IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Exploring Awareness Levels Of Consumers Towards Solar Products

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Abstract: In light of the growing importance of environmental sustainability, the transition to renewable energy sources like solar energy has become crucial. Solar products, which harness solar energy for various applications, hold significant potential in addressing energy needs while minimizing environmental impact. However, the widespread adoption of these products is heavily influenced by consumer awareness and understanding of their benefits and functionality.

This study examines how demographic variables such as age, monthly family income, and educational qualification impact consumer awareness of solar products. Using a descriptive and exploratory approach, the research gathered data from 120 participants in Haryana through a structured questionnaire. The analysis, which includes Chi-square tests and descriptive statistics, reveals significant associations between consumer awareness and demographic factors. Younger consumers, those with higher income, and individuals with higher educational qualifications are more likely to be informed about solar products. The findings emphasize the need for targeted education and outreach to enhance awareness, promoting the adoption of solar energy solutions for a more sustainable future.

Keywords - Exploring, Awareness, Consumers, Solar, and Products.

I. INTRODUCTION

In the contemporary world, where environmental sustainability has become a critical concern, the transition to renewable energy sources is not just a choice but a necessity. Among the various renewable energy technologies, solar energy has emerged as a prominent solution for addressing energy demands while reducing environmental impact. Solar products, which utilize solar energy for various applications such as electricity generation, water heating, and lighting, have gained significant attention globally. Despite their potential to contribute to a sustainable future, the adoption of solar products depends largely on the awareness and understanding of consumers regarding their benefits, functionality, and availability.

Significance of Solar Energy and Solar Products

Solar energy is an inexhaustible and clean source of energy that has the potential to meet global energy needs while minimizing carbon emissions. Solar products, which include solar panels, solar water heaters, solar cookers, solar lamps, and more, are innovative solutions designed to harness this renewable resource. These products offer numerous advantages, including cost savings, energy independence, and environmental benefits. Governments and organizations worldwide are actively promoting the adoption of solar products through subsidies, tax incentives, and awareness campaigns. However, despite these efforts, the adoption rate remains inconsistent, particularly in developing regions, where awareness levels often act as a barrier.

Consumer Awareness and Its Importance

Consumer awareness refers to the knowledge, understanding, and familiarity that individuals possess regarding a product or service. In the context of solar products, awareness encompasses aspects such as the functionality of solar technologies, their environmental and economic benefits, available government incentives, and the steps required for installation and maintenance. High levels of consumer awareness are crucial for fostering informed decision-making, dispelling misconceptions, and encouraging the adoption of solar products. Conversely, a lack of awareness can lead to resistance, skepticism, and underutilization of these sustainable solutions.

Current State of Consumer Awareness

The current level of consumer awareness regarding solar products varies significantly across regions, socio-economic groups, and education levels. In developed countries, where renewable energy policies are well-established, awareness levels tend to be higher due to widespread campaigns, educational programs, and market penetration of solar technologies. In contrast, in developing countries, limited access to information, misconceptions about costs and reliability, and lack of educational initiatives often hinder awareness. Understanding these disparities is essential for tailoring strategies that address the unique challenges faced by different consumer segments.

Factors Influencing Consumer Awareness

Several factors influence the awareness levels of consumers regarding solar products:

1. **Educational Background:** Higher levels of education are often associated with greater awareness of renewable energy technologies, including solar products. Education equips individuals with the ability to understand technical information and evaluate the benefits of such technologies.
2. **Access to Information:** The availability of reliable and easily accessible information plays a critical role in shaping consumer awareness. Media channels, online platforms, and community programs serve as key sources of information about solar products.
3. **Government Policies and Incentives:** Awareness campaigns, subsidies, and tax benefits introduced by governments significantly influence consumer knowledge and interest in solar products.
4. **Socio-economic Factors:** Income levels and social status can impact awareness, as individuals from higher income groups may have better access to information and resources related to solar technologies.
5. **Cultural and Regional Contexts:** Cultural attitudes towards sustainability and regional factors such as climate and availability of solar resources can shape consumer perceptions and awareness.

Challenges in Enhancing Consumer Awareness

Despite the growing emphasis on renewable energy, several challenges hinder the enhancement of consumer awareness regarding solar products:

1. **Lack of Comprehensive Information:** Many consumers lack access to detailed and accurate information about solar products, including their benefits, installation processes, and long-term cost savings.
2. **Misconceptions and Myths:** Common misconceptions, such as the belief that solar products are expensive or unreliable, create barriers to awareness and adoption.
3. **Limited Outreach Efforts:** In many regions, awareness campaigns do not reach rural or marginalized communities, leading to gaps in knowledge.
4. **Complexity of Technology:** For some consumers, the technical aspects of solar products can be difficult to understand, resulting in confusion and hesitation.
5. **Economic Constraints:** For low-income groups, the perception of high upfront costs associated with solar products

may overshadow their long-term benefits, reducing awareness and interest.

II. Review of Literature:

2.1 Easwaran and Sudarvel (2024) "A Study on Impact of Demography Factor on Consumer Awareness on Solar Energy Product," explored the factors influencing consumer awareness of solar products in Madurai District, Tamil Nadu. Solar energy, as a sustainable and non-polluting energy source, has gained attention due to its potential to address rising energy demands and contribute to a sustainable economy. The study aimed to assess consumer awareness of solar products, highlighting the importance of awareness in driving purchase decisions. A descriptive research approach was adopted, using both primary and secondary data. A sample of 300 respondents was selected proportionately for analysis. The researchers employed simple percentage analysis and Chi-Square analysis to assess the

level of consumer awareness. The findings provided insights into the varying levels of awareness and suggested strategies to enhance consumer understanding of solar products. This study contributes to the literature by emphasizing the role of demographic factors in shaping consumer awareness and promoting solar energy adoption.

2.2 Asif et al. (2023) "Influencing Factors of Consumers' Buying Intention of Solar Energy: A Structural Equation Modeling Approach," examined the determinants influencing consumers' intentions to adopt solar energy in rural China. This research aimed to address the gap in understanding consumer behavior towards solar energy adoption for household purposes, particularly in rural areas. The study extended the Theory of Planned Behavior by incorporating three additional variables: environmental knowledge, environmental concern, and beliefs about the benefits of solar energy. Data were collected through a comprehensive survey involving 847 respondents in Hebei Province, and the analysis was conducted using Structural Equation Modeling. The findings revealed that attitude, environmental knowledge, subjective norms, perceived behavioral control, and beliefs about the benefits of solar energy positively influenced consumers' intentions to purchase solar energy systems. However, environmental concern was found to have no significant impact on buying intentions. The study highlighted the importance of fostering societal norms, increasing consumer awareness, and emphasizing the tangible benefits of solar energy to encourage adoption.

2.3 Luckett and Needham (2021) "Marketing Strategies to Use Solar Energy in Homes," explored homeowners' awareness of the benefits of solar energy and their perceptions of marketing strategies for residential solar energy systems. The study, grounded in disruptive innovation theory, utilized a single-case study approach and involved face-to-face interviews with 20 residential homeowners in an Ohio county. The research focused on two key objectives: (1) understanding the perceived benefits of solar energy and (2) examining perceptions of the rationale behind marketing strategies for residential solar energy systems. Through inductive analysis and coding, three major themes emerged: (1) the recognition of environmental benefits from solar energy systems, (2) the high cost of equipment, even with government incentives, and (3) a significant lack of accessible marketing information for consumers. The findings highlighted that homeowners were largely unaware of marketing strategies and the social change implications of adopting solar energy.

2.4 Sridevi and Aravindhan (2021) "Consumer Awareness and Attitude on Solar Products with Special Reference to Coimbatore City," explored the factors influencing the usage of solar products among consumers in Coimbatore. The study, conducted with a sample size of 185 respondents selected through random sampling, utilized a structured questionnaire and employed statistical tools like Percentage Analysis, Factor Analysis, and ANOVA for data analysis. Findings revealed that the majority of respondents preferred solar water heaters over other solar products, with Luminous being the most favored brand. Respondents identified solar products as a means to save electricity and uplift their standard of living. The study highlighted that most respondents used solar home lighting systems and emergency lights as power backups during outages, with affordability being a key driver of adoption. The results also emphasized the significant potential of solar products in the future, with many respondents agreeing that solar energy would play a pivotal role in addressing power cuts and promoting sustainability.

2.5 Lavrinenko et al. (2020) "Marketing of Renewable Energy Sources," examined the marketing challenges and opportunities for renewable energy in Russia. The study highlighted that, unlike other developed nations, Russia has been slow to adopt alternative energy, largely due to its vast fuel reserves, climatic conditions, and limited installations of renewable energy systems. To foster the growth of alternative energy, the study recommended the implementation of effective marketing strategies. These strategies included market segmentation, increasing end-user awareness, and providing both functional and non-functional educational efforts for consumers. The research also emphasized the importance of utilizing social media platforms, such as Facebook, Instagram, and SEO, to advertise renewable energy resources, as they cater to a wide audience and could help raise awareness about alternative energy solutions in Russia.

2.6 Ayoub et al. (2019) "Factors Affecting Consumer Purchase Intentions for Solar Energy Application at Domestic Level" explored the determinants influencing consumer intentions to adopt solar energy for household use. The research employed a cross-sectional design with a positivist approach, utilizing a quantitative methodology. A structured questionnaire served as the primary data collection tool, featuring four independent variables—perceived usefulness, perceived ease of use, behavioral attitude, and cost—and one dependent variable, consumer purchase intentions. Responses were gathered from 260 students at IBA using convenience sampling, and the data were analyzed using

SPSS. The study revealed that all four independent variables significantly influenced consumer purchase intentions. Additionally, the cost of solar energy, encompassing purchasing, operational, and repair costs, played a significant role. The findings underscored the need for increased public awareness of solar energy's benefits and highlighted barriers, including high costs and limited technical knowledge, in adopting solar energy domestically in Pakistan. The study recommended government interventions, such as subsidies, tax reductions, and investment in research and development, to make solar energy more accessible.

2.7 Khatke (2019) "The Study of Consumer Awareness of Solar Energy Systems and Impacting the Market through Model of Marketing Strategies," examined the awareness levels and market dynamics surrounding solar energy systems in western Maharashtra, specifically in the cities of Pune and Solapur. The study aimed to understand consumer awareness of solar products among households and professionals, investigate the usage levels of various solar systems, and provide recommendations for increasing awareness. A descriptive and analytical research approach was used, with data collected through surveys targeting 400 respondents, 200 from each city. Stratified random sampling was employed for this purpose. The findings highlighted that despite the immense potential of solar products in India, the market faced significant challenges due to a lack of awareness and high product costs. The study concluded that solar energy's value story needs to be communicated effectively to consumers, with a focus on financial benefits, to foster greater acceptance and drive the growth of solar installations, contributing to energy independence and environmental sustainability.

III. Objective of the Study:

- To examine the level of consumer awareness regarding solar products across different demographic variables.

IV. Hypothesis of the Study:

H0: There is no significant association between consumers' awareness regarding solar products across different demographic variables.

V. Research Methodology:

The research methodology for this study, "Exploring Awareness Levels of Consumers Towards Solar Products," follows a descriptive cum exploratory approach. A purposive sampling technique is employed to select a sample of 120 participants from Haryana, ensuring the inclusion of consumers who have shown interest in or are potential users of solar products.

Primary data is collected through a structured questionnaire, using a 5-point Likert scale to assess consumer awareness of solar products, including their knowledge of benefits, functionality, and availability. The questionnaire also gathers demographic information to explore how factors such as age, monthly family income, and educational qualification influence awareness levels.

Chi-square tests are used to analyze the association between consumer awareness and various demographic variables like income and education. Descriptive statistics and cross-tabulations are applied to identify patterns and trends in the data.

5.1. Data Analysis:

Data analysis involves examining, cleaning, and transforming data to uncover valuable insights, draw conclusions, and aid in decision-making. This process utilizes statistical and logical methods to identify patterns, trends, and relationships within the data, enhancing the understanding of the topic under study.

Frequency analysis of demographic variables involves summarizing the data collected on participants' characteristics, such as age, monthly family income, and educational qualification.

Frequency analysis of demographic variable

Demographic Variables		Frequency
Age	18-25	34
	25-30	36
	30-35	25
	Above 35	25
	Total	120
Monthly Family Income (In Rs.)	Less than 25,000	16
	25000 - 45000	26
	45,000 - 65000	32
	More than 65000	46
	Total	120
Educational Qualification	Graduation	47
	Post graduation	50
	Others	23
	Total	120

Source: Researcher's Compilation

The demographic profile of the respondents provides insightful information about their age, monthly family income, and educational qualifications.

Age Distribution: The majority of respondents fall within the age groups of 25–30 (36 respondents, 30%) and 18–25 (34 respondents, 28.3%). Respondents aged 30–35 and above 35 are equally represented, with 25 individuals each (20.8%), indicating a balanced mix of younger and mature participants.

Monthly Family Income: In terms of income, the highest proportion of respondents, 46 (38.3%), have a monthly family income exceeding ₹65,000, followed by 32 respondents (26.7%) in the ₹45,000–₹65,000 range. About 26 respondents (21.7%) earn between ₹25,000 and ₹45,000, while 16 (13.3%) belong to the income bracket of less than ₹25,000. This suggests that most respondents are from middle to upper-income households.

Educational Qualification: Regarding education, 50 respondents (41.7%) are postgraduates, 47 (39.2%) hold graduation degrees, and 23 (19.2%) fall into the "Others" category. This indicates a predominantly well-educated group of respondents.

Overall, the sample reflects diversity across demographic variables, enhancing the comprehensiveness of the analysis.

Frequency analysis of consumers' awareness towards solar products

The frequency analysis investigates consumers' awareness levels of solar products and how this awareness influences their purchasing decisions. It emphasizes the impact of consumer knowledge on the decision to buy solar products and highlights the connection between awareness levels and the frequency of solar product purchases.

Table Frequency analysis of consumers' awareness towards solar products

Statements	SD	D	N	A	SA
I am familiar with the concept of solar energy and its applications.	9	7	5	43	56
I am aware of the various types of solar products available in the market.	6	3	4	52	55
I understand the environmental benefits of using solar energy products.	5	2	3	52	58
I am knowledgeable about the cost savings associated with solar products.	8	5	9	43	55
I am aware of government incentives or subsidies available for purchasing solar products.	7	5	4	51	53
I can differentiate between solar products and other renewable energy options.	8	7	5	43	57
I know where to purchase solar products in my area or online.	5	3	4	52	56
I am aware of the installation process and maintenance requirements of solar products.	7	4	5	52	52
I understand the long-term benefits of investing in solar energy products.	8	6	7	45	54
I have sufficient knowledge about the durability and lifespan of solar products.	11	4	5	53	47

Source: Researcher's Compilation

The frequency analysis of consumers' awareness towards solar products reflects varying levels of familiarity and understanding across different statements.

Familiarity with Solar Energy: A large majority (56 respondents, 46.7%) strongly agree, and 43 (35.8%) agree, that they are familiar with the concept of solar energy and its applications. Only 9 (7.5%) strongly disagree, indicating a generally high awareness of solar energy.

Awareness of Solar Product Types: The majority (55 respondents, 45.8%) strongly agree and 52 (43.3%) agree that they are aware of the various types of solar products available in the market, highlighting good product knowledge.

Environmental Benefits: Most respondents (58 respondents, 48.3%) strongly agree, and 52 (43.3%) agree, with understanding the environmental benefits of using solar products, showing a high level of eco-awareness.

Cost Savings: Awareness of the cost savings associated with solar products is moderate, with 55 (45.8%) strongly agreeing and 43 (35.8%) agreeing, but 8 (6.7%) strongly disagreeing.

Government Incentives: 53 (44.2%) strongly agree and 51 (42.5%) agree, indicating a substantial awareness of government incentives and subsidies available for solar product purchases.

Differentiating Solar Products: 57 (47.5%) strongly agree and 43 (35.8%) agree, with fewer respondents indicating a lack of knowledge about distinguishing solar products from other renewable options.

Purchasing Locations: Awareness of where to purchase solar products is high, with 56 (46.7%) strongly agreeing and 52 (43.3%) agreeing.

Installation and Maintenance: Most respondents (52 respondents, 43.3%) agree, with 52 (43.3%) also strongly agreeing, reflecting adequate awareness of the installation process and maintenance requirements.

Long-Term Benefits: Awareness of the long-term benefits of investing in solar products is substantial, with 54 (45%) strongly agreeing and 45 (37.5%) agreeing.

Durability and Lifespan: Knowledge about the durability and lifespan of solar products is also relatively high, with 53 (44.2%) agreeing and 47 (39.2%) strongly agreeing.

In conclusion, the data shows a generally high level of awareness of solar products among respondents, with varying degrees of familiarity with different aspects such as government incentives, product types, and environmental benefits.

Association between consumers awareness regarding solar products across different demographic variables

The association between consumers' awareness of solar products and different demographic variables examines how factors such as age, income, and education impact consumers' knowledge and attitudes toward solar products.

$H_0$1: There is no significant association between consumers' awareness regarding solar products across age variable

Chi-Square Tests			
Age	**Value**	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	67.557	72	.026
Linear-by-Linear Association	.012	1	.014
N of Valid Cases	120		

Source: Researcher's Compilation

The Chi-Square test results examine the association between consumers' awareness of solar products and the age variable, testing the null hypothesis (H_0) that there is no significant association.

The **Pearson Chi-Square** value is 67.557 with 72 degrees of freedom and an asymptotic significance (p-value) of 0.026, which is less than the significance level of 0.05. This indicates a significant association between consumers' awareness of solar products and age.

The **Linear-by-Linear Association** test yields a p-value of 0.014, confirming a significant relationship between the variables.

With a p-value less than 0.05 in all tests, the null hypothesis (H_0) is rejected, indicating that age significantly influences consumers' awareness of solar products.

$H_0$2: There is no significant association between consumers' awareness regarding solar products across monthly family income variable

Chi-Square Tests			
Monthly Family Income	**Value**	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	74.604	72	.014
Linear-by-Linear Association	.341	1	.059
N of Valid Cases	120		

Source: Researcher's Compilation

The Chi-Square test results analyze the association between consumers' awareness of solar products and the monthly family income variable, testing the null hypothesis (H_2) that there is no significant association.

The **Pearson Chi-Square** value is 74.604 with 72 degrees of freedom and an asymptotic significance (p-value) of 0.014, which is less than the significance level of 0.05. This indicates a significant association between consumers' awareness of solar products and monthly family income.

The **Linear-by-Linear Association** test yields a p-value of 0.059, slightly above the threshold of 0.05, suggesting weak evidence for a linear relationship.

Overall, the Pearson Chi-Square test supports rejecting the null hypothesis, indicating that monthly family income significantly influences consumers' awareness of solar products.

$H_0$3: There is no significant association between consumers' awareness regarding solar products across educational qualification variable

Chi-Square Tests			
Educational Qualification	**Value**	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	68.298	72	.002
Linear-by-Linear Association	1.220	1	.069
N of Valid Cases	120		

Source: Researcher's Compilation

The Chi-Square test results examine the association between consumers' awareness of solar products and the educational qualification variable, testing the null hypothesis ($H_0$3) that there is no significant association.

The **Pearson Chi-Square** value is 68.298 with 72 degrees of freedom and an asymptotic significance (p-value) of 0.002, which is less than the significance level of 0.05. This indicates a significant association between consumers' awareness of solar products and educational qualification.

The **Linear-by-Linear Association** test yields a p-value of 0.069, slightly above the 0.05 threshold, indicating a marginally weak relationship.

Despite the mixed results, the Pearson Chi-Square test supports rejecting the null hypothesis, indicating that educational qualification significantly impacts consumers' awareness of solar products.

VI. Conclusion:

The study on "Examining the Association Between Consumers' Awareness of Solar Products and Demographic Variables" provides valuable insights into factors influencing consumer awareness of solar energy. The findings reveal that awareness of solar products is significantly impacted by demographic variables such as age, monthly family income, and educational qualification.

Chi-square tests demonstrated a significant association between consumers' awareness of solar products and age, with younger consumers showing higher awareness. Additionally, a strong link was found between monthly family income and awareness, indicating that individuals with higher income levels are more likely to be informed about solar options. Educational qualification also plays a key role, with respondents holding higher educational qualifications displaying greater awareness of solar products.

This study highlights the importance of demographic factors in shaping consumer knowledge of solar energy, suggesting that targeted efforts in education and outreach could increase awareness across diverse consumer groups. Ultimately, these findings could guide policymakers and businesses in promoting the adoption of solar energy, supporting sustainable development and renewable energy initiatives.

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