Predicting Consumers' Actual Purchase Behavior towards Residential Photovoltaic Solar System as A Sustainable Source

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Abstract
The Pakistani government has devised a plan to motivate its citizens to invest in renewable energy sources like solar panels, offering them tax discounts, simplifying financing options, and launching social media campaigns. However, the utilization of these environmentally friendly products as residential solar panels is still in its infancy stage in Pakistan. The objective of this study was to examine those essential factors that motivate consumers to purchase residential solar panels in Pakistan. A self-administered questionnaire survey was employed, and the connivance sampling technique has been used. The primary data was collected from Pakistan. Further, the data was collected in two stages: first, the response was taken from those consumers who showed the intentions to purchase solar panels, and second, the data was filled in from those individuals from the same population who had installed solar panels on their roofs. A total of 450 questionnaires have been filled out of 380 responses that were considered for the analysis after removing the outliers. Smart PLS software has been used to perform the analysis. Structural equation modeling (SEM) has been applied. The findings of this study shall help policymakers formulate strategies to bolster environmental sustainability initiatives using solar energy technologies.
Keywords: Theory of Planned Behavior (TPB), Theory of Reasoned Action (TRA), Purchase Intention (PI), Actual Purchase Behavior (APB), solar energy, Renewable energy, solar panels, SDGs (7 &13)

Introduction.
Energy is essential to a nation's ability to expand and develop economically. A nation cannot prosper if its energy resources are not well-diversified. The nation's economy is thought to depend heavily on electricity (Irfan et al, 2019). Since the residential sector is the greatest consumer of energy resources, the rapidly growing global population and their materialistic lifestyles will increase the demand for energy (International Energy Agency,

2019). (Ali et al. 2019). The widespread usage of renewable energy sources has increased due to the overuse of hydrocarbons and the greenhouse gas (GHG) emissions of conservative energy sources. The fact that home appliances are the primary source of carbon dioxide (CO2) emissions and account for 70% of global emissions highlights the significance of rooftop solar purchase (Ali et al. 2019).

Installing solar energy systems in homes can help reduce excessive carbon dioxide emissions. The demand for sustainable energy sources is rising due to several factors, including government policies, investment, adoption of technology, and supportive regulations for renewable energy technologies (Akbar et al. 2020). The purchasing rate of green and renewable energy is still low, even though they are now a major global focus of attention, study, and discussion. Not only are emerging economies but also developed nations showing a sluggish embrace of renewable energy (Zahari and Esa 2018). Various forms of renewable energy sources comprise geothermal, wind, hydropower, solar, and bioenergy. The photovoltaic (PV) system is ideal for generating power on a small scale, hence minimizing the production of dangerous waste and harming the environment (Li, Su, & Shu, 2014). The study suggested that PV systems technology is currently not widely acknowledged, due to its higher installation cost than other conventional energy sources (Singh, 2016; Denholm & Margolis, 2007). Therefore, it is imperative to develop more precise methods to address client requirements and implement practical solutions for environmental issues (Schelly, 2014). Hence, to address this deficiency, it is crucial to discover the specific characteristics associated with environmental concerns. These features are of utmost importance for customers that prioritize green energy, and they may even be willing to pay a significant extra cost for alternative energy sources (Schelly, 2014). Due to the growing global emphasis on energy security, and sustainable development progress, there has been a significant increase in the use of solar PV systems. Pakistan is currently engaged in proactive efforts to construct solar photovoltaic (PV) energy projects to strengthen its energy security and tackle its ongoing energy problem (Adnan et al, 2012). However, Pakistan gains advantages from its strategic geographical position in a region with abundant solar energy resources and its subtropical temperature, which provides optimal conditions for utilizing solar power (Adnan et al, 2012). Pakistan enjoys a yearly average of 8 hours of sunlight daily, which is seen as advantageous. The anticipated solar irradiance at this level is projected to yield an average power generation of 5.2 kilowatt-hours per square meter per day on a flat surface of solar panels (Khan et al, 2020). Furthermore, despite its advantageous geographical conditions and energy production from solar panels, the adoption of residential solar panels is still in its infancy stage in Pakistan even if compared with it neighboring countries (Ali et al, 2016; Qureshi et al, 2017). The empirical literature has also witnessed the

acceptability for use of photovoltaic products (Vuichard et al, 2021; Alsabbagh, 2019; Hai, 2019; Ahmad et al, 2017; Hanger et al, 2016; Wyllie et al, 2018; Liu, 2018; Guta, 2018), the decision making process for the adoption of solar energy products according to the behavioral concept (Barnes et al, 2022; Li et al, 2022; Waris et al, 2022; Shi et al, 2022; Bekti et al, 2022; Awais et al, 2022; Ahmed et al, 2022) and actual purchase behavior for solar panels (Aggarwal et al, 2019). How-ever, within the geographical confines of Pakistan, there is a lack of research on the behavioral characteristics of domestic customers when it comes to purchasing residential solar systems to achieve carbon neutrality (Kumar et al, 2024).

1. Literature review and hypotheses development

1.2 Linking Perceived Environmental Knowledge and Purchase Intention for residential solar panels.

In this current study TRA and TPB have been used to formulate the current theoretical framework of said study (Ajzen and Fishbein 1980; Ajzen, 1991). TRA asserts that intention serves as the foundation for real behavior. The intention is determined by two factors: attitude and subjective norms, as stated by Ajzen and Fishbein in 1980. Regarding the TPB, the individual's performance of a specific behavior is also influenced by their intention (Ajzen and Fishbein, 1980). The TPB consists of three distinct components "attitude, subjective norms, and perceived behavioral control" (Ajzen, 1991).

Perceived Environmental Knowledge is defined as the "cognizance and understanding of environmental issues and potential remedies for those issues." Individuals often avoid circumstances in which there is a lack of assurance and inadequate knowledge to direct their actions (Zsóka et al, 2013). Thus, individuals with elevated Perceived Environmental Knowledge exhibit a lack of patience when it comes to engaging in environmentally favorable actions (Frick et al., 2004). Individuals who have a positive environmental consciousness are aware consumers perceived actions that may have deep impact on the environment. Empirical study findings suggested a positive correlation between environmental concern and consumer's attitude for the purchase and installing of solar panels (Krishnaswamy et al, 2017). A study also explained the low adoption of Pohtovoltic panel systems in Malaysian among residential communities (Shakeel and Rahman, 2018). A study revealed a no correlation between Environmental Concern and purchase intention (Shakeel and Rahman, 2018). Nevertheless, the study also discovered that environmental concern has not influenced customers' purchase intention to acquire and use renewable energy technology (Lin and Syrgabayeva, 2016). A study also suggests that a thorough grasp of ecofriendly technologies and their implications is essential for understanding solar PV systems as a viable

alternative for home energy requirements (Batley et al., 2011). Thus, hypothesis formulated as follows.

H1. There is a positive association between Perceived Environmental Knowledge and Purchase Intention for solar panels.

1.2 Linking Perceived Environmental Knowledge and Actual Purchase Behavior for residential solar panels

Empirical research has indicated a direct correlation between a consumer's level of environmental knowledge and their actual purchasing behavior for environmentally friendly products such as solar panels (Molina et al, 2013; Goh & Wahid, 2014; Jaiswal & Kant, 2018). Several studies have explained a causal link between perceive environmental knowledge and consumer purchasing behavior through purchase intention (Chen, 2013; Maichum et al, 2016). Additional research has indicated that Perceived Environmental Knowledge plays a crucial role in determining the connection between consumer attitudes towards environmentally friendly products and their environmental knowledge (Vazifehdoust et al, 2013; Kumar et al, 2017; Jaiswal & Kant, 2018; Maichum et al, 2016). Furthermore, certain studies have elucidated the presence of less strong connections between the variables when examining customers' actual buying behavior in relation to their intention to purchase environmentally friendly products (Kumar et al, 2017; Vazifehdoust et al, 2013). Thus, it is crucial for the present study to establish the correlation between Perceived Environmental Knowledge and Actual purchase Behavior for residential solar panels.

Consequently, the hypothesis is formulated as follows:

H2. There is a positive association between Perceived Environmental Knowledge and Actual Purchase Behavior for solar panels.

1.4 Linking Subjective Norms and Purchase Intention for residential solar panels

Subjective Norms have a huge impact on consumers' intentions to conserve energy. Empirical research indicates a strong correlation between subjective norms and consumers' purchase intentions regarding solar panels (Abu-Elsamen et al, 2019; Irfan et al, 2020; Reyes-Mercado and Rajagopal, 2017; Sahu et al, 2021; Srivastava and Mahendar, 2018). One of the studies conducted in India elucidated that the social perception factor exerts a significant impact on the acceptance and implementation of rooftop solar systems (Satapathy et al, 2021). Furthermore, research conducted in Pakistan elucidated that social norms (SN) have a beneficial impact on influencing the inclination to acquire solar photovoltaic (PV) panels (Liang et al, 2021). Subjective Norms has significantly influenced a person's impression to conform to a particular behavior. Empirical studies have also shown cases where individuals choose not to engage in a specific behavior (Kumar et al, 2020). Hence, consumer peer influence plays a pivotal role in the acquisition

of home solar panels. A recent study conducted in Jordan and India predicted the impact of social influence which examining the purchase behavior of residential solar panels (Kumar et al, 2020). The findings from this study, supported by (Akroush et al, 2019; Kumar et al, 2019; Irfan et al, 2020) indicate that Subjective Norms does not have a substantial effect on buying behavior. It can be said with precision that social networks have a substantial impact on consumer behaviors because of the actions and viewpoints of a social group. Therefore, the second hypothesis follows as.

H3: There is an association between Subjective Norms and Purchase Intention for solar panels.

1.5 Linking Subjective Norms and Actual Purchase Behavior for residential solar panels

The consumer's attitude reflects the individual's perception of how their behavior will be affected, whereas subjective standards and measurements indicate the influence of society on behavior. Moreover, there is a belief that attitude and subjective norms have an impact on behavior by means of a cognitive link, specifically the intention to participate in the behavior (Fishbein and Ajzen, 1977). Behavioral intention refers to the motivational factors that influence a person's actions and shows the amount of effort the individual is willing to exert (Ajzen, 1991). Hence, the TRA considers behavioral intention to be the main determinant of real-life behaviors. TRA is helpful to forecast consumers' intents and subsequently transform them into tangible behavior (Ajzen and Fishbein, 1980; Fishbein and Ajzen, 1975). However, major actions lie on a spectrum between being completely voluntary and entirely involuntary.

H4: There is an association between Social Norms and Actual Purchase Behavior for solar panels

2.8 Linking Price/Value and Purchase Intention for residential solar panel

The individuals evaluate the effectiveness of technology by considering its purchase price (Palau-Saumell et al. 2019) and its perceived worth or value (Venkatesh, Thong, and Xu 2012). Moreover, the study explains that high-priced technology will significantly contribute to their daily tasks (Shaw and Sergueeva 2019). The studies also suggested that there is a strong correlation between the value of technology and the purchase intention and further use it. The price value significantly influenced consumers purchase intention for solar panels (Olmos Migueláñez, Sánchez Prieto, and García-Peñalvo 2015). Furthermore, middle-income workers, their intention to purchase technology was influenced by the price value (Palau-Saumell et al. 2019; Catherine and Geofrey, 2018) it also explained a direct correlation

between price value and performance, which in turn affects an individual's inclination to adopt new technology.

Consumer perception of product costs varies depending on factors such as socioeconomic related variables are also the biggest predictor for the adoption of the technology and to determined cost/ benefit (Zhai & Williams, 2012). A study revealed that 23% of the participants refrained from embracing green energy because they believed that the initial installation expenses were exorbitant (Zhai & Williams, 2012). One approach involves reducing prices or costs to stimulate demand for solar energy (referred to as a "supply push" strategy) (Liu et al, 2023). Another strategy seeks to improve the cost-effectiveness of solar energy to increase its appeal "demand pull strategy" (Wang et al, 2021). Hence, it can be inferred that the installation of solar panels by homeowners is influenced by both personal considerations and government policy. Thus, hypothesis stated as below.

H5: There is an association between Pirce/Value and Purchase Intention for solar panels.

2.9 Linking Prive/Value and Actual Purchase Behavior for residential solar panels

Economic factors play a pivotal role in influencing consumer's actual purchase behavior towards residential solar panels (Best & Nishitateno, 2019). The empirical studies examined the higher net wealth is generally associated with a higher likelihood of installing solar photovoltaic systems (Best & Nishitateno, 2019). Additionally, economic life events and concerns over rising electricity bills are crucial motivators for households to adopt solar PV technology, indicating that access to sufficient capital is essential for overcoming the upfront cost barrier (Bondio, 2018). Moreover, factors such as product knowledge, perceived benefits, and ecological lifestyle positively impact consumers' attitudes towards solar PV products, ultimately influencing their purchase intentions (Hasheem, et al 2022). The cost of installation significantly influences solar panel adoption, with various factors playing a role in this decision-making process. Research suggests that economic incentives, such as subsidies and lower installation costs, are crucial in driving the acceptance of solar panel systems by businesses and households (Feger et al, 2022; Atchike et al 2022). Studies have shown a positive relationship between economic factors, government policies, and actual purchase behavior for solar panels. (Vu & Nguyen, 2023). Furthermore, a study in India emphasized that environmental concern, performance perception, and ease of use significantly impact customers' attitudes towards solar energy, indicating a link between economic factors and purchase behavior (Verma & Sreeramulu, 2021). Thus, hypothesis as follows.

H6: There is a positive association between Pirce/Value and Actual Purchase Behavior for solar panels

3.0 Linking Purchase Intention and Actual Purchase Behavior for solar panels

Within the domain of TRA " Theory of Reasoned Action" and TPB "Theory of Planned Behavior" the empirical research has evident a positive relationship between purchase intention and actual purchase behavior in a various field such as such as entrepreneurial behavior (Shirokova et al, 2016), health-care behavior (Godin and Kok, 1996), e-purchase intentions and behavior (George, 2004; Pavlou and Fygenson, 2006), and decision making approaches (Shaw et al, 2000). Researchers have observed that purchase intention is a dependable sign for determining consumer' APB. (Armitage and Conner, 2001; Bird, 1988; Locke and Latham, 2002). Consequently, researchers have suggested using the TRA and TPB to assess customers' real purchasing habits regarding residential solar panels (Ajzen and Fishbein, 1980; Fishbein and Ajzen, 1975). These theories played a important role in assessing customers' perception (LaPiere, 1934; Wicker, 1969). Thus, hypothesis formulate as follows.

H7: There is a positive association between Purchase Intention and Actual Purchase Behavior for solar panels.

Linking Purchase Intention as mediator

Considering TRA and TPB the consumer behavior can be inferred from behavior intention (Liobikienė et al, 2016; Zheng et al, 2022). Moreover, empirical research has shown that consumers' intention has a favorable impact on their actual Purchase behavior solar panels (Kamalanon et al, 2022; Al-Mamun et al, 2018; Wei et al, 2017). The studies suggested the variable purchase intention as a mediator to influence motivational factors to increase consumer actual purchasing for residential solar panels (Kamalanon et al, 2022).

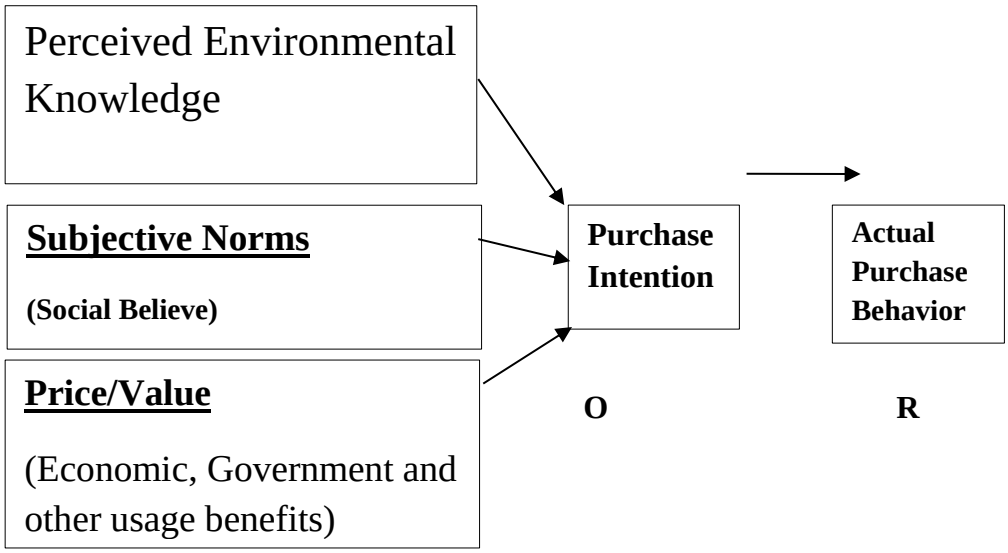
Therefore, the hypothesis is expressed as follows:

H8: Purchase Intention mediates between Perceived Environment Knowledge and Actual Purchase Behavior for solar panels.

H9: PI mediates the relationship between Subjective Norms and Actual Purchase Behavior for solar panels.

H10: Purchase Intention mediates the relationship between Price/Value and Actual Purchase Behavior for solar panels.

Theoretical Framework



3. Methodology

3.1 Sample and Data Collection

The current studies have been carried out in Pakistan. The study employed a post-positivist methodological approach. It is a highly populous country, constituting around 2.83% of the global population. Furthermore, Pakistan's unique geographical location and temperature are considered significant benefits for the country's utilization of solar energy (Raheem et al, 2016). Moreover, the utilization of renewable energy sources has emerged as a viable approach to fulfil Pakistan's increasing energy demands (Ali et al, 2020).

To accomplish the research objective, a theoretical framework has been established. The researcher utilized the quantitative technique using deductive reasoning, as recommended by Creswell & Creswell (2017). The data from Islamabad and Rawalpindi (cities of Pakistan) has been collected using the random sample technique. Out of the total of 450 replies received, 408 were deemed legitimate and included in the study. Empirical investigations have indicated that the quantitative technique is the most effective method for validating research frameworks and testing theories (Denscombe 2017). The study utilizes a cross-sectional design with two-time lags for data collection. The data is gathered through a market survey from customers, namely family heads, who have the authority to make decisions regarding the purchase of solar panels as a clean energy product. Thus, in the initial phase, the surveys were completed by consumers who had expressed an intention to purchase home solar panels. In the subsequent phase, the replies were completed by consumers who had made actual purchase of solar panels.

3.2 Measurement of the Study

The quantitative technique has been used in current study. Perceived Environmental Knowledge was measured with four items of scale and adapted from (Ellen et al, 1997). The Subjective Norms (Social believe) was measured with four items of scale for has been adapted from (Aggarwal et al, 2019). The Purchase Intention was measured with four items of scale and adapted from (Chan & Lau, 2000). The actual purchase behavior was measured with Five items of scale and adapted from (Kanchanapibul et al, 2014). The personality trait (Openness to Experience) was measured with four items of scale and adapted from (Cherry, 2017; Bansal et al, 2016).

4. Data Analysis and Results

4.1 Demographic Profile of the Respondents

The study's demographic data includes a sample of 380 respondents, with 59.2% males and 40.8% females. The age distribution shows that 46.1% are between 20-30 years, 31.1% are 30-40 years, 17.6% are 40-50 years, and 5.3% are over 50 years. In terms of marital status, 45.5% are single, and 54.5% are married. The city distribution indicates that 42.4% reside in Rawalpindi and 57.6% in Islamabad. Regarding education, 11.8% have Matric or below, 57.6% have Intermediate to Masters, 18.4% have MS/M.Phil., and 12.1% hold a PhD. Occupation-wise, 15.5% work in government or semi-government sectors, 60.5% in the private sector, 4.5% are retired, and 19.5% are self-employed. Income levels show that 45.5% earn less than 100,000, 30.8% earn between 100,000-150,000, 14.2% earn 150,000-200,000, and 9.5% earn above 200,000. Lastly, monthly unit consumption indicates that 16.3% consume less than 200 units, 39.5% consume 200-300 units, 27.1% consume 300-400 units, and 17.1% consume above 400 units. Further details have been exhibited in table 1.

Table 1

Gender	Frequency	Percentage
Male	225	59.2
F. Male	155	40.8
Age*	**Frequency**	**Percentage**
20-30	175	46.1
30-40	118	31.1
40-50	67	17.6
Above-50	20	5.3
Marital Status	**Frequency**	**Percentage**
Single	173	45.5
Married	207	54.5
CITY*	**Frequency**	**Percentage**
Rawalpindi	161	42.4
Islamabad	219	57.6
Education	**Frequency**	**Percentage**
Matric Or below	45	11.8

Intermediate-to-Masters	219	57.6
MS/M.Phil	70	18.4
PhD	46	12.1

Occupational Sector	Frequency	Percentage
Government/Sami. Government	59	15.5
Private	230	60.5
Retired	17	4.5
Self-Employed	74	19.5
Income Group	**Frequency**	**Percentage**
Less than 100,000	173	45.5
100,000-150,000	117	30.8
150,000 -200,000	54	14.2
200,000 and above	36	9.5
Monthly. Unit. Consumed	**Frequency**	**Percentage**
Less than 200	62	16.3
200-300	150	39.5
300-400	103	27.1
above 400	65	17.1

4.2. Outer Loading

The Table 2 explained that the value of all factor loadings of the variable are above .70 (expect three variable APB 3, SN 4 and PV3 that have been removed after screening) which is the minimum criteria as suggested by the empirical research (Henseler et al., 2015).

Table 2

Variables	Loadings
APB1	0.867
APB2	0.887
APB4	0.886
APB5	0.886
PEK1	0.809
PEK2	0.848
PEK3	0.849
PEK4	0.822
PI1	0.872
PI2	0.890
PI3	0.865
PI4	0.848
PV1	0.802
PV2	0.837
PV4	0.843
PV5	0.823
PV6	0.851
SN1	0.847

SN2	0.895
SN3	0.830

4.3 Reliability and Validity

Table 3

Variables	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Actual Purchase Behavior	0.904	0.905	0.933	0.777
Perceived Environmental Knowledge	0.852	0.853	0.900	0.692
Purchase Intention	0.892	0.892	0.925	0.755
Price Value	0.888	0.889	0.918	0.691
Subjective Norms	0.820	0.826	0.893	0.735

The minimum value of average variance extracted is above .50 for all variables (Henseler et al, 2015; Noor et al, 2021). The Cronbach's α and Composite Reliability (AVE) has been performed to check the reliability of the constructs (Henseler et al, 2015). Table three explained that value of both "both Cronbach's Alpha and Composite Reliability" are according to the minimum standard as advised in the empirical research (Sarstedt et al, 2017).

4.4 Fornell-Larcker Criterion

Table 4

Variables	Actual Purchase Behavior	Perceived Environmental Knowledge	Purchase Intention	Price/Value	Subjective Norms
Actual Purchase Behavior	0.882				
Perceived Environmental Knowledge	0.617	0.832			
Purchase Intention	0.685	0.603	0.869		
Price/Value	0.680	0.584	0.646	0.831	
Subjective Norms	0.606	0.526	0.595	0.559	0.858

The Fornell Larcker criterion & HTMT (Heterotrait-Monotrait) method has been used to evaluate discriminant validity of the study (Fornell

and Larcker, 1981). According to these calculations "each construct's square root of the Average Variance Extracted should be larger than its highest correlation with any other construct in the model" the results for both discriminant validity has been mentioned in table 4 and 5 that showed the correlation among the constructs.

4.5 Heterotrait-Monotrait Ratio (HTMT)

Table 5

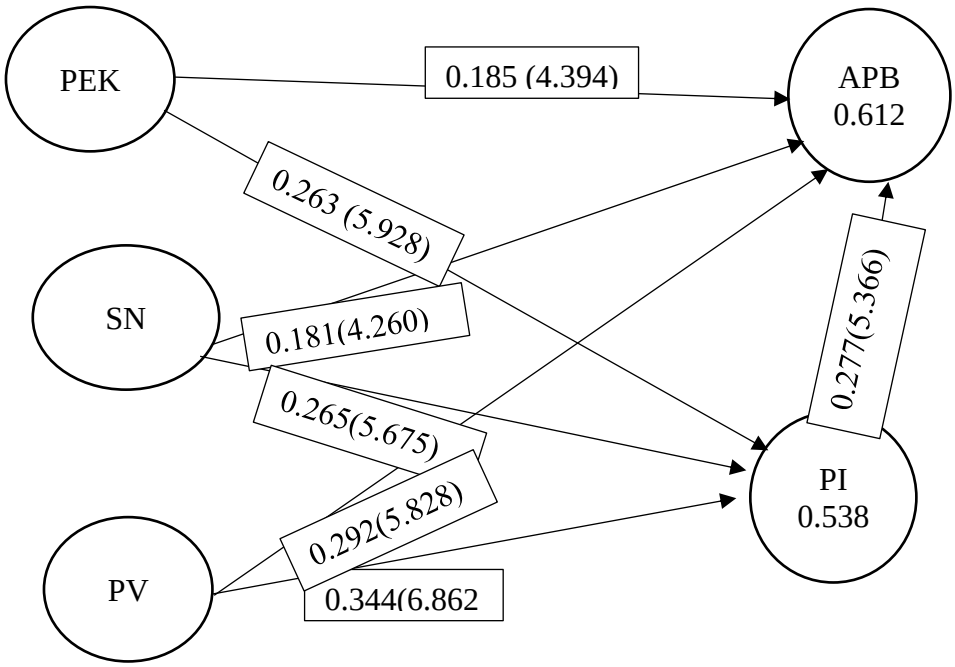
Variables	Actual Purchase Behavior	Perceived Environmental Knowledge	Purchase Intention	Price/Value	Subjective Norms
Actual Purchase Behavior					
Perceived Environmentally Knowledge	0.704				
Purchase Intention	0.762	0.690			
Price/Value	0.756	0.669	0.723		
Subjective Norms	0.702	0.628	0.694	0.653	

As per the results attained, the square root of AVEs, all of which exceed the diagonal correlation values, demonstrates strong discriminant validity. Empirical research has suggested utilizing the HTMT ratio as a more dependable technique for assessing discriminant validity, in conjunction with the AVE-based approach (Hair et al., 2019). According to the standards, the HTMT ratio of the constructs should be less than 0.90 to avoid issues with multicollinearity (Henseler et al., 2015). Furthermore, in relation to the mentioned study, the HTMT values for all constructions are below .09, indicating that the results have been confirmed/validated.

4.6 Measurement Model

The Structure equation modeling has been performed using Smart PLS 4.0 (Dash and Paul, 2021; Sarstedt et al, 2017). The result of the study explains that motivational factors including Environmental Concern (EC), Subjective Norms (SN) and Price/Value (economic government and other usage benefits has a deep impact on consumers Purchase Intention (PI) and Actual Purchase Behavior (APB) for solar panels. The value of path cofficents have been mentioned in figure 1 in appendix and 1A.

Figure 1A



4.7 Direct Hypothesis test results

Table 6

Hypothesis	Std. β	Mean	Std	T-value	P-Value	Findings
H1: Perceived Environmental Knowledge -Purchase Intention	0.263	0.263	0.044	5.926	0.000	Supported
H2: Perceived Environmental Knowledge -Actual Purchase Behavior	0.185	0.186	0.042	4.394	0.000	Supported
H3: Subjective Norms-Purchase Intention	0.265	0.264	0.047	5.675	0.000	Supported
H4: Subjective Norms-Actual Purchase Behavior	0.181	0.180	0.42	4.260	0.000	Supported
H5: Price/Value-Purchase Intention	0.344	0.343	0.050	6.862	0.000	Supported
H6: Price/Value -Actual Purchase Behavior	0.292	0.292	0.050	5.828	0.000	Supported

H7: Purchase Intention - Actual Purchase Behavior	0.277	0.276	0.052	5.366	0.000	Supported

4.7.1 Structural model and Hypothesis test

At the beginning of the model assessment in smart PLS, it is essential to resolve any collinearity issues that may arise. The investigations have elucidated that the "Variance Influential Factor-VIF" is the predominant tool for evaluating the outcomes of latent variables, whereas tolerance is the primary indication for measuring collinearity (Hair et al, 2019). Hence, the outcome of latent variables is valuable in evaluating the problem of collinearity. The empirical investigation has demonstrated that the anticipated construct should have a value of less than 3 for VIF (Variance Inflation Factor) and greater than 0.20 for the tolerance value, as stated by Becker et al. (2015). In the present investigation, it was noted that all values of the predictive construct fall within a range that suggests the absence of collinearity problems. The structural model path was employed to verify the hypothesized significant path (Sarstedt et al., 2017). The bootstrapping technique was applied using 5000 sub-samples, as described by Noor et al. (2021). The Beta coefficient (β), t-value, and P-value were assessed to validate the outcome. The coefficient of determination R2 was used to assess the overall fit and monitor variations in the dependent variables. Therefore, the result suggests a generally strong fit of the model.

The table displays the outcomes of a statistical analysis that examined various hypotheses (H1 to H8) regarding the connections between distinct variables. Each hypothesis (H1 to H8) is evaluated using the mean effect size, standard deviation (Std.), beta coefficient (β), T-value, and P-value. The findings determine if each hypothesis is corroborated.

H1: Within the relationship of Perceived Environmental Knowledge - Purchase Intention has a mean of 0.263 and a beta coefficient 0.253, T value 5.926, P value 0.00 explained a positive support.

H2: Within the relationship of Perceived Environmental Knowledge -Actual Purchase Behavior has a mean of 0.186 and a beta coefficient 0.185, T value 4.394 P value 0.00 explained a positive support.

H3: Within the relationship of Subjective Norms- Purchase Intention has a mean of 0.264 and a beta coefficient 0.265, T value 5.675, P value 0.00 explained a positive support.

H4: Within the relationship of Subjective Norms- Actual Purchase Behavior has a mean of 0.180 and a beta coefficient 0.181, T value 4.260, P value 0.000 explained a positive support.

H5: Within the relationship of Price/Value- Purchase Intention has a mean of 0.343 and a beta coefficient 0.344, T value 6.862, P value 0.000 explained a positive support.

H6: Within the relationship of Price/Value - Actual Purchase Behavior has a mean of 0.292 and a beta coefficient 0.0.292, T value 5.852, P value 0.000 explained a positive support.
H7: Within the relationship of Purchase Intention - Actual Purchase Behavior has a mean of 0.277 and a beta coefficient 0.277, T value 5.366, P value 0.000 explained a positive support.

4.8.2 Mediating Hypothesis

Table 8

Hypothesis	Std. β	Mean	Std	T-value	P-Value	Findings
H8: Perceived Environmental Knowledge- Purchase Intention- Actual Purchase Behavior	0.073	0.073	0.019	3.913	0.000	Supported
H9: Subjective Norms- Purchase Intention- Actual Purchase Behavior	0.0073	0.0073	0.019	3.909	0.000	Supported
H10: Price/Value- Purchase Intention- Actual Purchase Behavior	0.096	0.095	0.022	4.285	0.000	Supported

Additionally, mediating hypotheses are as follows.
H8: Purchase Intention has a mediating effect within Perceived Environmental Knowledge-Actual purchase Behavior explained mean of 0073, beta value 0.073, T value 3.913 and P value 0.000 indicated a positive relationship.
H9: Purchase Intention has a mediating effect within Price/Value-Actual Purchase Behaviour explained mean of 0.095, beta value 0.096, T value 4.285 and P value 0.000 indicated a positive relationship.
H10: Purchase Intention has a mediating effect within Subjective Norms-Actual Purchase Behavior explained mean of 0.0073, beta value 0.0073, T value 3.909 and P value 0.000 indicated strong relationship.
Hypothesis from H1 to H10 are tested and have strong relationship among all variables of the research. The coefficient of determination R^2 for the APB was 0.612.

5. Discussion

This study provides useful insights into the correlation between environmental concern and consumers to purchase residential PV systems.

The results presented here confirm the observations made in prior studies. The findings examine the behavior of various consumer viewpoints, depending on the customer's priorities. The study finds that customers typically gather knowledge about eco-friendly products from their social circle, including friends, relatives, and neighbors. They heavily rely on their opinions when making purchasing decisions. This study demonstrated the significant impact of society on the perceived individual advantages, because of cultural inquisitiveness and customer engagement, which foster trust in the provider by establishing a social connection. Therefore, when customers experience favorable sentiments from their neighbors, relatives, and friends, it has a beneficial effect on their inclination to embrace a residential PV system (Palm & Tengvard, 2011; Schelly, 2014). Another motive for investing in a household PV system is to symbolically display and embody an environmentally conscious way of living. The findings indicate that customers acquire knowledge about the potential of solar technology mostly through their family and close acquaintances. Furthermore, customers often gain education about solar technology through the communities they belong to and their interpersonal connections. This study concludes that there is correlation between environmental Knowledge and purchasing intention that is aligned with previous findings from earlier studies discovered that there is a significant and positive correlation between environmental concern and green purchase behavior (Abdul Wahid et al, 2011). Additionally, there is a need to raise awareness among consumers about the benefits of solar panels. Further elaboration on these topics will be provided in the upcoming parts. In view of the growing concern for environmental issues, this study can provide valuable insights into the significance of adopting environmentally friendly practices and the necessity of supporting sustainable technologies. Furthermore, the government can also incentivize increased foreign direct investment to further reduce the cost and foster a competitive environment among industry participants.

6 Conclusion

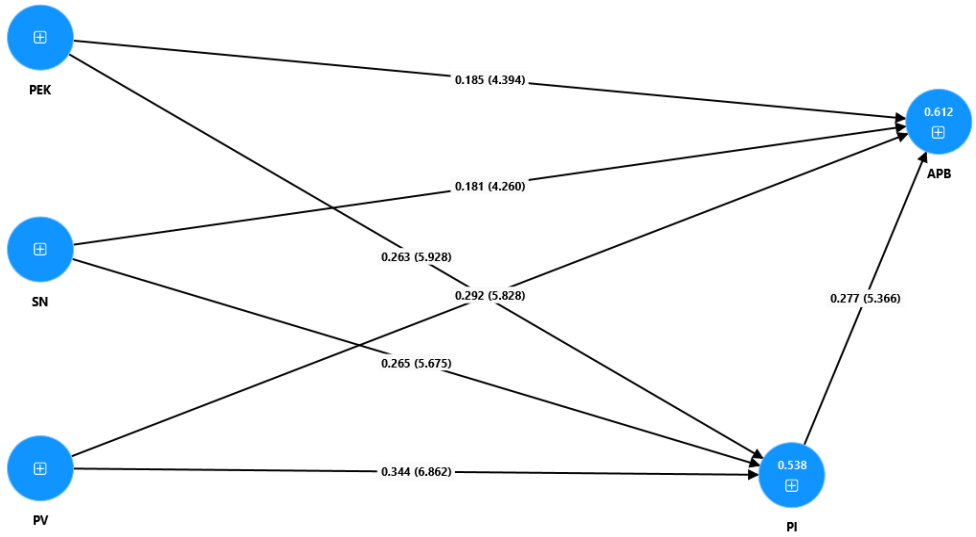
The utilization of fossil fuel for electricity production is unsustainable due to its rapid depletion. Moreover, other occurrences resulting from the use of fossil fuels, such as air pollution and oil spills have had a substantial impact on the ecosystem over time. The challenges have prompted the government to transition its energy composition to renewable sources, namely solar energy. Despite the global expansion of the solar panel business, the utilization of solar panels in Pakistan remains significantly restricted in comparison to other nations. The current study has demonstrated that while consumers express concern about environmental issues and acknowledge the benefits of solar panels, they lack the necessary expertise and experience to translate this awareness into actual purchases. This survey uncovers that a significant proportion of Pakistanis lack awareness of

government legislation pertaining to solar panels. Consumers also regarded solar panels as costly commodities. The study will aid policy makers in developing improved policies and institutional measures to encourage the adoption of solar panels among Pakistan.

7 Limitations and Future Direction

The present investigation has been carried out in Pakistan. It is advisable to gather data from both international sources and rural regions to facilitate a comparative analysis with more sample size. There are a few constraints in this study that should be considered for future research. Specifically, it is recommended to involve customers from lower income specially in the rural areas of Pakistan. The current study used the quantitative techniques in future the qualitative technique with semi stature questionnaire shall be used to conduct the studies. It is also recommended that other motivational factors such as Environmental concern, Intrinsic motivation, Green Marketing tools can be used for the future research to get inside consumer perception regarding actual purchase behavior for solar panels through consumer purchase intentions.

Figure 1



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