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Investigating the Determinants of the Adoption of Solar Photovoltaic Systems—Citizen's Perspectives of Two Developing Countries

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Abstract: The adoption of solar photovoltaic (PV) systems is seen as an important part of the sustainable energy transition. In this regard, it is crucial to identify the determinants of solar (PV) systems' adoption to facilitate this process. Therefore, this article aims to examine the determinants of SPVS adoption by contrasting the relationships in a cross-cultural environment. For the accomplishment of the purpose, this paper follows a quantitative method in which data is analysed by adopting the PLS-SEM approach using SmartPLS 3.3.9. After analysing the collected data of 464 consumers from Somalia and Pakistan, it is found that perceived usefulness, perceived ease-of-use, compatibility, observability, and perceived trust are significant predictors. However, no significant difference in influencing determinants has been observed between the two cultures using multi-group analysis. Further, perceived trust is not revealed as a significant determinant of behavioural intention in the Somalian context. The strongest relationship is found between attitude and behavioural intention in both cultures. In Somalia, the results reveal a variance of 49% in attitudes and 51% in intention to adopt SPVSs. In Pakistan, a variance of 60.1% in attitudes and 76.8% in intention to adopt SPVSs is found. Implications for both academics and managers to scale-up the adoption of SPVSs are made.

Keywords: technology adoption; solar photovoltaic systems; developing country

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1. Introduction

It is now the time for machines to take over the world, whether utilized for need or as a luxury. Devices require energy to perform tasks. The scientific community has long been worried about fulfilling the world's growing energy demand without causing environmental harm [1,2]. The use of limited traditional energy sources has resulted in such environmental degradation that pollution, acid rain, global warming, and other difficulties may be seen as a result [3]. Thus, generating green, clean energy from renewable sources is critical. Solar-powered energy has arisen as one of the most encouraging environmentally friendly power assets among all environmentally friendly power assets since it is plentiful, uninhibitedly accessible, and has economic potential [4]. Moreover, poverty reduction, industrial production and transportation, rural development, and health protection are all aided by solar energy development, whilst it also promotes sustainability and environmental quality [5].

According to studies, the ambient temperature in developing nations has been continuously rising [6,7]. This emphasizes the significance of using renewable and clean energy to reduce the temperature. Developing countries are lucky to have adequate natural resources for clean energy generation, such as sunlight-based energy [8,9]. Sun-based energy reception is characterized as the utilization of daylight to produce power [8]. The reception of these elective energy assets can create employment, improve energy availability and security, and reduce fossil fuel emissions, which degrade the ozone layer and add to the production of GHGs, raising the worldwide normal surface temperature [10].

Electricity is an indispensable condition for the sustainable development and modern growth of the world [11]. Its consumption is increasing worldwide day by day with the rapid advancement of technologies and quick urbanization. Contrary to this, solar (PV) systems can provide 11% of world's green electricity production with a reduction of 2.3 Gigatonnes of GHGs emission each year [12]. Oil/petrol represents the major contribution to the generation of electricity, followed by coal and gas [13]. Developed, as well as developing, economies are moving toward adopting renewable energy sources that oil, coal, and gas sources do not provide. Therefore, solar (PV) systems are becoming a sustainable source of electricity without harming the environment, increasing their power share by 43.14 times in past ten years, which was the highest capacity compared with other power-generation technologies [14].

Attitudes and adoption behaviours of consumers among lower and middle-income countries are also changing with the new age of inflation. The inflation rate in developing countries is increasing rapidly, such as from 13.8% in January 2014 to 17% in December 2014 [15], which attracts consumers to adopt solar (PV) systems to generate, supply, and consume electricity sustainably. In this connection, in order to reduce electricity bills, consumers intend to adopt solar (PV) systems instead of other fossil fuel sources (e.g., kerosene, coal, or natural gas) because these sources emit greenhouse gases (i.e., CO_2, NO_X, and SO_2) into the environment and steadily impact the biological system [16]. Thus, taking into consideration the substantial benefits, interest in using or adopting solar (PV) systems is increasing globally among consumers [11]. However, the reasons for this exponential growth are less known, which therefore needs further investigation. Thus, the main aim of this study is to build an understanding of the factors that influence the adoption of solar (PV) systems by the consumers. The conduct of this study is important to build the policymaker's understanding on the factors that significantly influence consumer's adoption of solar (PV) systems, so that they can develop a policy instrument for scaling-up the adoption among both adopters and non-adopters. Moreover, an increase in the adoption of renewable energy sources, such as solar PV systems, is expected to reduce 30% of GHGs in the energy sector [12,17].

Motivated thus, we seek to answer the research question: what determinants influence the consumer's adoption behaviour of solar (PV) systems in developing countries? To the best of our knowledge, quite a few studies have investigated the acceptance factors of solar (PV) systems by comparing low and middle-income countries. From the cross-cultural perspective, Sovacool and Lakshmi Ratan [18] analysed the acceptance factors of solar electricity in Germany, India, the United States, and Denmark qualitatively. In another study, the authors [19] qualitatively made a comparison of the implementation of solar home systems programs in Mongolia, China, Papua New Guinea, and Laos. In deploying renewable energy, the opinions of industry experts on the barriers of the whole world were taken, and measures to break these barriers were suggested [20]. Based on the premise that the influences of potential determinants will change over time and culture [21,22], this study addresses the research question by explaining the determinants of consumer's adoption of solar (PV) systems and by making a comparison between two developing countries. For this purpose, we develop a conceptual model to explore the determinants by integrating the technology acceptance model (TAM), diffusion of innovation (DOI), and the related literature. Our model posits that consumer's solar (PV) system's adoption behaviour is influenced by perceived usefulness, perceived ease-of-use, compatibility, observability, and perceived trust, which lead to the consumer's attitudes toward the intention to use. The developed model is validated by collecting the data from consumers of two developing economies (Pakistan and Somalia) through surveys and objective data.

The test results of our developed model indicate that, collectively, consumer's attitudes are determined by perceived usefulness, perceived ease-of-use, compatibility, observability, and perceived trust, which lead to the attitude and onward intention to use solar (PV) systems in both economies. However, the observability attribute is not revealed as a significant influencing determinant of intention to use in Somalia. Surprisingly, there is no significant difference of influencing determinants revealed between both countries after performing a partial least squares-multigroup analysis (PLS-MGA).

There are several theoretical contributions of this research which are as follows. Perceived ease-of-use is the strongest influencing factor of the perceived usefulness of solar (PV) systems in both contexts, followed by the relationship between attitude and behavioural intention. Although researchers assessed the impact of observability on predicting the behaviours of adopting solar (PV) systems [21,23], few scholars supposed it difficult to predict its impact on solar-adoption behaviour. Therefore, another contribution of this study is to cross-validate the observability attribute in two economies simultaneously and determine whether it is a useful measure in predicting solar-adoption behaviour. The theoretical contributions are important because academicians can seek help and evidence in validating existing and developing new theories on technological innovation adoption.

In terms of practical implications, our results reveal that initiatives such as installing lithium-ion batteries and removing underperforming batteries from the market can be taken in order to increase the usefulness of solar (PV) systems. Campaigns to educate rural-area consumers in their local language can be launched so that ease-of-use perceptions can be increased among consumers. Policymakers may also take the initiative to launch solar (PV) systems that are compatible with the norms, values, and future needs of consumers. They should also introduce and discern the positive results of solar (PV) systems used in the social system. Increasing the security and safety of renewable energy billing systems will have an important role in increasing consumer's trust so that the adoption of solar (PV) systems can be made on a large scale. The practical implications are important for practitioners for policy- and decision-making in removing the barriers and scaling-up the adoption of solar (PV) systems in the understudied cultures so that environmental quality and sustained economic development can be attained.

2. Literature Review on Solar (PV) System's Adoption

Energy is so important, and developing countries in particular should make urgent efforts to harness renewable fuels for various purposes. Several motivations for investors to finance renewable energy projects and the challenges were explored in [24]. Owusu-Manu and Mankata [24] listed twelve challenges in three main categories, including economic (such as industry's limited knowledge, incurred cost, and the payback period), commercial (lack of government policies, inefficient pricing schemes, and the local energy context), and regulatory (inappropriate regulatory structure and limited cooperate bond markets). Moreover, several barriers of technological (research and development, technical capacity), financial (economic utilization, financial investments in solar energy projects), political (political will or commitment, legislation), and social (knowledge and awareness) types were also explored [25]. Limited infrastructure, a lack of maintenance and operations skills, development and research projects, and technical obstacles such as energy storage and a lack of standards are all major technological roadblocks to widespread renewable energy adoption [26–28].

In a study conducted by Awais and Fatima [29] to assess the behavioural intention to use solar energy, they found personal norms to be the mediating variable between social norms and solar energy behaviour. By employing the value-belief-norm theory, all of the proposed hypotheses were accepted, except one which suggested a negative relationship between traditional values and the new ecological paradigm. Kapoor and Dwivedi [21] examined the impact of innovation characteristics (except the fifth characteristic, which is trialability) on sustainable consumption. Several modifications were made to the DOI theory to evaluate sustainable consumption. For instance, compatibility and observability were proposed to have effects on complexity and behavioural intention, and the impact of complexity on the relative-advantage for onward impact on the behavioural-intention of sustainable consumption, instead of direct relationships between causes (relative advantage, complexity, compatibility, and observability) and affects (behavioural intention and adoption). All proposed relationships were logged as approved [21]. Table 1 depicts a review of solar adoption studies with a summary.

Table 1. Review of solar-adoption studies with a summary.

Study	Country	Year	Summary
[30]	Malaysia	2014	Surveyed 200 Malaysian households to test the factors (relative advantage, cost, perceived ease of use, awareness, perceived behavioural control) on renewable energy acceptance.
[31]	The Netherlands	2015	Explored the four determinants (relative advantage, complexity, social influence, and knowledge of grants and costs) of photovoltaic adoption among households in the Netherlands.
[23]	Mexico	2017	Studied the role of different cognitive factors (such as social influence, subjective norms, perceived uncertainty, knowledge, asymmetric behaviour, beliefs about consequences, and so on) and DOI's innovation attributes on renewable energy technologies' adoption.
[32]	Iran	2018	Tested Iranian households' attitudes towards intent to use renewable energy by social norms, perceived behavioural control, awareness, relative advantage, and moral norms.
[33]	Pakistan	2018	Categorized different determinants and associated them with the DOI's adoption-decision attributes for investigating the households' solar PV adoption.
[34]	India	2018	Investigated the factors of households' adoption of solar microgrids baselining the model of Kerosene.
[35]	Austria	2018	Commissioned a model of renewable energy technologies' acceptance among Austrian individuals.
[36]	Germany	2019	Assessed the importance of economic, personality, and environmental factors of renewable energy systems given by the households.
[21]	India	2020	Discovered new relationships of DOI's innovation characteristics between compatibility and complexity, observability and complexity, and between complexity and relative advantage, and found their impacts on the use intention of solar innovation.
[37]	Malaysia	2017	Investigated the roles of ease-of use-and usefulness on attitudes towards use-intention of solar PV technology using TAM theory.
[38]	Uganda	2020	Examined the impacts on the socio-political, community, and market acceptances of renewable energy by the technological characteristics, environmental opportunities and threats, complex value, and low vulnerability.
[39]	India	2020	Explored the effects of knowledge and awareness, barriers (financial and technical types), and motivations (energy, financial, and environmental types) on solar innovation-adoption in households in India.
[40,41]	Ethiopia	2018, 2020	Collected cross-sectional data from households in Ethiopia to analyse the driving factors of solar energy technology-adoption behaviour.
[20]	Whole world	2019	Explored quantitatively several social, economic, technological, and regulatory barriers to remove them in deploying renewable energy.
[8]	Poland	2021	Investigated antecedents of renewable energy's adoption after collecting 467 responses from Polish consumers.
[42]	N/A	2022	Carried out a meta-analytic review of the solar-adoption literature to predict adoption intention.
[29]	Pakistan	2022	Employed value-belief-norm theory to evaluate a new ecological paradigm (intention to use, willingness to pay, and word-of-mouth intention).
[43]	Los Angeles	2022	Examined the impact of place-attachment and sense-of-attachment in measuring the pro-environmental attitudes among homeowners of Los Angeles.
[44]	Lebanon	2018	Analysed the significant difference between adopters and non-adopters of solar water heaters among consumers of Lebanon.

Note: Type and method to conduct above studies were empirical and quantitative survey.

There were several other studies carried out exploring the adoption-determinants of solar (PV) systems around the world by different researchers. For instance, the adoption-determinants of renewable energy were evaluated using the TAM [8]. Among six factors of adoption, two, that is, (one) initial cost and (two) risk and trust, were not found to be significant. Ease-of-use, financial incentives, relative advantage, and environmental concerns were realized to be significant [8]. In determining the factors of residential PV systems, Schulte and Scheller [42] performed a meta-analysis and revealed that subjective norms, environmental concern, and novelty seeking related to and affected the perceived benefits and onward adoption intention. Furthermore, perceived behavioural control also significantly influenced the residential PV system's adoption intention [42].

3. Theoretical Foundation and Hypothesis Development

Scholars have been conducting research on innovation or technology adoption for several decades. The first theory, which has been recognized as the base-theory in technology adoption studies, is the diffusion of innovation (DOI) theory proposed by Rogers [22]. However, innovation adoption studies started escalating after introducing the technology-acceptance model (TAM) [45], developing the instrument to evaluate the adoption perceptions [46] and presenting the theory of planned behaviour (TPB) [47]. This study integrates two theories, which are the DOI and the TAM. However, some modifications/amendments were made while joining these two models. Two well-established and mostly addressed attributes, which are perceived ease-of-use and perceived usefulness, have been engaged from the TAM model. These attributes are the basics of any technology or innovation, and are largely used by several eminent scholars in assessing the adoption of different technologies, such as open and big-data adoption [48,49], mobile payment adoption [50], adoption of online streaming services [51], and so on.

Diffusion of innovation (DOI) theory was adopted because earlier research was dominantly employing it for determining the factors or barriers of solar (PV) systems [20,21,23,30,38,41,52–55]. Two attributes of innovations, relative advantage and complexity, are not included in the model; rather, they synonymously correspond to perceived usefulness and perceived ease-of-use, respectively. The fifth characteristic of innovation, that is, trialability, was excluded from the model to observe its influence on solar technology-adoption. The rationale behind not including trialability in the conceptual model was that neither solar (PV) systems were introduced in trial versions, nor were they started as pilot projects for suppliers or households. The inherited nature of the residential solar (PV) systems does not allow trialability characteristics to be generally considered for adoption assessment [56]. Even the suppliers/vendors do not provide solar (PV) systems to the consumers on a trial basis and do not provide a warranty on solar-accompanied gadgets, except panels [33]). Furthermore, trialability has not been found to be a significant positive-predictor of solar energy adoption [33]. We include one more factor, namely perceived trust, instead of trialability (see Figure 1). We further believe that the integration of DOI and TAM can give a better understanding of the diffusion and adoption of solar PV.

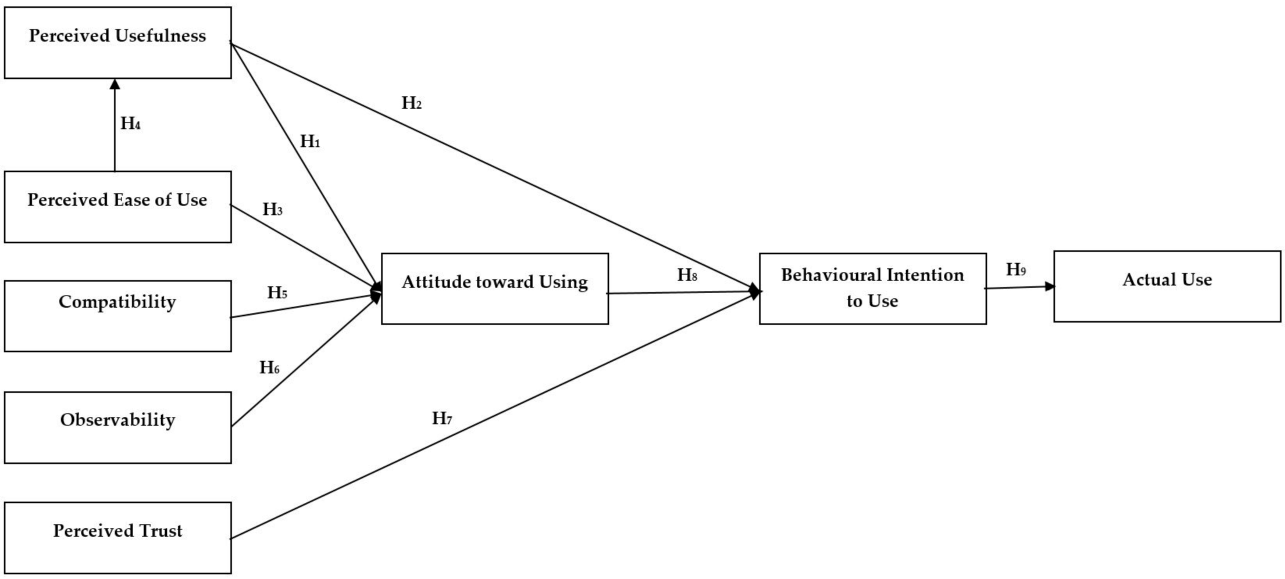

Figure 1. Conceptual Model integrating TAM and DOI Theories.

3.1. Perceived Usefulness

Perceived usefulness is defined as the extent to which a person believes that using technology will enhance her/his productivity [57]. Consumers are inclined to use or not use a technology based on their perceptions of productivity increase. It is a promising solution to meet the energy demands of a country or a household [16]. It is also argued that adopting solar innovation can improve energy access and security [6]. As the solar (PV) systems are highly reliable with life span expectation of maintenance, they are considered a highly favourable source of energy for future use [58]. On the contrary, the solar (PV) system's usefulness in terms of high capital cost, long payback period, and lack of consumer's confidence in long-term performance negatively affect the behaviour, i.e., their widespread adoption [59]. A close and positive relationship was argued between performance/productivity and the use of technology [38]. Along the same lines, the use of solar energy-equipped systems is argued to increase the consumer's job performance by helping to minimise costs related to electricity [21]. Studies on solar PV innovation have logged the impact of this (i.e., perceived usefulness) innovation characteristic on the adoption behaviour, such as the examination of solar PV's acceptance by the consumers [37]. We argue that perceived usefulness is an important factor in developing consumer's attitudes toward using solar PV. Further, the significant impact of perceived usefulness on the attitude has been observed in the attitude toward using solar PV technology [37]. Thus, we propose the hypothesis as follows:

Hypothesis 1 (H1). *Perceived usefulness will significantly influence the consumer's attitude toward solar PV.*

Despite the above facts, we also believe that perceived usefulness shapes the attitudes and the consumer's intention to use solar equipment. In this respect, not only are several instances relevant to finding the impact of perceived usefulness on attitudes, but these characteristics of innovation also impact behavioural intention to use solar-based energy systems. For instance, Nkundabanyanga and Muhwezi [38] investigated the influence of perceived usefulness on renewable energy's social acceptance and Tapaninen and Seppanen [60] examined the acceptance of household renewable energy systems. Based on this evidence, we formulate the following hypothesis:

Hypothesis 2 (H2). *Perceived usefulness will significantly influence the consumer's behavioural intention to use solar PV.*

3.2. Perceived Ease-of-Use

Perceived ease-of-use is the extent to which a person believes that using technology or a system will be free of effort [57]. Even if the consumers find a technology or system useful with respect to increase performance or productivity, their perceptions about hardship or difficulty in using it may be high [61]. Thus, technology may be assumed to be easy to use or free of effort, even with its high usefulness. Consumers would use a technology when it is found to be easier to use than their relevant technology and, thus, it would be more likely to be accepted. Similar is the case with Solar (PV) systems. Solar equipment is easy to install and maintain, as well as being easily available with low transportation costs [62]. Further, easy operational elements of solar (PV) systems can make their installation and maintenance easy on a day-to-day basis [58], which significantly affects consumer attitudes [23]. The systems can be speedily installed since most consumers already have electrical wiring installed in their homes [33], which makes the solar (PV) systems less complex. Researchers further argue that the better the consumer's skills or capability to handle solar (PV) systems are, the more they will intend to adopt them [53]. Moreover, Ahmad and Mat Tahar [37] also framed, investigated, and found the significant positive impact of this (perceived ease-of-use) characteristic on building consumer's attitudes toward solar PV technology. Accordingly, we also propose the hypothesis that:

Hypothesis 3 (H3). *Perceived ease-of-use will significantly influence the consumer's attitude toward solar PV.*

Ease in the use of solar-based energy systems is not only argued (as mentioned above) as shaping consumer's attitudes, but it also increases the solar (PV) system's usefulness. In previous studies, the ease of using technology was found to have a strong and direct antecedent to technology-usefulness [63]. This has been further hypothesised and empirically confirmed in solar innovation [37]. Thus, we propose the following hypothesis:

Hypothesis 4 (H4). *Perceived ease-of-use will significantly influence the perceived usefulness of solar PV.*

3.3. Compatibility

In this study, compatibility refers to the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters [22,33]. Innovations are more attractive when they fit with the consumer's lifestyles, values, and future needs [21]. Conversely, the incompatibility of innovation with consumer's cultural values will restrict its acceptance [22]. Consumers are more apprehensive about their daily life matters, such as heating, cooling, and electricity [4], and, accordingly, they change their lifestyle significantly by adopting renewable energy sources, such as solar (PV) systems. The severe load-shedding/shortfall of electricity also generates the present and forthcoming needs of the consumers to accept and use solar energy systems [64]. The technicalities in handling the solar (PV) systems and solar-generated electricity also fit with the local needs of the individuals, thereby becoming the cause of the increased rate of solar adoption. In terms of sociocultural beliefs, the solar (PV) systems are adopted largely since they are alternative, effective, and widely recognised sources of energy compared with wind, hydropower, and biomass energy at the individual level [33,58]. The citizens believe that the solar-powered electricity available for use is similar to the generated and consumed conventional electricity [56]. The geographic and environmental conditions (for instance, the availability of abundant sunlight), particularly in South Asian countries [33,64,65], create standardisation, reduce uncertainty, and thereby, allow households to use solar (PV) systems.

We argue that citizens will affiliate their positive affections with solar (PV) system's adoption when it is aligned with their sociocultural values and beliefs, previously introduced ideas, and future needs [33,53]. Social psychologists believed, and accordingly recorded, its strong positive impact on attitudes toward adopting renewable energy technologies [23,59]. We, therefore, also propose to hypothesise its effects on attitude as:

Hypothesis 5 (H5). *Compatibility will significantly influence consumer's attitudes toward using solar PV.*

3.4. Observability

Observability is the degree to which the results of an innovation are visible to others [22]. As solar (PV) systems are dominantly consisting of hardware/electrical components instead of software, they are apparent to observation. Residents install solar panels on their home's rooftops to generate and consume electricity with or without having batteries (as electricity storage devices). On the one hand, by installing solar (PV) systems, they believe that the value of their properties will be increased [56]. On the other hand, they would be providing solar-generated electricity to the main grid station to reduce bills [11]. Such types of visibility of results within social systems generate overall affective reactions of citizens to adopt solar (PV) systems. Further, Qureshi and Ullah [33] stated that uncertainties in household's minds about to use of solar (PV) systems would be reduced by observing their positive results. In addition, like cellular phones, solar (PV) systems are becoming a fashion in social circles. Such social change happened since consumers saw the popular usage of solar (PV) systems inside and outside of their geographic areas, as they are attractive and not hidden or intrusive systems [59]. Thus, the observability or visibility of the results of solar (PV) systems can be considered as the driving force of generating affective reactions in adopting them.

Scholars contend that some innovations (any idea, system, process, or product) are easily noticed and proliferated in a society, whereas some are hard to discern and describe [22]. Societal members are expected to adopt technology on a large scale if they observe and notice technology's favourable societal results. Consequently, the results of solar-based energy systems are more evident to other consumers. Several social scientists, including Reyes-Mercado and Rajagopal [23], Faiers and Neame [56], Faiers and Neame [59], and Labay and Kinnear [66], recorded pieces of evidence of the strong positive impact of observability on shaping consumer's attitudes toward using solar technology. Thus, this characteristic of solar-equipped systems is hypothesised as:

Hypothesis 6 (H6). *Observability will significantly influence consumer's attitudes toward using solar PV.*

3.5. Perceived Trust

By using solar (PV) systems, consumers find electricity without interruption. Their daily activities will never be affected by the absence of electricity, as it can be provided without any delay by the use of solar PVs [28]. These perceptions will generate the consumer's inclination toward solar PV usage. Solar PVs, being small-scaled electricity-generation units, reduce the risks of electricity being stolen by other people who, consequently, can enhance their proclivity to its deployment [20]. Similarly, when individuals perceive that solar energy technologies can be trusted in terms of their safety and security, this can enhance their proclivity to accept and use them [37]. Solar-based energy systems have several integrated pieces of equipment to generate in-house electricity with no dependence on power supply organizations [25]. In some cases, consumers also provide the generated electricity to the power-generation companies. This can increase consumer's assurance of receiving correct electricity bills. There are several instances found in the previous literature where trust influenced the acceptance and adoption of solar PVs [8,38]. We argue that perceived trust shapes consumer's affections toward solar PV, and thus hypothesize that:

Hypothesis 7 (H7). *Perceived trust will significantly influence consumer's attitudes toward using solar PV.*

3.6. Attitude

Several references in information technology/systems research have been made where attitude is highlighted as the mediator role in using a particular technology [45,67]. It is defined as the cumulative affective reaction of an individual in using technology, innovations, or systems [68]. Labay and Kinnear [66] proposed the importance of attitudinal attributes such that, from the perspective of consumers, social psychologists would be reassured by finding the influence of attitudinal perceptions on the adoption behaviour of solar (PV) systems. On the one hand, attitudes towards using technology only partially mediate the relationship between beliefs and behavioural intentions [45]. This attribute is further framed to recognize it as a mediator between beliefs and intention of solar adoption, but this is not tested [32]. On the other hand, it is the strongest predictor of behavioural intentions [68]. Attitudes are considered as general predispositions that lead to a set of intentions instead of performing a specific behaviour [23]. Moreover, in a study conducted by Ahmad and Mat Tahar [37], attitude to use solar energy-equipped systems was a strong predictor of behavioural intention. We also include the attitude construct to reaffirm its existence as a strong predictor of behavioural intention towards using solar equipment. Accordingly, we formulate the following hypothesis:

Hypothesis 8 (H8). *A consumer's attitude will significantly influence the behavioural intention to use solar PV.*

3.7. Behavioural Intention

Behavioural intention is suggested in several innovation diffusion and adoption models as a dominant predictor of the adoption of an innovation [22,61,68,69]. This variable is suggested as instinct-based, which the consumers often link with a specific behaviour [70]. It has also been acknowledged as a significant predictor by several other studies on solar adoption [21,23,38]. Hence, we propose the below hypothesis:

Hypothesis 9 (H9). *A consumer's behavioural intention will significantly influence solar PV usage.*

4. Methodology

The data for this study was collected from the adopters of the solar (PV) system of two developing countries, Pakistan and Somalia. The data was collected from Pakistani and Somalian solar consumers during the month of May 2022. First, the questionnaire demographics, constructs, and relevant items were chosen from the existing studies on solar adoption, and then the questionnaire was designed using Google Forms. We distributed a total of 250 questionnaires in Somalia and 600 in Pakistan through an online link, because this method of collecting data is easy and fast. In order to determine the minimum sample size, we used G*Power software, setting a statistical power of 0.95 and effect size of 0.15, a probability level of 0.05, and eight variables [71]. Putting these parameters together, this study required a minimum sample size of 160.

The online questionnaire link was disseminated among consumers of solar-based energy systems using email and individual WhatsApp numbers. One hundred and forty-four consumers responded and filled the survey completely in Somalia, whereas a total of three hundred and forty responses were collected from Pakistan, signing the online questionnaire link. A low response rate was achieved since this is the drawback of online questionnaires [72]. According to the sample size guidelines of Sekaran and Bougie [72], the results of 384 responses can be generalized to a population of one million. Therefore, 464 responses are sufficient for a population of over one million. A total of three records from the Somalian cluster and nineteen records from the Pakistani cluster were discarded, since the consumers selected the same options for all question items or they followed a pattern in answering the questions. A 57.6% and 56.7% response rate was recorded in

Somalia and Pakistan, respectively, which was more than that of the acceptable response rate (that is, 30%) [72].

The survey consisted of a variety of questions and scales. It had three dichotomous questions, which were area, gender, and the consumer's possibility of using solar-generated electricity if the price is the same as fossil fuel-generated electricity. There were five nominal scale questions, including consumer's willingness to install and pay for solar-based energy systems, type of solar equipment in use, duration of use in years, age, and qualification. PU, EU, CO, OB, TR, AT, and BI were evaluated on a seven-point Likert scale (1 = extremely agree to 7 = extremely disagree). All of these constructs are of reflective nature except for the actual use. The advantage of the seven-point Likert scale is that the responses are fine-tuned and allow the respondents to remain neutral as well in answering a question [73]. Further, the actual use or adoption of solar (PV) systems had three items (that are, (1) actual daily use in hours (six-point Likert scale), (2) frequency of use (six-point Likert scale), and (3) duration of use in years (five-point Likert scale)). Thus, 29 items were measured on a seven-point Likert scale. Items of PU construct were adopted from Nkundabanyanga and Muhwezi [38], EU, CO, OB, and BI were taken from the study conducted by Kapoor and Dwivedi [21], and items of AT construct were taken from Ahmad and Mat Tahar [37]. Moreover, items of actual-use construct were adopted from [61,74].

An initial analysis, namely the pilot test, which is the essential part of conducting the survey on large-scale consumers, was conducted on 30 respondents. A pilot study provides the understandability of the developed survey attempted by the consumers of different ages, gender, and education qualification groups. It also helps in further collecting the data from a large number of consumers by ensuring that they can easily understand the questionnaire items and respond by selecting the appropriate option. All of the changes recommended by the consumers were incorporated in the survey. For instance, some respondents suggest asking about the area of consumers to be the urban or rural and the duration of use of solar (PV) systems in years.

The consumers of solar (PV) systems were approached by implementing a purposive sampling technique, since the feedback or opinion of the adopters of solar (PV) systems was to be considered. After collecting the data, the phase came in where the collected data was transformed into specific codes, since the data collected through Google Forms was partially in coded form. One of the authors carefully coded the data corresponding to the prior set values. For instance, a value of 1 was set for urban and 2 for rural and, similarly, 1 for male and 2 for female. After transforming the data and checking missing or similar values in a particular record, the analysis was conducted in SmartPLS 3.3.9, a well-known and well-utilized tool in social science research [75]. The SmartPLS 3 works on the partial least square (PLS) technique to build the structural equation model (SEM). The PLS-SEM was adopted because it does not follow normal distribution assumptions; as the study is exploratory where an extension of an existing structural theory was to be tested, it obtained parameter estimates by repeated least squares regression with a single dependent variable each time [76].

5. Results

5.1. Descriptive Statistics of Demographics

In addition to some personal characteristics (such as gender (male = 326, female = 136), age (21–30 years = 242, 31–40 years = 128), and education (associate diploma = 102, postgraduate diploma = 156) of consumers, data on several other demographics (such as area, willingness to install and pay for solar, the possibility of using solar-generated electricity, type of solar equipment in use, duration of use of solar) variables were also collected to provide a detailed picture of solar diffusion and adoption (Table 2). There were 328 respondents who belonged to urban areas. A large number of consumers (a total of 315) were willing to pay and install solar (PV) systems if the government provided subsidies for solar (PV) system installation. A total of 322 consumers positively agreed to the possibility of using solar-generated electricity if the price is the same as that of fossil fuel-generated electricity.

With respect to the type of solar equipment in use, 47 consumers were using a solar-heating type of equipment, 145 were using lighting, 15 were using cooking, 104 were using electrical appliances (such as TVs and pressing irons), and 151 were using any other type of household solar equipment. Most of the consumers (a total of 177) fell in the range of 0 to 1 year of using solar (PV) systems.

Table 2. Profile of Respondents and other Demographics.

Categories	Values	Somalia N = 143	Pakistan N = 321
Gender	Male	102	224
	Female	41	97
Age	<21 years	18	40
	21–30 years	77	167
	31–40 years	39	89
	41–50 years	08	22
	51–60 years	01	02
	Above 60 years	00	01
Education	High school or below	02	37
	Intermediate	03	12
	Associate diploma	01	101
	Bachelor's degree	58	05
	Postgraduate diploma	03	153
	Master's degree	71	11
	Doctorate	04	02
	Other	01	00
Area	Urban	130	200
	Rural	13	121
Willingness to install and pay for solar	Do not know.	12	47
	No. I am not willing to install and pay even if it is subsidized.	25	27
	Yes, I am willing to install and pay if I get a 100% subsidy.	66	124
	Yes, I am willing to install and pay if I get a 50% subsidy.	31	95
	Yes, I am willing to install and pay, but I do not need any subsidy.	09	28
Possibility of using solar-generated electricity	Yes	101	221
	No	42	100
Type of solar equipment in use.	Solar heating	15	32
	Lighting	42	103
	Cooking	09	06
	Electrical appliances (such as TVs and pressing irons)	34	72
	Any other household solar system	43	108
Duration of solar use	0–1 year	61	117
	1–3 year	34	67
	3–5 year	08	42
	5–10 year	07	33
	Over 10 year	33	62

5.2. Reliability and Validity Analysis (Measurement Model)

The research model, after data collection, was evaluated by performing a reliability and validity analysis. These are always the part of the measurement model and the first part when the analyses are performed using SmartPLS [76]. In the measurement model, one—the values of variance inflation factor (VIF) were recorded for both Somalia and Pakistan (Table 3), two—factor loadings were observed, three—Cronbach's alpha values of each construct were obtained, four—composite reliability values were achieved, five—average variance values were extracted (AVE), and six—discriminant validities were made.

Table 3. Variance Inflation Factor of both clusters.

	VIF (Somalian Cluster)	**VIF (Pakistan Cluster)**
AT1	1.443	3.376
AT2	2.383	4.232
AT3	1.982	3.095
AT4	1.595	3.835
AU1	1.263	2.231
AU2	1.263	2.231
BI1	2.431	3.856
BI2	2.223	3.004
BI3	2.537	4.229
BI4	2.030	3.481
CO1	1.539	2.483
CO2	1.671	2.540
CO3	1.522	1.824
CO4	1.568	2.420
EU1	1.042	1.035
EU2	1.288	1.628
EU3	1.445	1.279
EU4	1.277	1.418
OB1	1.414	1.468
OB2	1.424	1.561
OB3	1.098	1.766
OB4	1.389	1.919
PU1	1.547	2.073
PU2	1.855	2.997
PU3	1.607	2.555
PU4	1.334	1.903
PU5	1.595	2.508
TR1	1.385	1.820
TR2	1.333	2.029
TR3	1.126	1.401
TR4	1.110	1.463

All of the construct's values achieved the recommended acceptable values, according to the guidelines of Hair and Hult [76]. Moreover, the items EU1, OB3, and TR3 of perceived ease-of–use, observability, and perceived trust constructs respectively were removed due to their low factor loadings in the Somalian cluster (Table 4). However, only one item EU1 of perceived ease-of–use construct was deleted due to its low factor loadings in the Pakistani cluster (Table 5). The values of Cronbach's alpha, composite reliabilities, AVE, and discriminant values of each construct have been mentioned in Table 4 (Somalian cluster) and Table 5 (Pakistani Cluster) after deleting the three items.

Table 4. Reliabilities and Validities of different Constructs (Somalian Cluster).

Constructs	Item Code	Factor Loadings	Cronbach's Alpha	Composite Reliability	AVE
Perceived Usefulness (PU)	PU1	0.717	0.803	0.863	0.559
	PU2	0.810			
	PU3	0.733			
	PU4	0.703			
	PU5	0.770			
Perceived Ease-of-Use (EU)	**EU1** *	**0.189**	0.664	0.809	0.590
	EU2	0.722			
	EU3	0.892			
	EU4	0.672			
Compatibility (CO)	CO1	0.730	0.767	0.850	0.586
	CO2	0.748			
	CO3	0.784			
	CO4	0.797			
Observability (OB)	OB1	0.825	0.712	0.816	0.602
	OB2	0.615			
	OB3 *	**0.609**			
	OB4	0.864			
Perceived Trust (TR)	TR1	0.742	0.583	0.781	0.545
	TR2	0.804			
	TR3 *	**0.371**			
	TR4	0.663			
Attitude (AT)	AT1	0.727	0.816	0.879	0.647
	AT2	0.879			
	AT3	0.830			
	AT4	0.773			
Behavioural Intention (BI)	BI1	0.880	0.877	0.916	0.731
	BI2	0.852			
	BI3	0.872			
	BI4	0.814			
Use Behaviour/ Actual Use	AU1	0.745	0.627	0.831	0.713
	AU2	0.933			

* item(s) removed. Note: Values of Cronbach's alpha, composite reliability, and AVE are presented after removing the items.

Table 5. Reliabilities and Validities of different Constructs (Pakistani Cluster).

Constructs	Item Code	Factor Loadings	Cronbach's Alpha	Composite Reliability	AVE
Perceived Usefulness (PU)	PU1	0.796	0.886	0.917	0.688
	PU2	0.871			
	PU3	0.835			
	PU4	0.781			
	PU5	0.862			
Perceived Ease-of-Use (EU)	**EU1** *	**0.013**	0.696	0.825	0.612
	EU2	0.817			
	EU3	0.827			
	EU4	0.697			

Table 5. *Cont.*

Constructs	Item Code	Factor Loadings	Cronbach's Alpha	Composite Reliability	AVE
Compatibility (CO)	CO1 CO2 CO3 CO4	0.858 0.866 0.812 0.887	0.879	0.916	0.733
Observability (OB)	OB1 OB2 OB3 OB4	0.799 0.687 0.811 0.844	0.801	0.867	0.620
Perceived Trust (TR)	TR1 TR2 TR3 TR4	0.800 0.860 0.694 0.753	0.783	0.86	0.607
Attitude (AT)	AT1 AT2 AT3 AT4	0.908 0.930 0.896 0.920	0.934	0.953	0.835
Behavioural Intention (BI)	BI1 BI2 BI3 BI4	0.915 0.891 0.923 0.911	0.931	0.951	0.828
Use Behaviour/ Actual Use	AU1 AU2	0.931 0.936	0.852	0.931	0.871

* item(s) removed. Note: Values of Cronbach's alpha, composite reliability, and AVE are presented after removing the items.

In order to assess the discriminant validities of the constructs, three criteria (Fornell–Larcker, cross-loadings, and Heterotrait–Monotrait Ratio (HTMT)) [76] are applied. However, the discriminant validities of the constructs using the Fornell-Larcker criterion were reported in this study. In the Fornell–Larcker criterion, a comparison between the correlation of the latent variables and the square root values of the AVE [76] was performed. The Fornell–Larcker criterion is grounded on the premise that each construct shares more variance with its underlying items than with any other construct [76]. Table 6 for Somalian and Table 7 for Pakistani clusters indicate the values of each construct's discriminant validity using the Fornell–Larcker criterion.

Table 6. Fornell–Larcker Criterion for Discriminant Validity (Somalian Cluster).

	AU	AT	BI	CO	OB	EU	TR	PU
AU	0.845							
AT	0.154	0.804						
BI	0.133	0.682	0.855					
CO	0.015	0.575	0.546	0.765				
OB	0.193	0.385	0.324	0.338	0.701			
EU	0.231	0.607	0.492	0.52	0.445	0.662		
TR	0.215	0.669	0.534	0.527	0.483	0.572	0.665	
PU	0.091	0.569	0.559	0.639	0.263	0.472	0.548	0.747

Table 7. Fornell–Larcker Criterion for Discriminant Validity (Pakistani Cluster).

	AU	AT	BI	CO	OB	EU	TR	PU
AU	0.933							
AT	0.208	0.914						
BI	0.278	0.862	0.910					
CO	0.276	0.721	0.748	0.856				
OB	0.230	0.523	0.527	0.530	0.788			
EU	0.262	0.601	0.626	0.639	0.562	0.782		
TR	0.193	0.680	0.676	0.705	0.556	0.625	0.779	
PU	0.235	0.687	0.693	0.752	0.452	0.560	0.659	0.830

5.3. Measurement Invariance of Composite Models (MICOM) Analysis

Before testing hypotheses and performing multi-group analysis nationality-wise (i.e., Pakistan and Somalia), it is compulsory to establish the measurement invariance. A three-step hierarchical procedure was followed for the accomplishment of these purposes. The aforementioned procedure consisted of three elements, namely: (one) configural invariance, (two) compositional invariance, and (three) the equality of composite mean values and variances [77]. For configural invariance, we had identical indicators per measurement model, identical data treatment, and identical algorithm settings or optimization criteria for both measurement models. Therefore, the configural invariance was established. Next, we checked the compositional invariance (i.e., composite scores were created equally across groups). All original correlations of all constructs with 5% quantile values were compared. The results of the MICOM analysis reveal (see Table 8) that the original correlations of all constructs were greater than 5% quantile scores, and all permutation *p*-values were also insignificant (i.e., >0.05). Hence, the compositional invariance was also confirmed.

Table 8. MICOM Analysis (Step 2).

	Original Correlation	Correlation Permutation Mean	5.00%	Permutation *p*-Values
Actual Use	0.999	0.996	0.986	0.582
Attitude	1.000	1.000	0.999	0.428
Behavioural Intention	1.000	1.000	0.999	0.292
Compatibility	0.999	0.999	0.997	0.402
Observability	0.995	0.995	0.987	0.346
Perceived Ease-of-Use	0.998	0.997	0.990	0.558
Perceived Trust	1.000	0.997	0.992	0.906
Perceived Usefulness	0.999	0.999	0.997	0.642

Although the first two steps, i.e., configural invariance and compositional invariance, are the basic conditions for performing a multi-group analysis, composite equality was also assessed. The third step was assessed with two criteria: (one) mean original difference (Pakistan–Somalia) and (two) variance original difference (Pakistan–Somalia). The PLS-MICOM results indicate that the values of the mean original difference did not fall within the range of 2.5% and 97.5% values (see Table 9).

However, the values of variance-original difference of attitude, compatibility, observability, perceived trust, and perceived usefulness constructs fell within the range of 2.5% and 97.5% values (see Table 10). On the contrary, the values of variance-original difference of the perceived ease-of-use, behavioural intention, and actual use constructs did not fall within the range of 2.5% and 97.5% values, as presented in Table 10. Hence, the partial invariance of the measures was established.

Table 9. MICOM Analysis (Step 3)—Mean Original Difference.

	Mean-Original Difference (Pakistan–Somalia)	**2.50%**	**97.50%**
Actual Use	0.370	−0.190	0.178
Attitude	0.408	−0.181	0.196
Behavioural Intention	0.458	−0.187	0.187
Compatibility	0.394	−0.174	0.170
Observability	0.468	−0.196	0.185
Perceived Ease-of-Use	0.326	−0.198	0.194
Perceived Trust	0.378	−0.195	0.193
Perceived Usefulness	0.274	−0.184	0.188

Table 10. MICOM Analysis (Step 3)—Variance Original Difference.

	Variance-Original Difference (Pakistan–Somalia)	**2.50%**	**97.50%**
Actual Use	0.255	−0.128	0.128
Attitude	−0.228	−0.327	0.392
Behavioural Intention	−0.412	−0.311	0.335
Compatibility	−0.245	−0.271	0.298
Observability	−0.067	−0.261	0.280
Perceived Ease-of-Use	−0.385	−0.285	0.280
Perceived Trust	−0.193	−0.258	0.296
Perceived Usefulness	−0.203	−0.279	0.350

5.4. Hypothesis Testing (Structural Model)

After evaluating the construct's reliabilities and validities in the first phase of PLS-SEM, the formulated hypotheses were tested by assembling the constructs in a structural model and calculating the path coefficients, standard deviation, *t*-statistics, and *p*-values. The calculations were performed using the bootstrap technique (on 5000 samples), which was applied to 462 records. Each hypothesis was tested by adopting the significant level with a *p*-value of 0.05, 0.01, and 0.001, as depicted in Figure 2. The interactions between PU and AT, PU and BI, EU and AT, EU and PU, CO and AT, OB and AT, TR and BI, AT and BI, and BI and AU were assessed by the means of *t*-statistics and path coefficient (β). The consequences of the structural model, corresponding to Somalia, after performing the PLS-SEM (that is, bootstrapping) analysis are revealed in Table 11. Since all hypotheses (H1, H2, H3, H4, H5, H6, H7, H8, and H9), in the context of Pakistan, were found true, a collective remark of "Accepted" was mentioned in the Remarks column (Table 12).

Table 11. Testing of Hypotheses using PLS-SEM (Somalian Cluster).

Paths	**Path Coefficient (β)**	**Standard Deviation**	***t*-Statistics**	***p* Values**	**Remarks**
H1: PU→AT	0.260	0.087	3.002	0.001	Accepted
H2: PU→BI	0.234	0.123	1.899	0.029	Accepted
H3: EU→AT	0.301	0.090	3.341	0.000	Accepted
H4: EU→PU	0.471	0.069	6.811	0.000	Accepted
H5: CO→AT	0.215	0.097	2.230	0.013	Accepted
H6: OB→AT	0.112	0.083	1.351	0.088	Accepted
H7: TR→BI	0.069	0.099	0.696	0.243	Not-Accepted
H8: AT→BI	0.503	0.111	4.526	0.000	Accepted
H9: BI→AU	0.133	0.097	1.38	0.084	Accepted

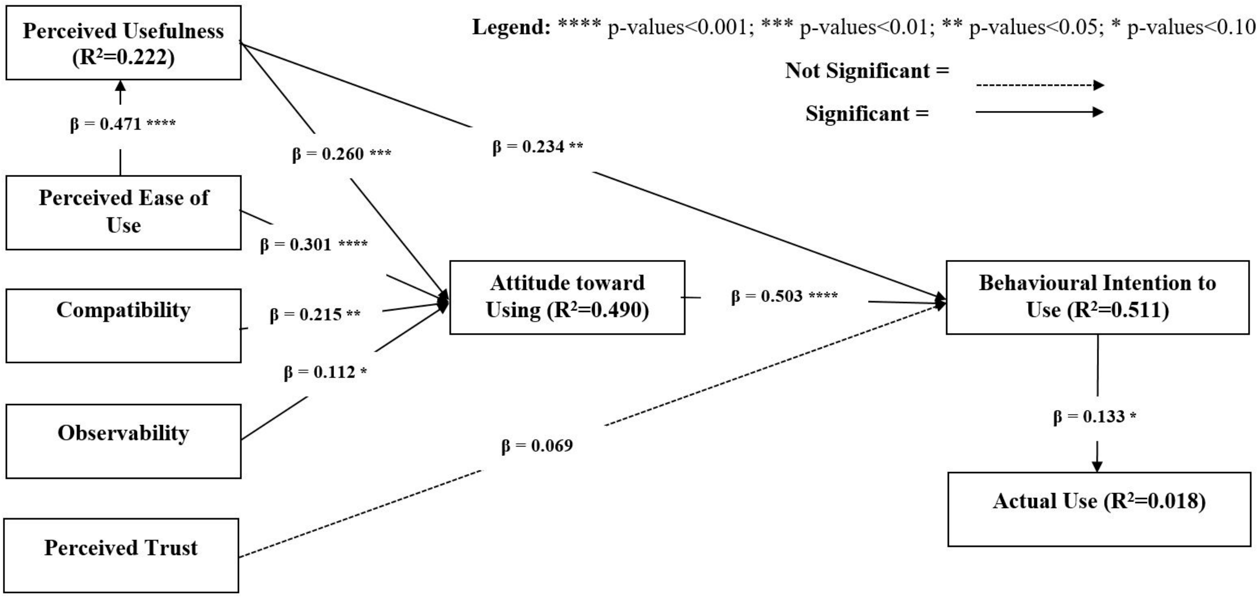

Figure 2. Validated Model using PLS-SEM (Somalian Cluster).

Table 12. Testing of Hypothesis using PLS-SEM (Pakistani Cluster).

Paths	Path Coefficient (β)	Standard Deviation	*t*-Statistics	*p* Values	Remarks
H1: PU→AT	0.290	0.065	4.475	0.000	
H2: PU→BI	0.149	0.050	2.992	0.003	
H3: EU→AT	0.150	0.062	2.418	0.016	
H4: EU→PU	0.560	0.046	12.079	0.000	
H5: CO→AT	0.339	0.072	4.732	0.000	Accepted
H6: OB→AT	0.128	0.048	2.686	0.007	
H7: TR→BI	0.114	0.044	2.572	0.010	
H8: AT→BI	0.682	0.055	12.461	0.000	
H9: BI→AU	0.278	0.051	5.448	0.000	

Figures 2 and 3 depict the percentage of variance (R^2) explained by the model in Somalia and Pakistan respectively. However, the percentage of variance explained by the model, collectively, is 29.7% for perceived usefulness, 56.8% for attitude, 67.3% for behavioural intention, and 7.3% for actual use of solar PV.

5.5. PLS Multi-Group Analysis (PLS-MGA)

For the multi-group analysis, we followed the conservative and robust approach proposed by Henseler and R. Sinkovics [77] in PLS-SEM. We selected each path coefficient in the structural model and ran complete bootstrapping with 5000 samples. A probability value of less than or equal to 0.05 indicates a significant difference in the group-specific PLS path coefficient for the selected relationship. The results of the PLS-MGA are presented in Table 13, which shows that there is no significant difference in Pakistani and Somalian cultures since no determinant is significantly influencing the solar PV adoption, except for the relationship between attitude and behavioural intention at a *p*-value of less than 0.10. Further, considering the difference between the two cultures or nationalities, the perceived ease-of-use negatively influences the attitude. Similarly, the relationship between perceived usefulness and the behavioural intention is also negative. However, both relationships are not significant, as represented in Table 13.

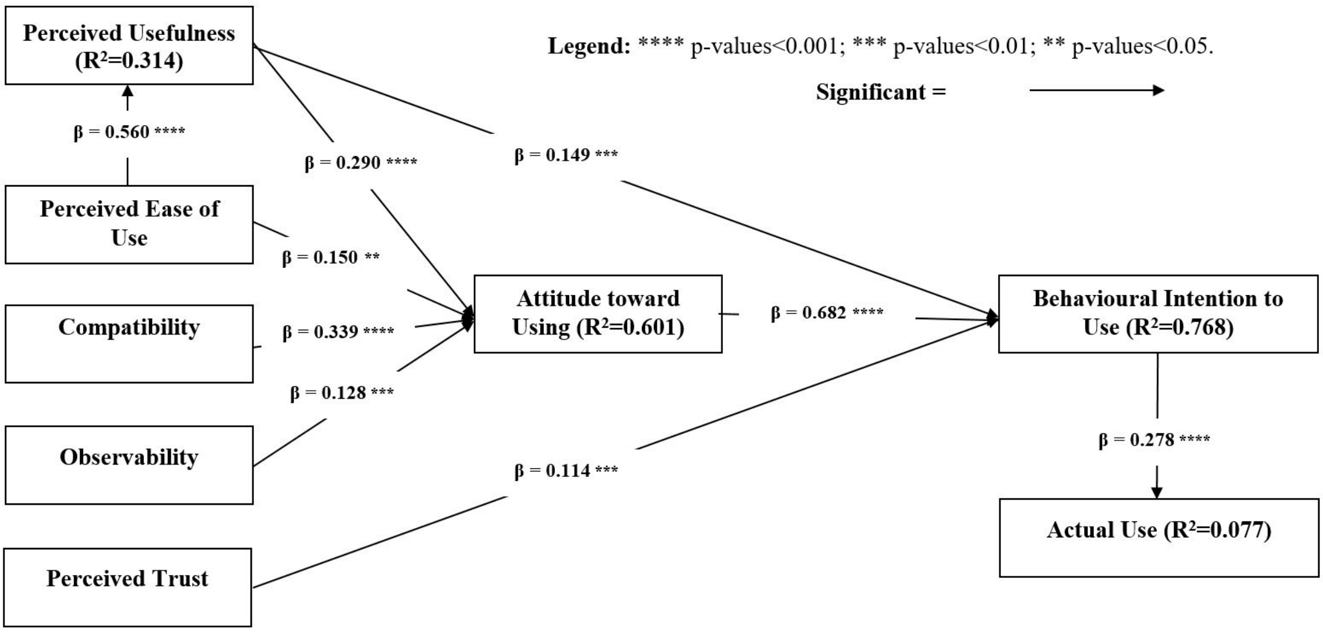

Figure 3. Validated Model using PLS-SEM (Pakistani Cluster).

Table 13. PLS-MGA Results.

	Path Coefficients-Diff (Pakistan–Somalia)	*p*-Value New (Pakistan–Somalia)
AT → BI	0.199	0.098
BI → AU	0.134	0.135
CO → AT	0.123	0.303
OB → AT	0.016	0.869
EU → AT	−0.151	0.181
EU → PU	0.089	0.291
TR → BI	0.018	0.859
PU → AT	0.032	0.770
PU → BI	−0.095	0.477

6. Discussion

6.1. Discussion

The results highlight and verify that the usefulness of the solar (PV) systems is vital in shaping the consumer's attitudes (H1), as well as behavioural intention (H2), in the Pakistani and Somalian samples. Thus, the results validate the earlier finding of Nkundabanyanga and Muhwezi [38] on the acceptance of renewable energy. Consumers of both cultures (i.e., Pakistan and Somalia) have significant positive perceptions in building their attitudes and increasing their intentions by the contribution of solar (PV) systems in increasing their performance and productivity [78]. Consumers can make an investment decision in installing solar (PV) systems if they feel that solar technology will not damage the roof and cause leaks into the house, and thereby will not affect their work performance [39]. Further, ease-of-use is also revealed as a major contributing attribute in defining the attitude toward the acceptance and use of solar (PV) systems in both cultures (H3). Not only is the relationship between EU and AT significantly positive, but the relationship between EU and PU also is. Comparing with the earlier studies in Africa [25,38] and Asia [32,33], the results show a strong positive relationship between the ease-of-use and usefulness (H4) of solar (PV) systems in both samples, since the easier the maintenance, operation, installing, and time to repair a solar technology is [79], the more they found it useful in improving their quality of life and productivity [38].

The compatibility of solar (PV) systems is an important driver in shaping the behaviour of consumers. The relationship between CO and AT (H5) is significantly verified in both clusters. The results are aligned with previous studies on related innovations [33]. According to the results, the compatibility attribute contributes to shaping the consumer's attitude toward the use intention of solar (PV) systems [23], since studies conducted in Pakistan [80,81], India [82], and African countries [83] chronicled that solar (PV) systems are fit in their geographical location, consistent with cultural norms, and homogenous with future needs [84]. Taking the innovation attributes from Roger's theory, not only the compatibility but also the observability attribute is a significant predictor of attitude (H6). Thereby, observability increases the consumer's attitudes toward the use intention of solar (PV) systems, which is in tune with the studies conducted in Pakistan [33] and India [21,52]. The results of adopting solar (PV) systems in the social system are apparent in providing electricity, increasing the property value, and saving money in Africa [85].

By comparing the results of the samples of two different cultures, the results indicate substantial dissimilarity in the relationship between TR and BI (H7), such that it was significant in the Pakistani sample whereas it was insignificant in the Somalian sample. Thus, Somalian consumers consider that trust has no role in forming their intention to adopt solar (PV) systems, whereas Pakistani consumers consider that it does. The current study's results provide surprising evidence of trust having no substantial impact on behavioural intention in Somalia due to safety and security concerns, which is consistent with the earlier study on consumer's perceptions of renewable energy acceptance in Uganda [38]. Another reason for such results might be the duration of their use, since the majority of the adopters (i.e., 95 out of 143 consumers were using solar (PV) systems from 0 to 3 years) were early adopters of solar (PV) systems. They may need some more time in using solar (PV) systems to build their trust in these systems and form pro-environmental behaviours. Moreover, the market manipulation, with regard to counterfeited solar products and their prices, can be another reason for an insignificant influence of trust on developing intentions in African consumers, since they cannot receive a reliable electricity supply throughout the day and year without good-quality solar products [25,83].

Beliefs surrounding areas such as usefulness, easiness, compatibility, observability, and trust in solar (PV) systems innovation generate positive affection in consumer's minds, according to the current findings. Further, Davis developed the TAM theory on the premise that the positive affective belief leads to the production of strong positive behavioural intention of consumers. This premise is supported by the findings of this study as well as the previous studies on solar energy adoption, including [21,33,38,52]. Hence, we conclude that attitude contributes significantly to increasing the behavioural intention to use solar (PV) systems (H8), in line with earlier studies in Asian and African cultures [32,86].

Behavioural intention shapes or forms the consumer's usage of solar (PV) systems (H9), which is aligned with the study conducted in India [21]. Although our results witness poor variance in the actual use of solar (PV) systems, the variance in Pakistan's context is much better, and the variance in the Somalian context is slightly better than Indian consumer's perceptions [21]. Moreover, there are studies with a low variance in the adoption of technologies, for instance, Khurshid, Zakaria [48], and Kapoor and Dwivedi [21]. However, in alignment with the earlier studies [21,61,68], this study reports behavioural intention as a significant predictor of solar (PV) system's adoption. In contrast, the findings do not match to the previous study in solar (PV) system's adoption i.e., Corbett and Hershfield [43].

6.2. Theoretical Implications

The theoretical model, from the theoretical or academicians perspective, claims that attitude is the ideal attribute to measure for determining intention and for onward solar (PV) systems usage by the consumers. This is why it was proposed that attitude is a determinant of intention to use solar (PV) systems. The relationships were compared from a cross-cultural perspective of two developing countries. In both Pakistani and Somalian contexts, the relationships were found to be significant. No discontinuity between attitude and intention's relationship and between intention and actual behaviour was recorded, which confirms that the paths are adequate to predict the consumer's behaviour toward adopting solar (PV) systems. Therefore, theoretically, this casts no serious doubts as to whether attitude is a predictor of intention and onward usage of solar (PV) systems in the two developing countries. The results coincide with the earlier research on renewable energy adoption [21,23,32,37] and highlight the importance of analysing the relationships between attitude and intention and onward use behaviour in greater depth.

In our study, a few key attributes of renewable energy adoption have been theoretically modelled using information system theories. This study evaluates the impact of five attributes on attitude and onward intention to use solar (PV) systems, and identifies PU, AT, BI, and AC as the dependent variables based on the earlier pieces of evidence on renewable energy adoption. All of the relationships were proposed based on the logical reasoning of the extant literature on solar (PV) systems, and all of them turned out to be significant, except for the relationship between TR and BI in the Somalian culture. Theoretically, this study provides substantial evidence of the proposed relationships empirically. The results indicate, theoretically, that attitudes are formed by the consumer's perceptions about solar (PV) system's usefulness, ease, alignment with values and norms, discernibility of results, and trust.

Our research can serve as the base study worldwide on a cross-cultural perspective which builds on the existing knowledge of how solar (PV) system's adoption is spread globally. The model formulated in this study holds a deep-rooted applicability to be considered for similar innovations and pro-environmental attitudes and behaviours of consumers of other cultures and countries. Given that solar (PV) systems have not been empirically assessed for their acceptance in the cross-cultural context, i.e., simultaneously in Pakistani and Somalian contexts, to date, this study becomes the first of its kind to offer empirical insights into the behaviour of innovation's socio-technical characteristics cross-culturally. The results of this study add to the existing knowledge on Roger's DOI theory and Davis' TAM theory (as well as integrating both theories) from the cross-cultural perspective of solar (PV) system's adoption in developing countries. The research model can be used or serve as the base model to modify or add other socio-technical attributes of innovation for validating the influences of the hypothesized relationships on the consumer's adoption of solar (PV) systems.

6.3. Practical Implications

Taking into account the results of this study, governments, policymakers, and relevant practitioners need to look ahead in order to increase solar (PV) system's adoption for a sustainable environment, since certain characteristics of this technology are acknowledged as the most important area of concern for fostering the adoption of solar (PV) systems. Consumers seem not to be sceptical about using solar (PV) systems in both economies, which means that relevant policy instruments may be executed in order to scale-up the adoption of solar (PV) systems.

PU and EU have several managerial implications, since both attributes have a strong positive impact on attitude toward using solar (PV) systems. Perceived usefulness may also be increased by installing lithium-ion batteries instead of lead-acid batteries, because they do not allow for an enormous amount of energy wastage [11]. Incentive mechanisms such as feed-in tariffs (FiTs) can be provided or introduced to prosumers to increase the adoption rate of solar (PV) systems [11], since 68% of consumers require subsidy from the government to purchase and install solar (PV) systems. There is a need to educate energy consumers about the usefulness of lithium-ion batteries. Moreover, removing batteries that are underperforming from the market may be another step. Consumer knowledge and education may be the element limiting them in solar (PV) system's adoption on a large scale. Therefore, policymakers should launch campaigns, particularly in rural areas, to educate consumers on installing and maintaining solar (PV) systems, so that they cannot find any difficulty in using this technology [23]. However, campaigns can be launched on social media that distribute the published brochures in the local language. Moreover, R&D firms in the relevant regions, focusing on the requirement of the consumers, need to develop user-friendly PV technologies to inspire and establish a positive attitude toward future adoption of solar (PV) systems [37].

Given that the compatibility and observability of solar (PV) systems has a strong influence on building consumer's attitudes, a manager should particularly promote the aspect of compatibility of solar (PV) systems with the daily and future needs and local cultural values of the consumers. A technology having low expenses, regardless of the source type, is the major concern of consumers, particularly in developing nations, where the R&D firms and suppliers should focus on reducing development, purchase, and installation expenses so that the rate of adoption can be increased. Policymakers may also take the initiative of highlighting the importance and effectiveness of geographic conditions to promote adoption. They should further introduce and discern the positive results of solar (PV) systems used in the social system. In this respect, the policymakers can make the social network campaigns strong to reduce consumer uncertainties, improve knowledge, and help consumers to understand the positive results of solar (PV) systems. Since trust is proposed to have an impact on increasing consumer's behavioural intention, the relationship is validated in Pakistan only. Somalian policymakers should take into account the concerns of increasing private benefits to the consumers, such as the security and safety of renewable energy billing systems [38].

7. Conclusions and Limitations

In current times, humanity is facing global warming as the most complex issue, along with sustainable development as the biggest challenge. In this regard, the world is increasingly recognizing environmental concerns. With the advancement of information and communication technologies, as people become aware of these concerns, they show their interests in using the latest technologies that best fit in their culture or improving quality of life. We also see that environment-friendly innovations are being introduced in local and international markets, and that consumers are largely adopting them. The adoption of solar (PV) systems by consumers can be scaled up if an understanding of the factors influencing adoption can be developed. Thus, this study's primary objective was to build an understanding of the factors that influence the adoption of solar (PV) systems by the consumers. It was a cross-cultural study for which analyses were performed using SmartPLS, and it conducted robust analyses such as MICOM and PLS-MGA. Drawing on Rogers' DOI and Davis' TAM theories, their integration, and the prior literature in the relevant domain, we identify perceived usefulness, perceived ease-of-use, compatibility, observability, and perceived trust to be the strong determinants of attitude and onward intention to use solar (PV) systems in Pakistan. Despite these determinants, surprisingly, perceived trust was not revealed as a strong determinant of solar (PV) system's adoption in Somalia. Overall, the model contributes to theory building in the adoption and diffusion of solar (PV) systems by consumers in developing countries. Moreover, the study also offers guidance to governments, suppliers, and practitioners in scaling-up the adoption of solar (PV) systems.

Researchers can find several limitations and methods for conducting future studies in the adoption and diffusion of solar (PV) systems areas. First, as our data were collected cross-culturally but only in two developing nations, the research can be expanded by collecting the data from several other countries at a time to extend its generalizability. Second, although we developed a research model using well-accepted information systems theories, there is a gap in evaluating the adoption using the IS success model, UTAUT, and so on, which should be fulfilled by future scholars. Third, the readers can see several demographic variables in this study; no evaluation was made to see their impacts on the adoption of solar (PV) systems. Therefore, the evaluation of the impact of consumer's demographic characteristics on the adoption of solar (PV) systems is another future research direction for social scientists. Some other demographics can also be probed to examine their impact on adoption, such as (one) how many days/hours of electricity backup remains, (two) how much load or capacity (300 KVA, 500 KVA, 1000 KVA, and so on) of solar (PV) systems they are using to meet their needs. Fourth, the MICOM analysis with respect to urban and rural areas can also be performed for deeper insights. Although the ratio of consumers (17% for Somalia and 8% in Pakistan) who are not willing to install solar PV system even if it is subsidized is not significant, there can be a need to investigate the reasons on why they are not willing to install solar PV system.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su141811764/s1.

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Institutional Review Board Statement: This study did not require ethical approval. However, the respondents (consumers) were given the instructions to fill out the questionnaire. Moreover, we promised confidentiality with them, i.e., the respondents' personal information will not be disclosed in any case, and only aggregated results will be reported.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: We are uploading the data supporting reported results on the interface as Supplementary File(s).

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