cronbach's Alpha
Perception of self-effectiveness			0.702	0.922	0.919
PSE1	I have the knowledge necessary to utilise RE	0.731			
PSE2	I have complete control over utilising RE	0.811			
PSE3	I have all RE utilisation resources	0.905			
Environmental concern			0.509	0.805	0.805
ECN1	I am concerned about pollution	0.726			
ECN2	I am concerned about environmental issues	0.740			
ECN3	I am concerned about climate crises	0.695			
ECN4	Environment could be improved by using RE	0.680			
Belief about the cost of RE utilisation			0.611	0.887	0.893
BCRE1	Utilisation of RE creates additional costs	0.869			
BCRE2	Renewables are costly as a massive investment is required for RE projects	0.953			
BCRE3	The cost of RE consumption is high due to substantial installment cost	0.741			
Awareness of RE			0.569	0.902	0.904
ARE1	I have the awareness that the market is providing RE-based solutions	0.553			
ARE2	I have the awareness about the advantages of RE usage	0.829			
Perception about neighbour's participation			0.683	0.937	0.939
PNP1	Neighbours' Participation encourages me to utilise RE	0.780			
PNP2	Neighbours' participation motivates me to utilise RE	0.807			
Belief about the benefits of RE			0.676	0.936	0.937

BBRE1	Using RE decreases GHG emissions and improve energy composition	0.653			
BBRE2	The usage of RE would strengthen public scenery	0.843			
BBRE3	The usage of RE would improve energy supply	0.814			
BBRE4	New RE installations would create employment opportunities	0.865			
Intention to utilise RE			0.553	0.832	0.826
IURE1	I intend to utilise RE	0.687			
IURE2	Energy-saving attitude provokes me to utilise RE	0.753			
IURE3	I intend to pay more for RE than other energy sources	0.646			
IURE4	I strongly suggest that other people must use RE	0.581			

Notes: Method of rotation: Promax; **Method of extraction:** Maximum Likelihood.

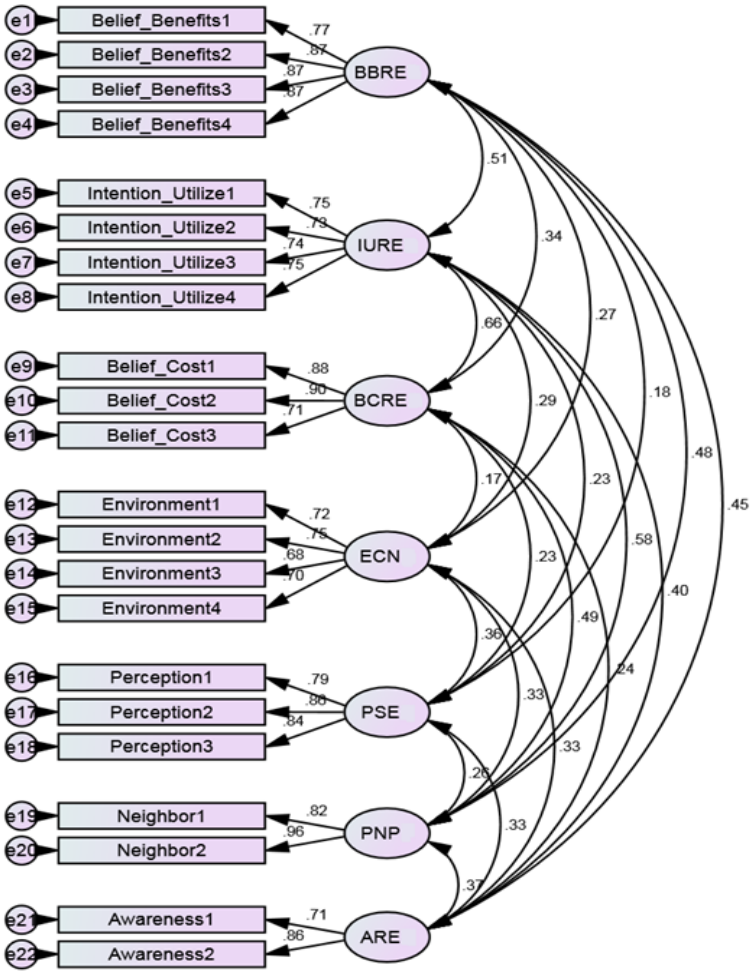

Fig. 2. Measurement model.

4.7. Hypothesis testing and estimation of structural equation

After getting valid and reliable measures, the structural model was estimated, and the hypothesised relationships were analysed. As an essential step, the R^2 value was computed

to assess the variations in the outcome variable explained by explanatory variables. Cohen (2013) suggested that the R^2 value should not be less than 0.35. Our analysis shows that the R^2 value is 0.75 which surpasses the threshold value, suggesting considerable interpretation. To test all relationships proposed in the model, curve estimation and the SEM algorithm based on covariance were conducted which provided a high F-value, specifying that the model has linear relationships. A collinearity diagnostic test was performed to check the multicollinearity problem. Field (2009) indicated that the value of the Variance Inflation Factor (VIF) should not exceed 10. The results show that the multicollinearity problem does not exist in the model since the VIF of all variables did not exceed the recommended value.

The schematic representation of SEM has been illustrated in Fig. 3. Table 6 reports the structural model's goodness-of-fit indices. It is obvious from Table 6 that the values of all fit indices are within the recommended criterion (Lucianetti et al., 2018), denoting that the data has been incorporated by the model absolutely. From the results obtained, the path coefficient value (β) of the relationship between PSE and IURE is 0.70 with a p-value < 0.001, indicating that consumers' IURE is significantly and positively affected by PSE. Thus, hypothesis 1 (*H1*) was accepted. It was found that BCRE has a negative effect on consumers' IURE, as the path coefficient value (β) of the relationship between BCRE and IURE is -0.00 with a p-value <0.05. Therefore, we accepted hypothesis 2 (*H2*). Similarly, the path coefficient values (β) of the relationship between ARE and IURE, and PNP and IURE are 0.10 and 0.0 with p-values < 0.01 and < 0.05 respectively, revealing that consumers' IURE are significantly affected by ARE and PNP. Thus, hypothesis 4 (*H4*) and 5 (*H5*) were accepted. On the contrary, the path coefficients of the relationships between ECN and IURE, and BBRE and IURE failed to support the hypotheses 2 (*H2*) and 6 (*H6*). As a result, ECN and BBRE do not have a significant effect on consumers' IURE and therefore rejected. Table 7 reports the structural paths and hypotheses validity.

4.8. Additional testing

Endogeneity testing is mainly used to keep the robustness of research results (Jean et al., 2016). Therefore, we have employed it because it can cause a possible threat to our findings. Besides, the maximum likelihood estimate could be distorted due to endogeneity bias, posing a significant threat to results' validity. To overcome this, we performed the Heckman test by using the Stata program to get propensity values while examining endogeneity. It was revealed that the same significance has been obtained as in the previous model, specifying that our results do not have endogeneity bias (see Table 8).

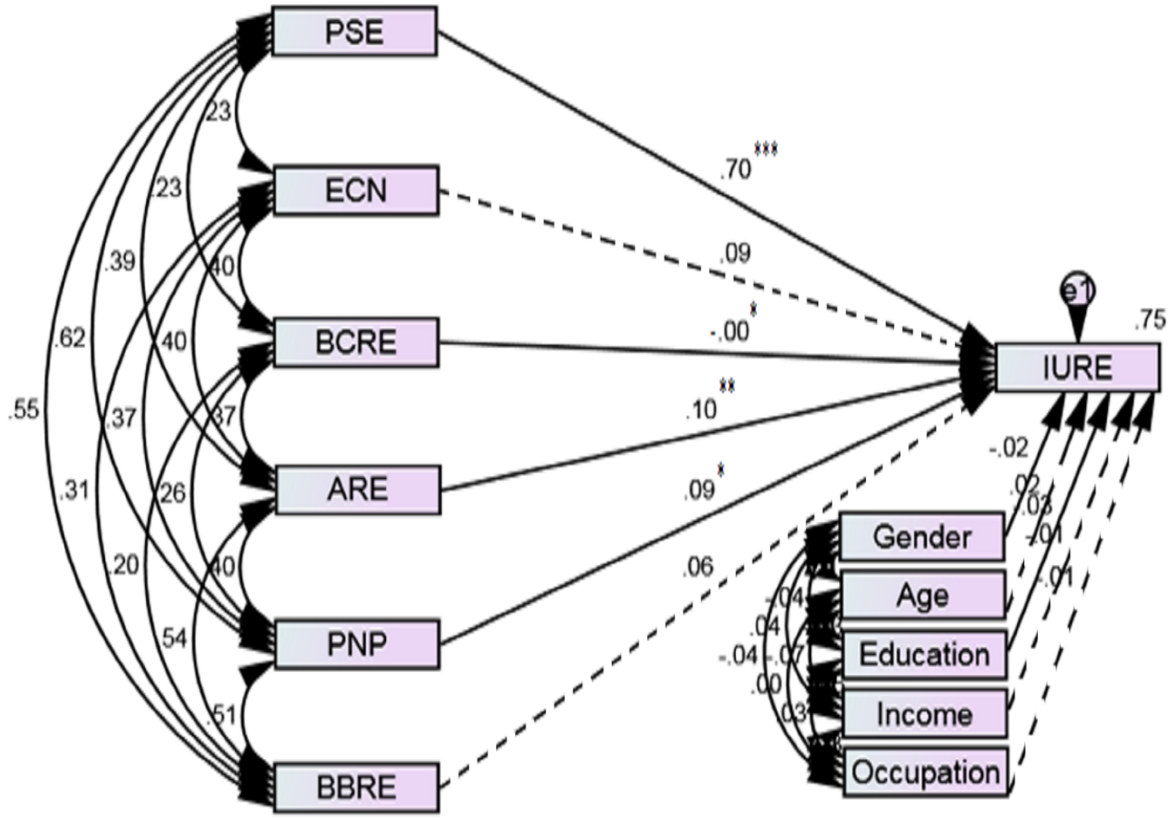

Fig. 3. Schematic representation of SEM. Smooth lines indicate significant paths and broken lines indicate insignificant paths. ***, **, * statistically significant at 0.001, 0.01, and 0.05 percent levels respectively.

Table 5: Kaiser–Meyer–Olkin (KMO) and Bartlett's Test.

KMO and Bartlett's test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.919
Bartlett's Test of Sphericity	Approx. Chi-Square	9958.990
	df	57
	Sig.	0.000

Notes: Cumulative variance explained: 63.97%; **df:** Degree of freedom**; Sig:** Significance.

Table 6: The goodness of fit indices of SEM model.

Fit statistics	**Value**	**Recommended criterion**	**Description**
X^2/df	1.362	< 0.08 good fit	Chi-square
CFI	0.990	> 0.9 good fit	Comparative fit index
IFI	0.991	> 0.9 good fit	Incremental fit index
GFI	0.981	> 0.9 good fit	Goodness of fit
NFI	0.965	> 0.9 good fit	Normed fit index
TLI	0.979	> 0.9 good fit	Tucker-Lewis index
RMSEA	0.032	< 3 good fit	Root mean squared error of approximation
SRMR	0.02	< 0.09 good fit	Standardised root mean squared residual

Table 7: Structural paths and hypotheses results.

Hypotheses	Structural paths	Coef (β)	Conclusion	VIF	R^2
H1	PSE ⟶ IURE	0.70***	Accepted	1.289	0.75
H2	ECN ⟶ IURE	0.09	Rejected	1.389	
H3	BCRE ⟶ IURE	-0.00*	Accepted	1.850	
H4	ARE ⟶ IURE	0.10**	Accepted	1.659	
H5	PNP ⟶ IURE	0.09*	Accepted	1.873	
H6	BBRE ⟶ IURE	0.06	Rejected	1.830	

Notes: Significance level (***p < 0.001, **p < 0.01, *p < 0.05).

Table 8: Endogeneity test.

Hypotheses	Structural paths	Coef (β)	*t*-Statistics	Conclusion
H1	PSE ⟶ IURE	0.071***	3.059	Not different
H2	ECN ⟶ IURE	0.582	-0.288	Not different
H3	BCRE ⟶ IURE	-0.005***	17.956	Not different
H4	ARE ⟶ IURE	0.072**	2.383	Not different
H5	PNP ⟶ IURE	0.045*	1.863	Not different
H6	BBRE ⟶ IURE	0.080	2.778	Not different

Notes: Significance level (***p < 0.001, **p < 0.01, *p < 0.05).

5. Discussions

5.1. Relationship between PSE and IURE

The findings of our study demonstrate that PSE has a positive and significant effect on consumers' IURE and is consistent with the earlier investigations of (Wojuola and Alant, 2017; Zhang et al., 2011). Energy efficiency, energy security and the eco-friendly character of RE could be the potential drivers that encourage residents to utilise RE. Out of various available energy generation sources such as oil-fired power generators and urgent power supply (UPS) in Pakistan, the utilisation of PV for domestic usage is more convenient, simple to use and has a longer life duration. Buyers' technology evaluation and understanding of its use would help to develop confidence in RETs as significant dynamics in the coming years.

5.2. Relationship between ECN and IURE

It is commonly understood that RPTs use help to improve the environment and can reduce carbon production discharges. Some former studies found that the intentions of residents to utilise RE are affected by ECN (Kalkbrenner and Roosen, 2016; Wang et al., 2018). Based on these findings, it was anticipated that similar outcomes may occur in Pakistani as well. The results of our study, however, show that ECN does not has a significant influence on consumers' IURE. The potential cause could be connected with the vital desire for which people buy such power generation solutions. In addition, unlike the governments who value climate change problems, control carbon emissions, and expect technology to genuinely substitute the reduction of energy prices, achieve long-term environmental benefits, and gradually contribute towards environmental improvement, residents in Pakistan

put less focus on climate issues and pollution bottlenecks during purchase decisions (Shakeel et al., 2018; Ikram et al,. 2019). The absence of a strong policy mechanism is one of the primary reasons for this kind of behavior (Irfan et al., 2020). The Pakistani government seldomly make it easier for people to have awareness about the environmental problems, their obligations, and an active role they can perform in promoting the environment.

5.3. Relationship between BCRE and IURE

RE-based power solutions are expensive in contrast with traditional energy generation methods and the higher purchasing cost has been turned out to be a key barrier to their adoption. For instance, it currently costs approximately 5-6 times more to set up PV systems for domestic purposes in comparison to other available energy generation techniques, such as UPS and power generators. A normal Pakistani household cannot bear such above-average charges and refrain from using RE solutions. Research results aid our supposition because cost has a negative impact on consumers' IURE. The findings of former studies are in line with our results, as Sardianou and Genoudi (2013) and Iskin et al. (2013) reported that cost is a significant hurdle of RE adoption. In another study, Komendantova and Yazdanpanah (2017) revealed that high cost often influences the intention of citizens and discourage them from accepting RETs.

5.4. Relationship between ARE and IURE

The results reveal that awareness has a positive and significant impact on consumers' IURE, specifying that residents with a good knowledge of RE are more likely to have a positive attitude towards RE and tend to utilise it. These results are in accordance with the findings of a previous study (Ali et al., 2019). Similarly, Abdullah et al. (2017) exposed that awareness positively affect the intention of consumers to use RE. The possible reason is that residents have awareness of RE and the advantages it offers compared with conventional energy sources. Because of the country's prevailing energy crises, more and more residents are becoming aware that RE use may resolve these problems and ultimately fix the energy shortage problems of the country. Consumers' awareness about RE technology, markets, and support of installation is rapidly increasing which would be handy in the years to come.

5.5. Relationship between PNP and IURE

The findings uncover that PNP has an encouraging effect on consumers' IURE. Our results are coherent with the previous findings of (Fischer and Sauter, 2004). In another study, Kosugi et al. (2019) found that residents' intentions of adopting PV systems are positively affected by PNP. In a country like Pakistan, the social system is very integrated, and the actions of friends, family, neighbours, peers, and society have a significant effect on decision making. The former knowledge of peers about using RE might affect the behaviour of

residents in a manner that a pleasant experience enables RE acceptance, whereas, an unpleasant experience has a bad impact on buyers' intentions. These findings signify that PNP has a significant role during RE purchase decisions.

5.6. Relationship between BBRE and IURE

The findings of the study disclose that consumer's BBRE has no substantial effect on their intention to use RE. These outcomes disagree with the previous researches that showed that residents' buying behaviours are based on their positive belief of the benefits about a particular product they urge to purchase (Stigka, 2014). If residents are aware of the perceived benefits of RE use, they would accept it. Yasmin and Grundmann (2019) reported that citizens may not have adequate knowledge about the benefits of RETs which is the major impediment of RE adoption. Another reason could be that during RE deployment in the country, the Pakistani government has not promoted the comprehensive benefits of RE, and citizens still favour conventional energy sources, which are cheap in comparison to RETs. Furthermore, residents' belief in RETs is limited, therefore, the acceptance of RE is at its preliminary phase in the country.

6. Conclusions

This study examines the impact of influencing factors on the intention of consumers to accept and use RE. Possible factors have been addressed that may inspire or prevent people from using RE in this analysis. By incorporating three novel and integral factors, this study has expanded the theoretical framework of TPB. In the four major Pakistani cities, an inclusive survey was arranged, and data analysis was performed by using SEM. Research results disclose interesting findings with significant policy proposals and decision-making insights. Consumers' IURE is positively and significantly influenced by awareness, perception of self-effectiveness, and perception about neighbour's participation. On the contrary, it is negatively influenced by belief about the cost of RE utilisation. While belief about RE benefits and environmental concern do not have significant influences on consumers' intention.

This study would serve as a useful guide for policymakers, organizations, and stakeholders involved in RETs business. Based on research findings, it is recommended that the importance of mitigating climate changes, energy-saving, and making eco-friendly energy supply choices needs to be stressed urgently. Public awareness of environmental problems and the benefits offered by RE to address these problems should be increased by all stakeholders such as government, NGOs, and public and private institutions. This can be accelerated by organising climate and environment related awareness-raising workshops and campaigns at the state level. Almost all RE development projects are capital intensive and need high initial investment i.e., solar energy parks, wind power plants, biomass plants, and

hydropower projects. Therefore, the government should provide developers with simple and long-term financial support. A unique loan quota should be recommended to banks and other monetary organisations for RE development programs. In order to encourage national and multinational companies to invest in RE programs, the interest rate should be lowered. The findings show that the belief of the citizens regarding RE costs has a negative impact on their IURE. The government of Pakistan should therefore introduce subsidy schemes to encourage domestic consumers to use RE.

Pakistan has an integrated social system denoting that there is a deep influence of the actions of friends, family, neighbours, and society on consumers' minds. Social standards should therefore be reshaped by enabling residents to choose RE over conventional energy sources. The government-industry cooperation should be enhanced to authenticate that the national policy targets of integrating RE in Pakistan's energy portfolio are generating the desired outcomes. Enterprises dealing with RE development should substitute old marketing tactics with novel business concepts to fully commercialise RETs. A robust policy mechanism is necessary to improve consumers' intention and public acceptance of RE in the long run. In order to quickly deploy RE in the country, the government must replace the old energy policies which are typically intended for traditional energy sources with new and transparent policies.

For domestic purposes, the off-grid RE system is an effective and appropriate technology. The system could benefits individuals, as the shutdown of electricity during the summer season lasts from 8-10 hours in the urban areas and 14-18 hours in the rural areas of Pakistan. R&D is also an essential value-adding component of the renewable sector. At the local level, continuous R&D activities can improve the production facilities which in turn would minimise production costs and reliance on foreign markets.

The current study also has some limitations which should be taken into account while doing new researches in this area. First, the authors did not measure attitude towards RE which is an important factor in behavioral studies. It would produce better results if this factor was analyzed in the study. Second, four big cities were considered for data collection purposes, and rural areas were not included. Throughout urban and rural areas, socio-economic characteristics such as income, awareness, and education can differ considerably. Future researchers can tackle this limitation by taking inputs from rural dwellers as well. Finally, it could be interesting to raise the relationship between awareness and belief about the benefits of RE which the current study did not mention. A future research could be conducted to raise the relationship between awareness and belief about the benefits of RE.

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Appendix: Survey questionnaire

Table A.1
Factors influencing the intention of consumers to utilise RE.

Variables	Statements	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Perception of self-effectiveness						
PSE1	I have the knowledge necessary to utilise RE					
PSE2	I have complete control over utilising RE					
PSE3	I have all RE utilisation resources					
Environmental concern						
ECN1	I am concerned about pollution					
ECN2	I am concerned about environmental issues					
ECN3	I am concerned about climate crises					
ECN4	Environment could be improved by using RE					
Belief about the cost of RE utilisation						
BCRE1	Utilisation of RE creates additional costs					
BCRE2	Renewables are costly as a massive investment is required for RE projects					
BCRE3	The cost of RE consumption is high due to substantial instalment cost					
Awareness of RE						
ARE1	I have the awareness that the market is providing RE-based solutions					
ARE2	I have the awareness about the advantages of RE usage					
Perception about neighbour's participation						
PNP1	Neighbours' Participation encourages me to utilise RE					
PNP2	Neighbours' participation motivates me to utilise RE					
Belief about the benefits of RE						
BBRE1	Using RE decreases GHG emissions and improve energy composition					
BBRE2	The usage of RE would strengthen public scenery					
BBRE3	The usage of RE would improve energy supply					
BBRE4	New RE installations would create employment opportunities					
Intention to utilise RE						
IURE1	I intend to utilise RE					
IURE2	Energy-saving attitude provokes me to utilise RE					
IURE3	I intend to pay more for RE than other energy sources					
IURE4	I strongly suggest that other people must use RE					