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Shah Rukh Shakeel, and Saleem ur Rahman

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Shah Rukh Shakeel[1,a)] and Saleem ur Rahman[2,b)]
[1]*School of Technology and Innovations, University of Vaasa, Wolffintie 34, 65200 Vaasa, Finland*
[2]*School of Marketing and Communication, University of Vaasa, Wolffintie 34, 65200 Vaasa, Finland*

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Adoption of renewable energy technologies is a complex and intricate process affected by a multitude of factors. The objective of this study is to examine the factors influencing consumers' intention to use renewable energy technologies for household usage in Pakistan. In order to understand the adoption behaviour, we have extended the actual framework of the theory of planned behaviour by integrating three additional factors, i.e., environmental concern, cost, and awareness. The findings of this research are based on primary data collected from 244 households in the twin cities of Islamabad and Rawalpindi through survey questionnaires. The proposed hypotheses were then tested and analysed using structural equation modelling. The results reveal that factors such as subjective norm, perceived behavioural control, and attitude positively influence consumers' intention to use renewable energy technologies in Pakistan, whereas cost has the opposite effect. Interestingly, awareness and environmental concern were found to be insignificant. The results of this study highlight the need to increase environmental awareness, frame innovative financing mechanisms, and address the benefits that renewable energy technology offers, all through an integrative and coherent effort. *Published by AIP Publishing.*
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I. INTRODUCTION AND BACKGROUND

Over the past few decades, environmental and climate change issues have taken the centre stage in political and economic debates around the globe. The excessive use of hydrocarbons for energy generation purposes has severe effects on the environment, nature, and society as a whole. Efforts are being made to ensure a smooth transition from conventional fuels to renewable sources for energy generation purposes. However, the successful and smooth transition from one energy source to another is very much dependent upon the efforts at multiple levels and on the input of all the stakeholders involved in the process (Kern and Smith, 2008).

Entrepreneurs and energy technology companies are important elements in this transition process since without the availability of affordable and reliable energy technologies, the transition of the energy system and the attainment of related environmental targets will remain only a dream. Therefore, invention, diffusion, and adoption of technologies by consumers all become important. However, for a technology which is high-tech, is radical in nature (requires changes in existing institutional and technical infrastructures), and belongs to an industry which is in the earlier phases of development, it may be challenging to achieve successful commercialization in isolation (Shakeel *et al.*, 2017). Story *et al.* (2011) affirmed that a single company is rarely

[a)]Author to whom correspondence should be addressed: sshakeel@uwasa.fi and shahrukh.sipra@gmail.com
[b)]Saleem.Rahman@uwasa.fi

capable of ensuring the successful commercialization of a technology. The diffusion of such technologies often requires cooperation between individual actors, organization, and support from other stakeholders. Actors surrounding the innovator companies can impart knowledge and provide access to relationships and other resources that are important for commercialization. Similarly, the role of consumers in facilitating and accelerating this transition cannot be overlooked. Consumers, as end users, must make the final choice between conventional and environmentally friendly solutions. Therefore, their understanding of the issues and their awareness (AW) regarding the alternatives become an important topic. Environmental and economic policymakers emphasize consumers' responsibility and the role they can play in achieving environment-related targets. According to Aarikka-Stenroos *et al.* (2014), successful commercialization requires innovation in promoting interaction and communication between individuals and communities. Therefore, consumers' actions and behaviour towards renewable energy sources have become pivotal in achieving energy-related targets and in the attainment of a sustainable future.

Pakistan, as a populous and developing country, requires ample supplies of energy to meet its domestic energy requirements and keep its development on track. However, despite being endowed with enormous resources and energy generation potential, the country has not been able to meet its primary energy needs and has experienced acute energy crises (UNDP, 2014). Electricity is the sector that has suffered the most from the energy shortages. The gap between demand and supply is managed through routine power cuts. The duration of power cuts can be 8–10 h a day in the cities and 10–14 h a day in rural areas, depending upon the generation capacity and the energy demanded (GIZ, 2016). This inability to ensure the necessary energy supplies has hindered the country's economic development and has impacted the social life of its inhabitants. The restricted supplies of electricity from the grid have left households and businesses in disarray, leaving them with no other choice but to install an alternative energy generation system in homes and workplaces. This prolonged absence of grid electricity has led to the development of whole new markets for alternative energy generation systems—including rechargeable devices, storage batteries, uninterruptible power supplies (UPSs), power generators, and solar photovoltaics (PVs). To this end, a standard household generally relies on a UPS, an oil-fired power generator, and/or rechargeable devices for access to electricity when power from the grid is turned off.

Pakistan is blessed with enormous renewable energy potential, and the use of renewable energy technologies (RETs) for the power generation can help to reduce import costs and decrease emissions, offering a long-term solution. Despite the significant energy generation potential, the use of sustainable energy technologies such as solar PV is not always a preferred choice. A number of factors are attributed to the low adoption of RETs worldwide including the cost, use of the technology, lack of supportive policy frameworks, and low levels of environmental awareness (Karakaya and Sriwannawit, 2015). However, there have been hardly any studies conducted in the context of Pakistan to understand the drivers encouraging or discouraging consumers to opt for or abstain from RETs. Extant research has primarily focused on the availability of different energy sources and their potential (Ghafoor *et al.*, 2016), the state of the energy generation sector (Shaikh *et al.*, 2015), the impact on industry and the economy (Shahbaz and Ali, 2016), emission reduction (Yousuf *et al.*, 2014), energy security (Sahir and Qureshi, 2007), analysis of government initiatives and policies (Shakeel *et al.*, 2016), studies of the barriers that the sector is facing (Rafique and Rehman, 2017), and the way forward (Amer *et al.*, 2016). However, studies from the perspectives of technology companies and consumers have largely remained unaddressed. In the absence of relevant information, it becomes difficult for companies, policymakers, and other stakeholders to formulate effective strategies and devise measures to encourage customers to use renewable-based solutions, consequently enhancing the adoption of such technologies. This study attempts to bridge the gap by investigating the factors influencing consumers' intentions (INTs) to use RETs for household purposes. The remaining sections of this paper deal with: (a) the theoretical framework and hypothesis development, (b) the methodology of the study, (c) the results and analysis, (d) the discussion, (e) the conclusion and implications, and (f) the limitations and suggestions for future research.

II. THEORETICAL FRAMEWORK

Previous research has argued that consumers' decision-making is a complex phenomenon, and an actual purchase decision may have been influenced by several divergent factors, such as economic, social, and psychological factors (Olshavsky and Granbois, 1979). To understand the complex nature of consumers' purchase decisions, several theoretical frameworks have been applied by researchers, for example, social cognitive theory (SCT), self-efficacy theory (SET), the theory of reasoned action (TRA), and the theory of planned behaviour (TPB) (Ajzen, 1985; Ajzen, 1991; and Fishbein and Ajzen, 1975). Among these frameworks, TPB remains prominent and widely adopted (Madden *et al.*, 1992). TPB envisages an individual's intention to engage in certain behaviours. The TPB considers that individual behaviour is driven by behavioural intentions, corresponding: (a) attitude (ATT) towards a behaviour, meaning how positive or negative an individual feels about the behaviour of interest, keeping in view the outcomes of that particular behaviour, (b) subjective norm (SN) refers as a social influence to perform or not to perform certain behaviours, (c) perceived behavioural control (PBC) considers an individual's subjective evaluation of how easy or difficult one feels to engage in certain behaviour, based on one's perceived enablers or impediments to that behaviour (Ajzen, 1991) (see Fig. 1). TPB has been applied to various aspects of consumer research, such as online buying (George, 2004), environmental and green behaviour (Kumar and Chandra, 2018), and organizational studies (Chen *et al.*, 2017). There is a consensus among researchers that the use of any particular technology is largely influenced by different multidimensional factors with economic, social, and regulatory dimensions (Leucht *et al.*, 2010). The adoption of RETs becomes even more complex due to the high cost of the technology, the long payback period, and the societal impacts it promises to have. Several studies have applied the TPB framework to examine the influence of different factors on sustainable energy technology adoption behaviour, and these studies acknowledge that this model is suitable and assumes rational behaviour (Alam *et al.*, 2014; Chen, 2016; and Korcaj *et al.*, 2015). Acknowledging the suitability and robustness of TPB for examining the consumers' intention to use RETs in Pakistan, we have extended this model by integrating three contextual factors, namely, environmental concern (EC), cost, and awareness. Environmental concern can be regarded as the degree to which consumers are aware of the problems of environmental degradation, cost is the total price the consumer pay for the purchase of the technology, and awareness is the degree to which consumers are aware of the RETs and their benefits. The integration of these contextual factors enabled us to make the framework comprehensive enough to investigate the factors that may play an influential role in shaping consumers' intention to use RETs. Section III discusses the hypotheses, and Fig. 2 presents the framework.

III. HYPOTHESIS DEVELOPMENT

A. Environmental concern

Environmental concern (EC) is the degree to which people are aware of environmental problems and are concerned about solving them. An increasing number of people around the world are becoming conscious of the environmental impact of their daily consumption

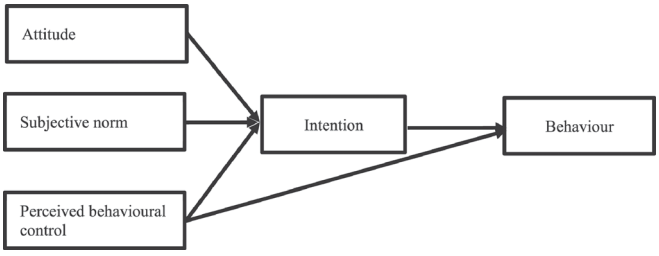

FIG. 1. Theory of planned behaviour.

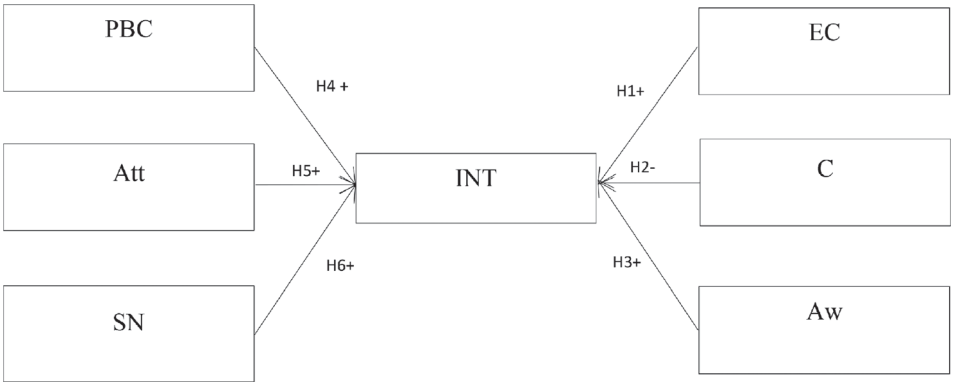

FIG. 2. Renewable energy intention research model (TPB extended for this study).

behaviour and wish to minimize the damage it causes (Fujii, 2006). Individuals who show such concerns also made efforts to protect the environment and demonstrate a favourable attitude towards green purchases (Tan, 2011). Growing attention has been paid by researchers to examining consumers' EC and the influence this has on their decisions to buy sustainable products. Dienes (2015) affirmed that EC is a major determinant of consumers' pro-environmental intentions, influencing their intention to purchase environmentally friendly products. It is further argued that people who show concern about environmental damage tend also to be cautious about their energy usage and to hold favourable attitudes towards the use of RETs (Lin and Syrgabayeva, 2016). Zhang *et al.* (2015) found that energy conservation becomes a self-perceived responsibility of consumers who are concerned about the environment. Hartmann and Apaolaza-Ibanez (2012) affirmed that environmentally conscious consumers view energy conservation more favourably. According to Liu *et al.* (2013), the sensitivity of consumers towards climate change issues can influence their intention to adopt RETs. Urban and Scasny (2012) argued that EC has an influence on consumers' desire to save energy. Based on the arguments, we expect that consumers' EC will favourably influence their intention to use RETs. Therefore, it is hypothesized that

H1. *Consumers' environmental concern will positively influence their intention to use RETs.*

B. Cost

Consumers evaluate price information to determine the monetary sacrifice related to the purchases they make (Dodds *et al.*, 1991). Cost (C) is perceived as one of the principal barriers to the adoption of RETs (Ghosh and Ghosh, 2018). The overall cost of RETs has decreased over the years (Chu *et al.*, 2016); however, it is yet to reach at the level where it can compete with existing solutions (Shakeel *et al.*, 2017). RETs are believed to be expensive, requiring high initial installation costs (Claudy *et al.*, 2013). Several studies have found a negative relationship between the cost and the adoption of RETs (Park and Ohm, 2014 and Yaqoot *et al.*, 2016). Zografakis *et al.* (2010) revealed that consumers are reluctant to pay additional price for RETs. Research conducted by Powers *et al.* (1992) affirmed that the higher the cost of the technology, the higher the consumers' reluctance to use it. Hansla *et al.* (2008) found that consumers' willingness to pay for green electricity decreases with the increase in its cost. In their study, Traber and Kemfert (2009) also found that despite the advantages that a renewable energy technology can offer, its association with high cost represents a huge impediment to its adoption. More recently, the studies conducted by Eder *et al.* (2015), Kardooni *et al.* (2018), and Luthra *et al.* (2015) in the developing world context identified capital cost as a major obstacle in the adoption of RETs. Based on these arguments, we hypothesize that

H2. *There is a negative influence of cost on consumers' intention to use RETs.*

C. Awareness

Awareness (AW) is an important factor in consumers' decisions to adopt a new technology (Howard and Moore, 1982). In the context of RET use, awareness can be regarded as consumers' knowledge and understanding about the technology and the advantages and disadvantages that the use of technology may have regarding costs, savings, efficiency, and related matters (Van Raaij and Verhallen, 1983). According to Zografakis *et al.* (2011), awareness is an important factor in determining consumers' RET adoption decisions. Alam *et al.* (2014) concluded, in their study conducted in the Malaysian context, that awareness is positively related to consumers' intention to use renewable energy sources. Von Borgstede *et al.* (2013) explained that the reason for adoption may be the technological benefits or the environmental offering the technology has. Ek (2005) stated that consumers who are fully aware of how their actions can lead to the reduction of carbon footprints may take measures to change their current way of life and adopt technologies and other means to contribute positively towards the environment. Therefore, it can be deduced that an effort should be made to increase consumers' awareness about the availability of technologies and to reiterate the benefits the use of these technologies may yield and the positive environmental impacts they may have (Islam, 2014). However, due to poor education and understanding, people may not always be aware of the need for saving energy and protecting the environment (Wang *et al.*, 2014). This lack of awareness can be a critical factor with a negative influence on consumers' adoption of new technologies (Sathye, 1999). Given the importance of awareness in renewable energy adoption, it is therefore hypothesized that

H3. *There is a positive influence of consumers' awareness on their intention to use RETs.*

D. Perceived behavioural control

Ajzen (1985) explained that perceived behavioural control (PBC) is the belief of an individual in his ability to perform any behaviour. PBC directly influences the intentions of an individual and indirectly influences his or her behaviour. If an individual is not capable of performing any behaviour, the corresponding intentions will not be formed. In the context of RETs, PBC is related to how easy or difficult a consumer believes it would be for him or her to adopt the technology. One aspect that can influence an individual's PBC is related to the technicalities associated with the use of the technology. PBC has been found to positively influence consumers' purchase of environmentally friendly products (Ham *et al.*, 2015).According to Korcaj *et al.* (2015), to use a renewable energy source, an individual must have access to the resources required for the purchasing and installing a RET and the use of a RET. Studies reveal that PBC is positively related to consumers' energy conservation intentions (Alam *et al.*, 2014). Wang *et al.* (2017) argue that PBC plays an important role in consumers' vehicle choices with respect to energy. Tan *et al.* (2017) found that PBC had a positive influence on Malaysian consumers' use of energy-efficient appliances. Halder *et al.* (2016) found that PBC was a strong determinant of consumers' intention to use bioenergy in Finland and India. Based on these arguments, it is therefore hypothesized that

H4. *Perceived behavioural control positively influences consumers' intention to use RETs.*

E. Attitude

Attitude (ATT) is an important element of the TPB that refers to the evaluation of any behaviour by an individual as favourable or unfavourable (Ajzen, 1985). Attitude can be regarded as consumer's positive or negative feelings towards the use of RETs. The origin of these positive or negative feelings may be based on the outcomes and benefits expected from their use, which may be environmental, economic, or social. The extant literature shows that attitude is positively related to consumers' intention to use RETs. Consumers believe that green energy helps to prevent climate damage and global warming, decreases our dependency on conventional energy, and improves air quality (Hartmann and Apaolaza-Ibanez, 2012). Tan *et al.* (2017) argued that attitude is a powerful predictor of household energy use. Attitude has also

been found to be a strong predictor of consumers' ecological behaviours, such as recycling and fuel conservation (Kaiser and Gutscher, 2003). Greaves *et al.* (2013) found a strong relationship between employees' attitude towards the environment and their energy saving behaviour. In addition, Tan *et al.* (2017) affirmed a positive relationship between attitude and consumers' intentions to purchase energy-efficient household appliances. Attitude has also been found to be positively associated with consumers' intentions to reduce energy (Fujii, 2006). Ha and Janda (2012) found that attitude has a strong effect on consumers' purchase intention toward energy-efficient products. Moreover, Afroz *et al.* (2015) reported the positive influence of attitude on consumers' intention to purchase environmentally friendly vehicles. All these arguments lead to the formulation of the following hypothesis:

H5. *There is a positive influence of consumers' attitude on their intention to use RETs.*

F. Subjective norm

A subjective norm (SN) is defined by Ajzen (1991) as a perceived social pressure to perform or not to perform certain behaviours. The SN can be regarded as an influence or pressure from friends, family members, and peers, resulting in the use of RETs. The SN or normative social influence has been identified in earlier studies as a significant factor influencing consumers' energy and conservation behaviour. For example, Hori *et al.* (2013) found a positive relationship between SN and consumers' energy saving behaviour. Subjective norm indeed exerts a positive impact on consumers' energy saving and carbon reduction behaviour (Chen, 2016). Rogers *et al.* (2012) suggested that the success of community renewable energy projects depends on fostering new social norms for energy generation. Ozaki (2011) argued that social norm influences consumers' adoption of green electricity. Moreover, Gadenne *et al.* (2011) revealed a positive relationship between SN and consumers' environmental and energy saving behaviour. In their study, Ozaki and Sevastyanova (2011) reported that SN is an important motivational factor in encouraging the purchase of sustainable energy technologies. Similarly, Liu *et al.* (2013) found that consumers would be likely to undertake a similar action if their neighbours chose to use a RET. Most recently, Jayaraman *et al.* (2017) found a positive influence of SN on consumers' purchase intentions regarding PV panels. The findings of these studies reflect the fact that consumers are likely to be influenced by the opinions and actions of other people. Therefore, it is rational to assume that this may also hold true in the context studied here. Based on this, we hypothesize that

H6. *There is a positive influence of subjective norm on consumers' intention to use RETs.*

IV. METHODS

A. Measures and data collection

The scale items for measuring the awareness, cost, and PBC are adopted from the study by Alam *et al.* (2014). Scale items related to the EC variable are obtained from the studies of Bang *et al.* (2000) and Hartmann and Apaolaza-Ibanez (2012). Scale items for measuring attitude and intention to use (INT) are adopted from the studies of Chou *et al.* (2015) and Yazdanpanah and Forouzani (2015). All the scale items were measured on a Likert scale from 1 (strongly disagree) to 5 (strongly agree). The data were collected during the months of March and May in 2017, using the convenient random sampling technique in the twin cities of Islamabad and Rawalpindi, Pakistan.

B. Data analysis and results

The Statistical Program for Social Scientists (SPSS 20.0) was used to analyse the demographic data of the respondents. However, for model fit analysis, we used the structural equation modelling (SEM) of partial least squares (PLS) approach, using SmartPLS 3.0 application software. PLS is a widely used variance-based SEM technique which is used for examining the relationships among latent variables. The PLS method is efficient, is less stringent, does not make data distribution assumptions, and works well with a small sample size (Hair *et al.*,

2011). In addition, since this study aims to examine consumers' intention to use RETs, PLS, which is intended for predicative analysis, is more suitable than covariance-based techniques (Reinartz *et al*., 2009).

C. Sample characteristics

A total of 244 questionnaires were filled out by the respondents. The majority of respondents (37, 15.2%) were 36–40 years of age. There were more male respondents (148, 60.2%) than female respondents. A total of 144 respondents (59.0%) were married. Respondents were mostly bachelor degree holders (131, 53.7%). Only two respondents (0.8%) had income levels less than 5000 PKR, whereas 59 (24.2%) had income levels above 60 000 PKR (see Table I).

TABLE I. Demographic characteristics.

Characteristics		N	Percentage (%)
Age (years)			
	18–20	16	6.6
	21–25	41	16.8
	26–30	36	14.8
	31–35	27	11.1
	36–40	37	15.2
	41–45	23	9.4
	46–50	23	9.4
	51–55	21	8.6
	56–60	10	4.1
	Above 60	10	4.1
Gender			
	Male	148	60.7
	Female	96	39.3
Marital status			
	Married	144	59.0
	Unmarried	98	40.2
	Divorced	1	0.4
	Widowed	1	0.4
Education			
	Primary	3	1.2
	Secondary	22	9.0
	Bachelor's degree	131	53.7
	Master's degree	84	34.4
	PhD	4	1.6
Income (in Pakistani rupees)			
	Less than 5000	2	.8
	5001–10 000	4	1.6
	10 001–15 000	14	5.7
	15 001–20 000	16	6.6
	20 001–25 000	14	5.7
	25 001–30 000	26	10.7
	30 001–35 000	19	7.8
	35 001–45 000	31	12.7
	45 001–50 000	29	11.9
	50 001–60 000	30	12.3
	Above 60 000	59	24.2

D. Descriptive statistics, correlation, and discriminant validity of measures

As shown in Table II, the descriptive statistics of the data were checked using the mean and standard deviation, and the interrelationships between the variables were checked using Pearson's correlation test. In addition, the discriminant validity of the data was assessed using the square root of the average variance extracted (AVE).

E. Measurement model

A confirmatory factor analysis (CFA) test was performed to assess whether the data collected to test the model in this study resulted in an adequate fit. To test the internal consistency of the items for each variable, we used composite reliability (CR) (Fornell and Larcker, 1981). Moreover, the discriminant validity and convergent validity of the measures were also checked. Discriminant validity is the degree to which two or more measurement items for the factors are not theoretically interrelated (Paulraj *et al.*, 2008). Convergent validity refers to the degree to which measurement items are theoretically related to each other (Fornell and Larcker, 1981). Convergent validity was assessed using the item loadings and the average variance extracted (AVE). As shown in Table III and Fig. 3, values of AVE for each construct higher than 0.50 indicate that more than 50% of the variance was accounted for by latent variables. The square root of AVE for each latent construct was larger than its correlation with other constructs, thus supporting the discriminant validity (see Table III) (Fornell and Larcker, 1981). Overall, the measurement model results demonstrate adequate validity and reliability.

F. Structural model and results of the hypotheses

After achieving adequate validity and reliability of measures, we evaluated the structural model (see Fig. 3) and tested the hypothesized relationships (see Table IV). The first step in assessing the structural model is to compute the R^2 statistic that demonstrates the amount of variance of the dependent variable explained by the independent variables in the model. The value of R^2 is 0.680, which is above the value of 0.35 suggested by Cohen (1988), and indicates considerable significance for the interpretation. Moreover, to discover whether the structural model has satisfactory predictive relevance for all the constructs, the cross-validated redundancy measures (Q^2) were computed using blindfolding in PLS. The value of Q^2 is 0.404. Multicollinearity is not a problem, and the variance inflation factor (VIF) indices are below the threshold value of 10 (Field, 2009). Bootstrapping is used in PLS to estimate the accuracy of the measurement model (Roldan and Sanchez-Franco, 2012). We adopted a bootstrapping method for sampling tests on the basis of 5000 bootstrapping, to calculate the path coefficient and generate *t*-values. Based on this criterion, the path coefficients of the hypothesized relationships show the strength of the relationships between the independent and dependent variables. For example, the path coefficient result did not support hypothesis 1, and therefore, we reject the hypothesis that EC positively influences consumers' intention to use RETs ($\beta = 0.089$, $p > 0.01$). Regarding the second hypothesis, we accept it because the effect of cost on consumers' intention to use RET is found to be negative ($\beta = -0.213$, $p < 0.01$). The influence of

TABLE II. Correlations and discriminate validity ($p < 0.01$). Values of square root of AVEs are shown diagonally in parentheses.

Sr.	EC	C	AW	PBC	ATT	SN	INT
EC	***(0.84)***						
C	−0.242	***(0.89)***					
AW	0.063	0.192	***(0.86)***				
PBC	0.265	−0.105	0.150	***(0.78)***			
ATT	0.420	0.039	0.499	0.475	***(0.87)***		
SN	0.273	−0.131	0.157	0.552	0.556	***(0.83)***	
INT	0.113	−0.325	0.214	0.664	0.630	0.565	***(0.82)***

TABLE III. Factor loadings and convergent validity.

Constructs	Items	Standard loadings	CR[a]	AVE[b]
Environmental concern				
e1	I am concerned about pollution	0.771	0.827	0.706
e2	I am concerned about climate change	0.904		
Cost				
c1	The use of RET incurs high repair and maintenance costs		0.880	0.787
c2	The purchase of RET requires high installation costs			
Awareness				
a1	I am aware of the availability of renewable-based solutions in the market and their usability	0.806	0.890	0.731
a2	I am aware of RET's benefits	0.922		
Perceived behavioural control				
Pbc1	I have the resources, knowledge, and ability to use RET	0.772	0.813	0.600
Pbc2	Using RET is entirely within my control	0.818		
Pbc3	I am confident that I would use RET in the future	0.716		
Attitude				
at1	Using a RET would be beneficial	0.870	0.857	0.750
at2	Using a RET in my house would be a wise idea	0.843		
at3	Using a RET in my house would be pleasant	0.851		
Subjective norm				
n1	People who are important to me think that I should use RETs in my home	0.832		
n2	I will use a RET if my colleagues think I should	0.794	0.869	0.688
n3	I will use a RET if people in my social network do (friends, relatives, neighbours, etc.)	0.861		
Intention to use				
i1	I intend to use a RET in the future	0.825	0.858	0.669
i2	I plan to spend more on RET than on conventional energy	0.836		
i3	I will strongly recommend that others use a RET in their house	0.792		

[a]AVE = (sum of squared factor loadings)/(sum of squared factor loadings) (sum of error variances).
[b]CR = (square of the sum of the factor loadings)/[(square of the sum of the factor loadings) + (square of the sum of the error variances)].

awareness on consumers' intention to use RETs is insignificant ($\beta = 0.175$, $p > 0.01$), and therefore, we reject hypothesis 3. While PBC ($\beta = 0.309$, $p < 0.01$), attitude ($\beta = 0.299$, $p < 0.01$), and SN ($\beta = 0.248$, $p < 0.01$) all positively influence consumers' intention to use a RET, we accept hypotheses 4, 5, and 6.

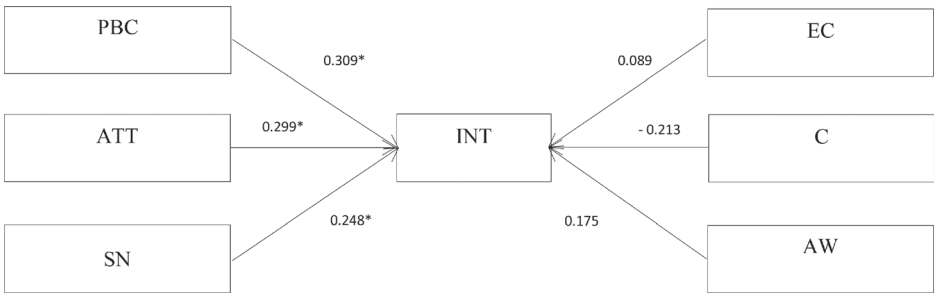

FIG. 3. Path coefficients (structural model).

TABLE IV. Hypothesis results.

Hypothesis	Hypothesized path	B	*t*-value	Label	*P*	VIF	R^2	Q^2
H1	EC → INT	0.089	1.424	Reject	0.155	1.249	0.680	0.404
H2	C → INT	−0.213	2.880	Accept	0.004	1.096		
H3	AW → INT	0.175	1.631	Reject	0.103	2.230		
H4	PBC → INT	0.309[a]	3.315	Accept	0.001	2.369		
H5	ATT → INT	0.299[a]	3.555	Accept	0.000	1.393		
H6	SN → INT	0.248[a]	2.788	Accept	0.005	2.873		

[a]$p < 0.01$.

V. DISCUSSION

A. Environmental concern and intention to use RETs

It is widely believed that the use of RETs can improve the environment and can help in reducing generation-related emissions. Based on the previous literature, it was hypothesized that a similar effect may occur in Pakistan's market also. However, unlike other studies that have found a positive influence of EC on consumers' intention to use RETs (Liu *et al.*, 2013 and Zhang *et al.*, 2015), this study did not reveal a significant influence. One possible reason may be related to the principal purpose for which these energy systems are bought by consumers. The environment-related factor may take priority for consumers in countries where the technology is used as an alternative to gain long-term economic benefits, reduce utility bills, or contribute positively towards environmental objectives. In a country like Pakistan, environmental and pollution-related matters are usually not a priority for consumers when making such decisions. This may be due to the fact that these matters have hardly been on the government's agenda, and attempts have seldom been made to make people aware of environmental issues, their responsibilities, and the role they can play in improving the environment.

B. Cost and intention to use RETs

The statistical results support our hypothesis, and the data reveal the negative effect on consumers' intention to use RETs. Renewable energy-based solutions are costly compared to traditional energy generation systems, and the added cost of purchase becomes an impediment to their adoption. For instance, currently, installation of solar PV for household users costs roughly five or six times more than other energy generation systems available in the market such as UPSs or oil-fired power generators. Moreover, the price is much too high for the average household to pay for the purchase in a lump sum. This finding supports the results of earlier research by Kardooni *et al.* (2018), Luthra *et al.* (2015), and Yaqoot *et al.* (2016), where the cost was found to negatively influence consumers' intention to use RETs. This indicates that cost is an important barrier and plays a critical role in consumers' intention to use a RET.

C. Awareness and intention to use RETs

The statistical results reveal that awareness does not have a significant influence on consumers' intention to use RETs in Pakistan. Our study contradicts the research findings of earlier studies in the literature that found a positive influence on the use of RETs (Alam *et al.*, 2014; Islam, 2014; and Zografakis *et al.*, 2011). One possible reason for this is that people are not yet fully aware of RETs and the benefits they offer. An earlier study by Wang *et al.* (2014) highlighted that awareness may not play a significant role, due to poor understanding of consumers concerning the usefulness of renewable energy sources. The market for RETs in Pakistan is not as established as that for the competing existing energy generation systems used by households. There is limited awareness about the vendors, technology, and installation services that can be trusted and that can deliver in the long run.

D. Perceived behavioural control and intention to use RETs

Our findings indicate that PBC positively influences the intention to use RETs. The results correspond to the findings of earlier research that PBC positively influences consumers' intention to use a renewable energy source (Alam *et al*., 2014 and Tan *et al*., 2017). For example, solar PV is more technical and complex than existing energy generation solutions available such as power generators or UPS. The lack of availability of technical experts, repair and maintenance costs, and the possession of very little or no prior experience of the technology may all make the adoption of such technologies troublesome. Consumer's knowledge about the technology and their perception of its usability in the long run are crucial factors in building trust and confidence in the technology.

E. Attitude and intention to use RETs

Attitude is found to positively influence intention to use RETs. Studies conducted by Afroz *et al*. (2015) and Tan *et al*. (2017) have also found a positive influence of attitude on consumers' intention to use RETs. The positive effect is due to the long-term economic and social benefits offered by these technologies. RETs can generate electricity over a long period without entailing additional costs. In addition, the use of such technologies also provides a solution to the basic problem that the users of oil-fired or gas-fired power generators face everyday, i.e., the issue of noise and smoke generated by the engine while operating. The use of solar PV installations helps in mitigating this constant noise which has become a significant concern for users.

F. Subjective norm and intention to use RETs

The results show that Subjective Norm (SN) does have a positive influence on consumers' intention to use RETs. The findings of this study are consistent with earlier research of Jayaraman *et al*. (2017) and Chen (2016) where SN and behaviour were found to have a positive influence on consumers' intention to use RETs. In a society like Pakistan, the influence of social groups and family members plays an influential role in decision-making. The society is very much integrated, and inputs from the close friends and relatives are considered important. The decision may also be influenced by the experiences peers have had of using the technology. Trust in the technology is rather limited due to the fact that the adoption of RETs is in its early stages. Input from peers may influence the decision if they have used a RET in the past or are currently using one. A positive experience with the technology automatically creates trust in the mind of the consumer who tends to give importance to the opinions and suggestions of others. This social influence may work as a stimulus and may encourage consumers to opt for the technology.

VI. CONCLUSION AND IMPLICATIONS

The objective of this study is to investigate the factors influencing consumers' intention to use renewable energy technologies for household purpose. This study seeks to address this challenge by studying the key factors influencing the adoption and diffusion of renewable energy technologies and by investigating the extent to which they play a role in a local context. An attempt has been made to explore the impact of these factors in the context of Pakistan and to see how these factors encourage or discourage consumers with regard to opting for these solutions. We have extended the TPB framework by integrating different contextual factors. Based on an in-depth literature review, it was hypothesized that factors such as environmental concern, cost, awareness, perceived behavioural control, subjective norms, and attitude may influence consumers' intention to adopt RETs in Pakistan. The data were collected and analysed using structural equation modelling (SEM). The results revealed interesting findings with important managerial and policy implications. Perceived behavioural control, subjective norm, and attitude of the consumers all have a positive influence on their intention to use RETs. However,

environmental concern and awareness are found to be insignificant, whereas cost has a negative effect.

This study has many implications for policymakers, companies engaged in the renewable energy technology business, and other stakeholders involved in the process. Based on the findings of this study, it is suggested that there is a need to adopt an integrated approach, and a coherent effort should be made by all stakeholders at various levels of society to raise the level of environmental awareness. Government, private companies, Non-profit organizations (NGOs), and other stakeholders should place more emphasis on devising policies that highlight environmental concerns and the reduction of emissions as key objectives. Seminars and workshops should be organized at university and college levels to make young people aware of this important subject and to ensure that environmental values are given consideration when purchase decisions are made in the future. In addition, sustainability-related studies should be integrated into the educational curriculum from the very beginning, in primary and secondary schools, so that students become aware of these issues and it becomes part of their routine to take steps which have a positive bearing on the environment. Awareness campaigns should be launched by the government using social, print, and electronic media to highlight the need for energy conservation, reducing carbon emissions, and maintaining a sustainable way of life.

Similarly, this study also offers important insights into the companies and state departments interested in the commercialization and enhanced diffusion of these technologies. RETs are still in the earlier phases of development, and their high cost, technical complexity, and the lack of trust in the technologies hinder consumers from opting for these solutions. There is a great need to disseminate information on what exactly these technologies can offer and how they are better than the existing solutions. If consumers are well advised and made aware of the long-term social, economic, and environmental benefits these technologies offer, this may increase people's interest in the technologies. Companies engaged in the sale and installation of RETs should emphasize services and packages to make consumers' purchase decisions easier. For instance, consumers' concern about the availability of experts, the durability of the technology, and repair and maintenance costs can be addressed by offering post-sale services in the form of warranties, repair and maintenance at reduced prices, and periodic visits to the installation site to ensure that the equipment is working at the optimum capacity. This will build consumer trust and confidence in the technology. It is also recommended that companies should launch marketing campaigns and hire professional sales personnel to highlight the economic benefits to the buyer, e.g., utility bill reductions or possible reductions that can be achieved using smart meters.

The government should develop strong and interactive relationships with industry to ensure that policy initiatives are generating the desired results. Information should flow both ways, i.e., input should be obtained from the stakeholders, and government's measures should be discussed to ensure the implementation in the right manner. It is also recommended that companies should look beyond the traditional model of sales and purchase if they want to successfully commercialize these technologies in Pakistan's market. The companies should alter their business model and offer the RETs at a low up-front cost. The remaining amount shall then be collected in the form of monthly installments or by offering a power purchase agreement (PPA), where customers are charged based on the power generated by the RETs.

VII. LIMITATIONS AND FUTURE RESEARCH

There are several limitations of this study that should be taken into account. First, the sample size limits the generalizability of the findings of this study. The data were collected from cities, which are by definition urban in nature. The demographic factors such as income, level of education, access to information, and awareness about the issues may be different compared to the same factors for people living in rural parts of the country. Moreover, the renewable energy industry is complex and is affected by a number of variables, and therefore, the number of factors investigated in this research may represent a limitation. The observed relationships might have been better understood by integrating additional factors such as trust, knowledge, relative advantage, complexity and/or ease of using a renewable energy source, environmental

and social responsibility, moral obligation, and the use of technology for personal/individual or group/collective purposes. Therefore, an interesting topic for future research would be to investigate the impact of some of these variables on consumers' adoption behaviour. Another important aspect that is lacking in this research is the investigation of the impact of some demographic aspects such as the income or level of education on the intention to adopt. We believe that studying the moderating effect of these variables may yield interesting findings. Finally, in this study, we have taken capital cost into consideration; however, the cost and benefit analysis and the estimations based on the Levelized Cost of Energy (LCOE) may also provide interesting insights. This can be an interesting aspect to be considered in the future research.

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