

# Consumers' Resistance to Eco-Innovation: Investigating the Behavior of Pakistani Consumers towards Adoption of Solar PV-Systems

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**Abstract:** This paper aims to investigate the behavior of Pakistani consumers' toward adoption of solar system and their effect on consumers' resistance. The domestic solar systems are a comprehensive electrification option for households in developing countries like Pakistan. The current energy crisis in Pakistan enforces the government and public to look into available alternative energy resources to meet the demand for electricity. The domestic solar systems are at an early stage and facing hurdles in disseminating into market; people do not know whether to adopt these technologies or not because of different uncertainty factors. An already tested innovation adoption framework, [1] diffusion of innovations theory, investigating consumers' behavior towards domestic solar systems is used in this study along with its classification of different innovation characteristics [2]. This foundation theory and its innovation characteristics were seen as constructive and useful in order to accomplish the objectives of the study.

**Keywords:** Innovation characteristics, Consumers' characteristics, Consumers' Resistance, Solar system, Socio-Demographic factors

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## INTRODUCTION

### Energy Crisis in Pakistan

Pakistan is facing a severe energy crisis, which is not only affecting the households but it also hinders the country's economic development and progress. Currently, multiple commissions and ministries are working on this issue to formulate a sustainable policy framework. The major challenge which the country is facing is to find economical and sustainable sources of producing electricity. After analysis of prevailing situation, immediate actions to overcome this crisis are recommended. Solar energy can be exploited for energy production in Pakistan. Moreover, the solar systems were not at maturity stage in past. [3] presented that domestic solar systems are expected to be competitive by 2017.

### Problem Statement

The human consumption activities exceed the ecological limits and depletion of these resources became a hot topic to discuss [4]. The world is facing a great challenge in coping with the issue of climate change [5]. The burning of fossil fuels and human reliance on carbon-based technologies has raised the global climate temperature and it is a single biggest challenge to be addressed. The world's 80% consumption of energy comes up from fossil sources such as coal, oil, natural gas and it stands for 99.6% of energy CO<sub>2</sub> emissions [6]. Energy conservation and efficiency, carbon capture storage, fossil fuel switching, nuclear energy, and renewable energy (RE) technologies are amongst some of those options. Solar energy is one of RE technology which can be used to generate electricity, where this technology is called photovoltaic (PV). Furthermore, the *micro-generation technologies* like domestic solar systems reduce the energy demand and CO<sub>2</sub> emissions.

### Significance of the study

The primary rationale behind this study is that Pakistan spends heavy amount of its budget on oil import. During 2011–2012, the country spent 33% of its budget amounting USD 14 billion on oil import to keep power houses of country in a running position. Pakistan pays USD 9.36 billion on oil import during financial year 2008–09. Hence, if it is supposed that the oil prices will remain constant, which is quite impossible, the country is expected to spend over USD 140 billion on oil import in five years. However, if we promote the use of renewable energy resources like solar PV-panels which is more sustainable, then government would spend this huge amount for educational and health. These prevailing problems urge the government and researchers for formulation of sustainable energy policy framework.

## LITERATURE REVIEW

### Consumer Resistance

The green and sustainable innovations generally experience resistance in consumer acceptance. These innovations hold apparent advantages over existing traditional products, but these innovative products still fail to develop and grab significant market share [7]. Empirical observations showed that across different product categories, majority (40–90%) of innovations faced failure and never become a commercial success [8]. A major cause for the slow rate of diffusion of these innovations is the consumers' resistance. This dilemma is needed to be investigated because of its critical importance at this stage when Pakistan is in severe need of this kind of speedy initiatives.

### Domestic Solar Systems

Domestic solar systems convert solar radiation into electricity. There are four types of solar systems; domestic photovoltaic (PV) systems, commercial systems, connected to electricity grid or used off-grid. An off grid solar system installed at summer cottage where there is no electricity

available. On the other hand, a domestic solar grid-connected system is an installed plant in a private house which is connected with electricity grid. The electricity produced by these PV-systems is directly utilized by household. The retail price of domestic solar systems is between PKR 2,00,000-3,00,000 for a normal household covering 5-6 members with an average electricity utilization capacity.

### **Adopter categories**

In a society, an innovation is not adopted concurrently by all the members of a society, but it goes after a specific course of adopter groups [9]. The different adopter categories hold different types of characteristics and demographics. The different types are categorized into innovators, early adopters, early majority, late majority and laggards. Empirical findings recommend that the different adopter groups are product specific; an innovator for one innovation might be a laggard for another innovation [10].

### **The Innovation-decision Process**

The innovation-decision process, by [11], illustrates the different phases that an individual goes through from gaining very initial knowledge to actual adoption of an innovation. It contains five phases; (1) knowledge, (2) persuasion, (3) decision, (4) implementation, and (5) confirmation, that necessitates a series of choices and actions through which an individual evaluates the choices and decides on whether to adopt an innovation or not.

### **Innovation Attributes and Rate of Adoption**

The rate of adoption refers to speed at which an innovation is adopted by individuals in a society. The attributes of an innovation were classified based on their importance for explanation of the rate of adoption, such as relative advantage, complexity, incompatibility, perceived risk, expectation for better product, and compatibility with values, trial ability and observability [12]. The rate of adoption is directly proportional to perceptions of

individuals about these attributes, which thus lead to faster diffusion process. [13] argues that innovation attributes is the most important determinant which explains 49-87% variance in rate of adoption.

Now, the innovation characteristics variables are described in detail for development of theoretical framework.

### **Relative Advantage**

[14] define the relative advantage as whether or not an innovation is seen to be better than the typical product, item or idea it replaces. Relative advantage can be demonstrated in financial terms or in communicating social prestige and it also includes factors such as initial cost, economic profitability, the impact on comfort, time and effort saving.

### **Compatibility with Life-style**

Compatibility refers to what degree an innovation is consistent with existing values, past experiences and needs of potential adopter [15]. Compatibility entails the match of innovation with individual's circumstances, individual feels familiar and serves as standard from which individuals judge the innovation.

### **Complexity**

[16] defines complexity as the *"degree to which an innovation is perceived as being relatively difficult-to-use and understands."* The complexity serves as significant barrier for adoption in high-technology domestic products [17].

### **Trial ability**

Trial ability refers to whether or not an innovation is tried out on a trial basis before purchase of an innovation or specific adoption decision is taken [18]. The trial ability is more important for relatively early adopters rather than late adopters.

### **Perceived Risk**

The perceived risk about the new products was first introduced by [19] as an additional element in adoption and

diffusion of innovation, which was later added by [20] as an important factor affecting consumers' resistance towards innovations. In this study, the discussion is about the degree of risk associated with adopting the PV-systems. It was proved that the perceived risk is negatively related to adoption and positively related to resistance [21].

### **Expectation for Better Products**

Sometimes, adoption of one technologically innovative product might have effect on adoption of other technological products [22]. [23] used term *expectation for better products* instead of *inhibitory effect on the adoption of other innovations* because it is easy to understand. Empirical findings about this factor are described later.

### **Consumers' Characteristic Factors**

#### **Attitude towards Existing Product**

The consumers' attitude towards existing product is influenced by tradition and ability of existing product in serving consumers' needs and wants. In such a case of favorable attitudes, consumers will not be willing to replace their old and still functioning products like traditional electricity with the new innovative products like domestic solar systems.

#### **Self-Efficacy**

It has also been found that self-efficacy has the power to predict the consumers' intention to use a variety of technological products [24]. Consumers with low self-efficacy chose those products which can be handled and used easily. It has been empirically verified that self-efficacy has its strong impact on consumers' resistance to technological products [25]. After [26] also considered the self-efficacy as a very critical determinant to study resistance and diffusion of innovations.

### **Research Questions**

This study strived to answer the following research questions;

RQ1: What is relationship between different innovation characteristic factors and consumers' resistance in adoption of domestic solar systems?

RQ2: What is relationship between different consumer characteristic factors and consumers' resistance in adoption of domestic solar systems?

RQ3: What is relationship between socio-demographic factors and consumers' resistance in adoption process of domestic solar systems?

RQ4: What is the inter-relationship (correlation) among all innovation characteristic factors and consumer characteristic factors?

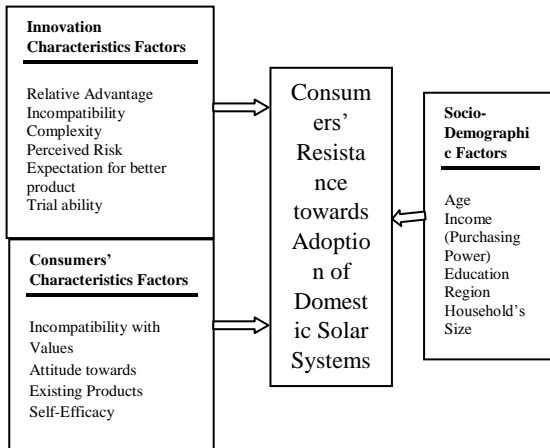
RQ5: What could motivate the future adoption of domestic solar systems in Pakistan?

### **Research Objectives**

The objectives of this study are;

- To investigate the impact of the innovation characteristic factors and consumer characteristic factors on consumers' resistance behavior.
- To explore the causes which prevent the consumers to adopt environmental innovations like domestic solar systems?
- To provide recommendations to government to formulate sustainable energy policy for micro-generation technologies, and also provides suggestions to practitioners to re-design their marketing strategies and NPD processes.

## CONCEPTUAL FRAMEWORK



### Hypotheses:

**H1.** There is a significant relationship between relative advantage of domestic solar systems and consumers' resistance towards domestic solar systems in Pakistan.

**H2.** There is a significant relationship between incompatibility of domestic solar systems with consumers' life-style and consumers' resistance towards domestic solar systems in Pakistan.

**H3.** There is a significant relationship between complexity to use domestic solar systems and consumers' resistance towards domestic solar systems in Pakistan.

**H4.** There is a significant relationship between perceived risk of using domestic solar systems and consumers' resistance towards domestic solar systems in Pakistan.

**H5.** There is a significant relationship between expectation for better products and consumers' resistance towards these domestic solar systems in Pakistan.

**H6.** There is a significant relationship between trial ability of domestic solar systems and consumers' resistance towards domestic solar systems in Pakistan.

**H7.** There is a significant relationship between incompatibility of domestic solar systems with consumers'

values and consumers' resistance towards domestic solar systems in Pakistan.

**H8.** There is a significant relationship between *attitude towards existing product* and consumers' resistance towards domestic solar systems in Pakistan.

**H9.** There is a significant relationship between self-efficacy of consumers and consumers' resistance towards domestic solar systems in Pakistan.

**H10.** There is a relationship between age of Pakistani consumers and their resistance behavior.

**H11.** There is a relationship between education of Pakistani consumers and their resistance behavior.

**H12.** There is a relationship between income of consumers and their resistance behavior.

**H13.** There is a relationship between consumers' region of residence and their resistance behavior.

**H14.** There is a relationship between consumers' households' size and their resistance behavior.

## RESEARCH METHODOLOGY

### Research Philosophy and Research Approach

In research philosophy, we observed three prevailing research paradigms used by the researchers which facilitate the knowledge creation. These three views are positivism, interpretivist and pragmatism. The approach adopted in this study is positivism.

Mainly, we have two kinds of research approaches, (1) inductive and (2) deductive [27]. These methods are used to analyze data and facilitate theory development, and it also serves in gaining deep insights about a particular research phenomenon [28]. In deductive approach, researcher inclined to find causal relationships and empirical data is used in deriving conclusions by developing and testing hypotheses [29].

## Data Collection

Various choices of research strategies are available such as case-study, survey, interviews and focus group discussions. Survey allows for collecting large amount of data from a sample in an economical & effective way [30]. [31] explained that survey is a common used and popular method to answer what questions.

## Population, Sampling Technique and Choosing Unit of Analysis

These respondents have good qualification and their age was greater than 22 years in 4 big cities of Punjab i.e. Lahore, Faisalabad, Sahiwal and Multan. These cities also have population from different socio-economic background.

Discussing sampling, it is impossible to gather data from all members; which is called census, due to cost and time constraints. We have two major kinds of sampling; (1) probability sampling and (2) non-probability sampling. All elements or respondents have the equal probability of being selected in probability sampling. The convenience sampling was also used because researcher does not know the exact size of population.

## Instrumentation

The questionnaire is adapted and changed by keeping in mind the context of Pakistan. Questionnaire was also included an open ended question for examining the general attitudes of respondents about solar systems.

## Data Analysis Techniques

SPSS software has been used to perform statistical tests. The questionnaire was based on [32] DOI variables and consumers' characteristics variables used in various studies. It is adapted and researcher made some changes according to Pakistani context. To measure the constructed variables, a five-point Likert scale was used. For checking the consistency in data, reliability analysis was done using Cronbach's alpha ( $\alpha$ ) method. Multiple regression analysis

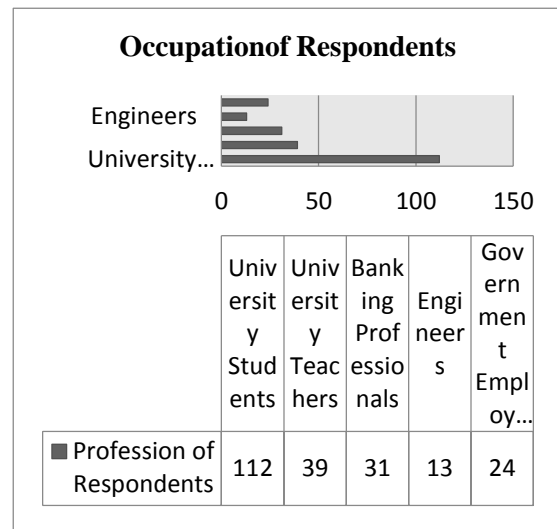
and correlation analysis was also done using SPSS 21.0 version.

## FINDINGS OF THE STUDY

### Data Collection and Demographic Information of Respondents

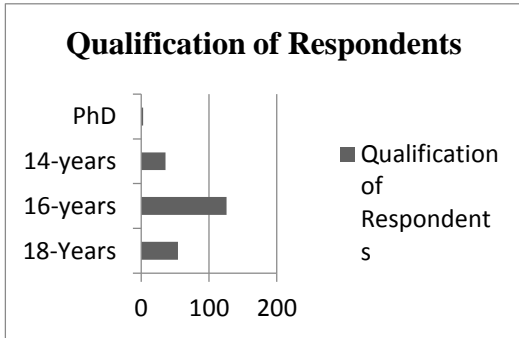
In questionnaire, the demographic information of respondents was also requested such as their age, income level, and area of residence, qualification and number of family members. The questionnaires were distributed among 300 respondents. Out of 300 distributed questionnaires, 219 questionnaires were returned complete and it is assumed a good response rate (73%).

University students represents major proportion of our respondents which is 112 (51%) students from (1) PU, Lahore, (2) UET, Lahore & Faisalabad Campuses, (3) University of Agriculture, Faisalabad, (4) BZU, Multan and (5) CIIT, Sahiwal Campus. After students, engineers and banking professionals were the major respondents with number of 39 (18%) and 31 (14%) respectively. University teachers and government employees were among the least participants with 13 (6%) and 24 (11%) respectively.

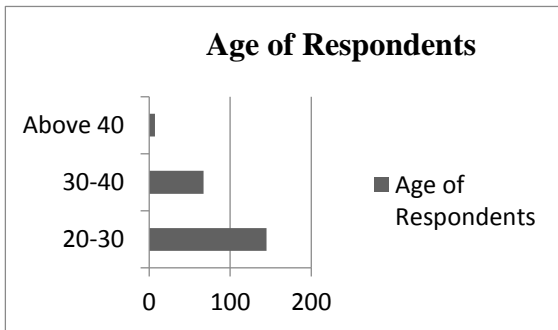


Comparative distribution of respondents on the basis of occupation

The participants with qualification of 16-years were dominant with 126 in numbers (58%), followed by two other groups i.e. 18-years, 54 in number (25%), and 14 – years, with 36 in numbers (17%). Only 03 respondents (0.05%) hold PhD degree represents lowest proportion. The age group of 20 – 30 years was leading with 145 respondents (60.6%), followed by 30 – 40 (36%) and above – 40 with only 07 respondents (3.4%).

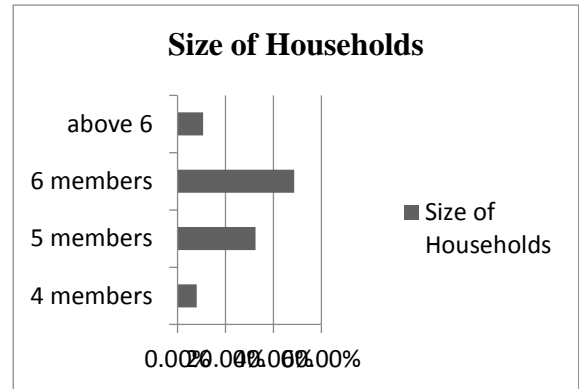


Comparative distribution of respondents on the basis of qualification

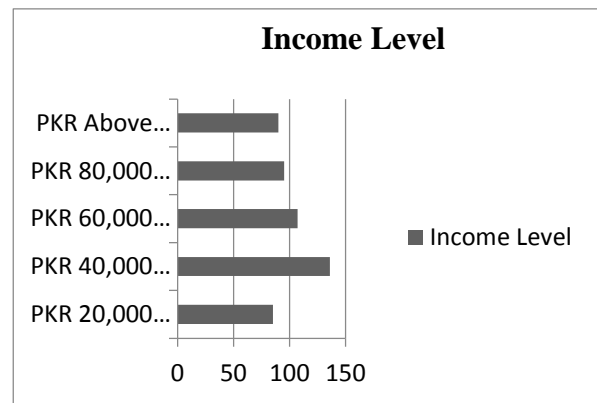


Regarding the variable of monthly income, majority of respondents (26.66%) were the middle-income groups, with income of PKR. 40000 - PKR. 60000, which represents their moderate purchasing power. The respondents, with income of PKR 20000 – PKR 40000, were the lowest among all respondents representing only 16.66% portion. The other group stayed between both of these income groups. The households size concentrates on six members per family with 107 respondents (48.73%), followed by five members with 72 respondents (32.5%). With the decrease of household’s size, the number of respondents also decreases.

Four members’ household and above six members represents low proportion with 14 respondents and 26 respondents respectively.



Comparative distribution of respondents on the basis of size of household



Comparative distribution of respondents on the basis of income level of respondents

### Reliability Analysis

To check reliability of data, consistency analysis using Cronbach’s alpha ( $\alpha$ ) method has been done using SPSS. Reliability analysis is used to measure the internal consistency of the collected data and it ranges from 0 – 1. Cronbach’s alpha ( $\alpha$ ) has been calculated to check for reliability analysis. It is assumed that the closer the value of Cronbach's alpha co-efficient to 1, the greater the internal consistency of data. [33] provides a rule of thumb: “ $\alpha > 0.90$  – excellent,  $\alpha > 0.80$  – good,  $\alpha > 0.70$  – acceptable,  $\alpha > 0.60$

– questionable,  $\alpha > 0.50$  – poor, and  $\alpha < 0.50$  – unacceptable”.

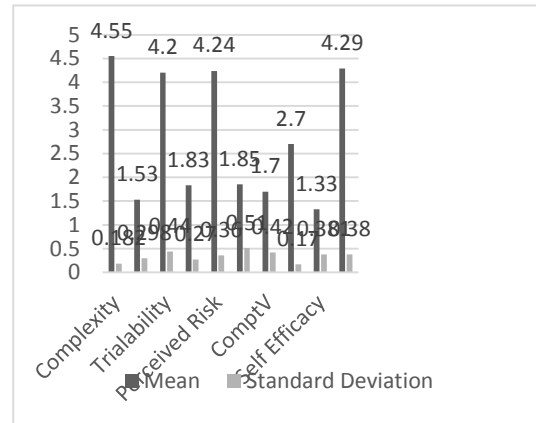
Factor	Cronbach's Alpha ( $\alpha$ )
Complexity	0.876
Relative Advantage	0.899
Perceived Risk	0.860
Compatibility with Life-style	0.724
Expectation for Better products	0.73
Trial ability	0.93
Compatibility with Values	0.751
Attitude towards Existing Product	0.77
Self-Efficacy	0.74
Consumer's Resistance	0.83

Trial ability, complexity, relative advantage and perceived risk have highest Cronbach alpha ( $\alpha$ ) scores with values of 0.93, 0.876, 0.899 & 0.86 respectively. However, compatibility with life-style, expectation for better products, and self-efficacy were the followers with values 0.724, 0.73 and 0.74 respectively.

**Descriptive Statistics**

In descriptive analysis of empirical data, that most of the respondents took domestic solar systems as a complex product. Compatibility with life-style and relative advantage were also seemed to be much important factor. Self-efficacy also shows trend towards low expertise and skills of

respondents to use solar systems. They seemed to be neutral.



Mean and Standard Deviation Values

ANOVA Table and estimates of regression parameters for Regression Model 1						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	22.577	8	2.822	2.941	0.003 <sup>b</sup>
	Residual	483.643	504	.960		
	Total	506.220	512			
a. Dependent Variable: R						
b. Predictors: (Constant), SE, RAL, COMPT, TR, PR, COMPTV, EXPCT, COMX						

**Normality of Data**

According to Central Limit Theorem, when number of observations exceeds 30, the data is approximately becoming normal. We obtained the values of skewness and kurtosis by using SPSS. The values of skewness and kurtosis are given in table. The data given in this table show that dependent variable is normal as values of Skewness and Kurtosis are near to 0.



Skewness and Kurtosis of variables						
	N	Mean	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
<b>Resistance</b>	513	4.29	-0.658	0.108	-0.350	0.215

**Regression Model 1**

We applied regression analysis in three phases and divide the analysis in three different models and check the impact of all variables by adding the variables in first two models. We devise an appropriate and suitable model named model 3. In model 1, we examined the impacts and model fitness of innovation characteristic variables and consumer characteristic variables with the consumer resistance.

Factors	Unstandardized Coefficients (β)	T	Sig.	Collinearity Statistics	Tolerance	VIF
COMX	.062	.201	.841	.022	46.275	
RAL	.207	2.522	.012	.407	2.456	
PR	-.065	2.0	.0	.157	6.3	

			91	47		18
COMP		-				
T	-.006	.035	.972	.083		12.041
EXPCT		-				
	-.018	.107	.151	.094		10.628
ATT		1.97				
	0.13		.051	.644		1.209
TR		-				
	-.044	.391	.96	.09		9.305
COMP		-				
TV	-.034	.232	.16	.074		10.410
SE		1.740	.082	.267		3.741

From the above table, overall regression is significant. If we see the Collinearity statistics of these variables, we find that there is serious problem of multicollinearity. For example, the value of tolerance for complexity is 0.022. It means that there is only 2% variability which cannot be explained by the variables other than complexity.

**Regression Model 2**

We can see from this table that there are two variables i.e. relative advantage and self-efficacy which are significant at 0.05 level of significance. The value of coefficient of determination for this model is 0.044 which is very small and indicates that the variables included in this model are not sufficient.

ANOVA Table and coefficients of regression model 2							
Model		Sum of Squares	Df	Mean Square	F	Sig.	
1	Regression	22.512	4	5.628	5.911	.000 <sup>b</sup>	
	Residual	483.708	508	.952			
	Total	506.220	512				
a. Dependent Variable: R							
b. Predictors: (Constant), TR, RAL, SE, PR							
Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Collinearity Statistics	
	B	Std. Error				Beta	Tolerance
1	(Constant)	2.456	.221		11.094	.000	
	RA	.207	.078	.172	2.665	.008	.449
	PR	-.052	.087	-.043	-.596	.552	.354
	SE	.159	.079	.137	2.011	.045	.406
	TR	-.039	.073	-.041	-.527	.598	.319
a. Dependent Variable: R							

The variables in research model of consumers' resistance demonstrated approximately 48% variation in consumers' resistance due to change in these four variables. The value of R is 0.484. The value of F statistics (F=5.911) explained the fitness of model.

**Regression Model 3**

ANOVA Table and coefficients for regression Model 3						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	38.220	9	4.247	4.564	0.000 <sup>b</sup>
	Residual	468.000	503	.930		
	Total	506.220	512			
a. Dependent Variable: R						
b. Predictors: (Constant), Income of Respondents, PR, No. of Family Members, Residence, Age, Qualification of Respondents, RAL, SE, TR						

Factors	Unstandardized Coefficients (β)	T	Sig.	Collinearity Statistics
Constant	2.014	6.137	0.000	Tolerance
Age	-.064	-.735	.463	.954
Residence	.179	2.330	.020	.977
Qualification	-.080	-.292	.771	.948
Households' Size	.084	1.577	.115	.980
Income	.065	1.738	.083	.980

RAL	.190	2.6	.0	.509	1.9
		34	31		64
TR	0.17	3.1	.0	.253	3.9
		87	25		15
PR	-.070	-	.4	.379	2.6
		.83	02		36
		8			
SE	.116	1.9	.0	.501	1.9
		36	53		98

Among the innovation characteristic factors, relative advantage had moderate impact on consumer resistance with beta value of 0.19. Perceived risk had negative relationship with resistance. Among consumer characteristic factors, self-efficacy and attitude has weak positive relationship with consumer resistance with  $\beta$ -values of 0.116 & 0.17 respectively. All the VIF values are below the 5.0 which provides sound basis for using these variables in model. The variables in new research model of consumers' resistance demonstrated approximately 27% variation in consumers' resistance due to change in these remaining six independent variables. The value of R is 0.270 and value of F-statistics (F=4.564) explained the fitness of model.

**Correlations Analysis**

Correlation Coefficients										
	Age	Resi.	Qual.	F.M	In come	RAL	PR	ATT	SE	R
Age	1	-.038	.162**	-.121**	.048	-.010	-.050	-.052	-.037	-.061
Resi.	-.038	1	.116**	-.005	-.072	-.005	-.003	-.002	-.017	-.081
Qual.	.162**	.116**	1	-.076	.065	.016	-.011	-.010	-.050	.093*
F.M	-.121**	-.005	-.076	1	.008	.041	.049	-.007	.027	.087*
In come	.048	-.072	.065	.008	1	.036	.000	-.000	-.006	.007

			72					3	07	5	3
RAL		-	-	.01	.04	.03	1	.686**	.682**	.550**	.191**
PR		-	-	.01	.04	.00	.686**	1	.729**	.699**	.141**
TR		-	-	-	-	-	.682**	.729**	1	.744**	.147**
SE		-	-	.05	.02	.06	.550**	.699**	.744**	1	.173**
R		-	.081	-.093*	.087*	.073	.191**	.141**	.147**	.173**	1

The factor of consumer resistance has moderate positive correlation with relative advantage, perceived risk, attitude towards existing products and self-efficacy. It also verified the regression results.

**CONCLUSION**

**Discussion**

- The findings of this study have shown that relative advantage of domestic solar systems is seen as positive by the respondents. Solar systems are seen as investment that is financially beneficial today which is the most important factor when considering adoption. In other words, consumers exhibited that domestic solar systems are beneficial for them.
- Findings in this study revealed that domestic solar systems are very difficult to use which indicates negative characteristic of self-efficacy. We have surprising results for self-efficacy which illustrates

that the resistance is going to increase with increase in self-efficacy. These results are not in line with previous studies.

- The demographic factors have significant impact on resistance. The education of respondents has weak negative link with resistance. It shows that the consumers do not intend to buy solar systems whether they are enough qualified or not. The income of consumers does not have any impact on consumers' resistance behavior.

### Implications

The above findings recommend number of implications for companies who design and manufacture the solar systems. The retailers and sellers should have focus on trial-based purchase of consumers. There are challenges present in dissemination of renewable technologies. Sometimes, consumers do not have awareness about these products. Therefore, companies also must have marketing companies to attract the attention of consumers. The potential for successful absorption is there, but need to explore.

### Future Research Directions

After findings of study, we have some future research directions which are follows;

- Only especial interesting finding is that most of respondents gave importance to relative advantage and self-efficacy, so these factors could be investigated in detail.
- The environmental aspect of green products was missed in this study which proposes a new research area for future research.
- Another aspect that could be of interest to investigate is to check the consumers' resistance relevant to adopter categories. This will provide a good understanding in what category the Pakistani consumers lie.

- The pay-back period which is related to relative advantage might provide insights about consumers' investment decisions.
- Answering to research question 5" this study provides the direction for research in implementation of feed-in-tariff systems in Pakistan. Thus, government support will boost the adoption of solar systems and it will be a good potential research area for academicians.

### Limitations

The consumers' awareness about domestic solar systems was the challenging area in this study. Due to financial and time constraints, study was limited to deductive approach using quantitative methodologies. To meaningfully explore this phenomenon of innovation adoption, the pragmatic approach with exploratory research design would be very suitable method to reach to some other dimensions because this study limited to innovation factors which restrict the responses on a designed scale. The scope of study is also limited because it includes four cities of Punjab province but this was due to lack of resources which have already mentioned. The convenience sampling technique imposes limitations on generalizability of findings. Thus, the futures studies will follow different triangulation approaches in data collection and analysis.

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