Extending the Theory of Planned Behaviour to Explain Household Rooftop Solar Adoption Intentions: The Roles of Environmental Concern, Government Subsidy Awareness, and Cost-Benefit Perception.

Abstract

The increasing demand for sustainable energy has highlighted the importance of rooftop solar systems as a clean and renewable source of energy. Despite various government subsidy schemes and promotional initiatives, the adoption of rooftop solar systems among Indian households remains relatively low. This study evaluates the factors influencing consumers' intention to install rooftop solar systems by applying the Theory of Planned Behaviour (TPB). A cross sectional quantitative research design was adopted. The primary data were collected from 256 household heads in North Kerala using a structured questionnaire. The data were analysed through Structural Equation Modelling. The findings revealed that environmental concern, government subsidy awareness, and cost-benefit perception had significant positive effects on consumers' attitudes towards rooftop solar systems. Attitude, subjective norms, and perceived behavioural control significantly influenced consumers' intention to install rooftop solar systems. Among these factors, attitude emerged as the strongest predictor of intention. The structural model explained 30.3% of the variance in attitude and 26.8% of the variance in intention.

Keywords: Consumer Intention; Theory of Planned Behaviour; Technology Acceptance Model; Awareness Level; Solar Rooftop System

1. Introduction

Carbon emissions from industrial activities are the leading cause of undesirable climate changes (Butturi et al., 2019). Innovation was recognized as the solutions to be essential for reducing greenhouse gas emissions and driving individual changes to the environment (Nguyen et al., 2022a). Installing solar panels on rooftops can reduce a country's greenhouse gas emissions by more than 50% within ten years and help achieve carbon neutral status in about 30 years (Marchi et al., 2018). In India, the significance of solar energy cannot be overstated. India ranks among the top five countries in the world in terms of installed solar capacity with over 73 GW installed as of March 2024, and a national target of 280 GW of solar energy by 2030, as outlined in its updated Nationally Determined Contributions (NDCs) under the Paris Agreement (MNRE,2024). The year 2024 saw quantum jump in capacity expansion, policy measures, and global-scale events reinforcing India's position as a global renewable energy leader. India's renewable energy journey reached a historic milestone in 2024, surpassing 200 GW of installed capacity-a testament to the nation's unwavering commitment to its ambitious target of 500 GW by 2030 (MNRE,2025).

Kerala is committed to become a Carbon Neutral State by 2050.The State Government had announced that it will meet the entire electricity requirement from renewable sources by 2040. The Department of Environment and Climate Change, Government of Kerala has proposed

sectoral policy interventions to transition towards a low carbon economy and thereby achieve carbon neutrality by 2050. The framework shall strive to allow residential consumers who do not have dedicated roof space to still invest in solar power plants and get appropriate renewable energy setoff in their electricity bills. In case of setting up of solar projects owned by ANERT on consumer premises, consumers shall be provided certain amount of free power, revenue share or roof rental (Department of Power, Government of Kerala, 2024). Promoting individual pro-environmental behaviour in emerging economies faces many obstacles, notably financial constraints and lack of knowledge (Joshi and Rahman, 2015), which lead to differences in customer behaviour towards environmentally friendly products (Sadiq et al., 2022; Nguyen et al., 2019c).

1.2 Objectives of the Study

1. To examine the influence of environmental concern, government subsidy awareness, and cost-benefit perception on consumers' attitude towards rooftop solar systems at the household level.
2. To analyze the impact of attitude, subjective norms, and perceived behavioural control on consumers' intention to install rooftop solar systems at the household level.

2. Literature Review and Hypothesis Development

2.1 Theoretical background

Theory of Planned Behaviour (TPB: Ajzen, 1991) is one of the most used models in research explaining consumption behaviour and sustainable consumption (Nguyen et al., 2016). The TPB is an expectancy value model which states that behaviour is a consequence of one's behavioural intention, which is in turn explained by the consumer's attitude (positive or negative evaluation of undertaking the behaviour), subjective norm and perceived behavioural control. The TPB is an extension of the TRA (Fishbein and Ajzen, 1975) which does not include perceived behavioural control and thus is not designed to explain behaviours that are outside an individual's volitional control. According to Fishbein and Ajzen's (1975) Theory of Reasoned Action (TRA), an individual's behaviour can be predicted by examining both their attitude toward the behaviour and the influence of subjective norms. Subjective norms refer to the perceived social pressure or expectations from significant others that may shape an individual's intention and motivation to perform a particular behaviour, regardless of the context. Ajzen (1985, 1991) then extended TRA by including the construct of perceived behavioural control (PBC), leading to the creation of the Theory of Planned Behaviour.

Ajzen (1985) explained behavioural intention as a direct antecedent of behaviour subject to a "person's control over the various factors that may prevent" an action from happening, and then introduced the concept of control over internal and external factors. This is described as Perceived Behavioural Control (Ajzen, 1991). TPB is one of the most widely used theories for exploring general human behaviour and is valued by researchers from the psychology, behavioural sciences, healthcare sciences, public environmental, and social sciences fields

(Kwon & Silva, 2020). Besides the core factors from the TPB model, many studies have extended the model by adding more context-specific factors such as psychological benefit, expectation, and innovativeness (Sun et al., 2020; Nguyen et al., 2022a). As noted by Rozenkowska (2023), TPB provides a strong theoretical framework for consumer behaviour research while allowing researchers to include context-specific factors that enhance its explanatory power. Attitude has been recognized as a predictor of behaviour (Casaló & Escario, 2018). The adopter's and non adopter's decisions are determined by their attitude, which is the antecedent of behavioural intention (Di Falco & Sharma, 2018; Jansson, 2011). Greaves et al. (2013) determined that attitude towards behaviour represents a person's total behaviour assessment, based on the conviction that the action will yield the intended outcomes. The most significant predictor in research on renewable energy is attitude, which favours sustainable development (Greaves et al., 2013).

Aklin et al. (2018) investigated the social acceptance of solar electricity among rural communities in northern India using a sample of 3,208 villagers. The study revealed that concerns regarding potential exploitation by private companies, along with the perceived higher cost of solar electricity compared to conventional grid power, were significant factors limiting the social acceptance of solar energy. Parkins (2018) found that the purchase intention of Canadian consumers toward solar energy is influenced by factors such as visual exposure to solar technology, public engagement, and perceived knowledge. Among these factors, the visibility of solar technology had the strongest positive effect on consumers' intention to purchase. This finding supports social learning and social network theories, which suggest that people are influenced by what they observe in their surroundings. The researchers not only used and modified the original TPB but also adapted other theoretical frameworks to extend their study models and test additional factors associated with consumer behaviour (Rozenkowska, 2023). Positive attitudes towards solar energy solutions will lead to increased intentions to adopt solar energy solutions (Zulu et al.,2021).Personal innovativeness not only positively affects customers' attitudes and behaviours but can also moderate the relationship between attitude and adoption intention as well as perceived monetary barriers and adoption intention (Vu et al.,2023).

2.2 Hypothesis Development

2.2.1 Environmental Concern

The environment understandings of individuals were implied to have a link with behaviour of green consumption (Smith and Paladino,2010), with attitude (Nguyen et al. (2019c). Environmental concern refers to the extent to which individuals are aware of environmental issues and are willing to support efforts aimed at protecting the environment. It shows a person's sense of responsibility toward environmental preservation and sustainable development. Individuals with high environmental concern are more likely to engage in environmentally friendly behaviours and support the adoption of green technologies (Dunlap & Jones, 2002; Smith & Paladino, 2010; Yadav & Pathak, 2016).

H1: Environmental concern positively influences attitude towards rooftop solar systems.

2.2.2 Government Subsidy Awareness

Awareness of renewable energy technology, particularly solar energy, refers to the extent to which potential users have access to and understand information about its applications, financial benefits, and environmental impact (Sidiras & Koukios, 2004).Government subsidy awareness refers to the extent to which individuals are informed about financial incentives, rebates, and other support mechanisms provided by governments to encourage the adoption of renewable energy technologies. Subsidies play a crucial role in reducing the initial investment costs associated with rooftop solar installations.When individuals are aware of such incentives, they are more likely to perceive rooftop solar systems as economically feasible (Claudy et al., 2013; Rai & Robinson, 2013; Zulu & Zulu, 2023).

H2: Government subsidy awareness positively influences attitude towards rooftop solar systems.

2.2.3 Cost-Benefit Perception

Cost-benefit perception refers to an individual's evaluation of the economic advantages and disadvantages associated with adopting a particular technology. Consumers who perceive that the benefits of rooftop solar systems outweigh their costs are more likely to develop favourable attitudes toward adoption. Positive cost-benefit perceptions can reduce financial concerns and increase the attractiveness of solar energy solutions. Previous research on renewable energy adoption has consistently identified perceived economic benefits as a significant determinant of consumer attitudes and intentions (Vu, Nguyen, & Nguyen, 2023: Claudy et al., 2013).

H3: Cost-benefit perception positively influences attitude towards rooftop solar system

2.2.4 **Subjective Norm**

According to Ajzen (2005), subjective norms are shaped by normative beliefs and an individual's motivation to comply with the expectations of important people in their life. Individuals who value the opinions of their family and close friends are more likely to be influenced by these social expectations when making decisions. In the context of household solar rooftop adoption, subjective norms refer to the positive or negative influence exerted by family members, neighbours, colleagues, relatives, and local government authorities on consumers' decision-making regarding the adoption of solar rooftop systems (Ali & Yadav, 2019).

H4: Subjective norms positively influence intention to install rooftop solar systems.

2.2.5 **Perceived Behavioural Control (PBC)**

PBC reflects an individual's perception of the ease or difficulty of performing a behaviour, self-efficacy focuses on confidence in one's capability to carry out that behaviour (Ajzen, 2002). In the context of solar rooftop adoption, PBC refers to consumers' perceptions of having the necessary knowledge, resources, and opportunities to install and use solar rooftop systems (Cass & Walker, 2009). Ajzen (2002) suggested that perceived self-efficacy should

be considered alongside perceived behavioural control (PBC) to better understand individuals' intentions and behaviour. Self-efficacy, introduced by Bandura (1977a, 1986), refers to an individual's belief in their ability to successfully perform a particular task. Bandura (1999) described self-efficacy as a fundamental belief that enables people to exercise control over their actions.

H5: Perceived behavioural control positively influences intention to install rooftop solar systems.

2.2.6 Attitude and Intention

Attitude is an individual's overall positive or negative evaluation of a particular object, behaviour, or idea (Ajezen, 2001). It is formed through three components: cognitive, affective, and conative. Studies have shown that a positive attitude enhances consumer knowledge and influences decision-making (Pacho & Batra, 2021). One of the major limitations of the Theory of Planned Behaviour (TPB) is the gap between intention and actual behaviour. Although individuals may express a strong intention to perform a behaviour, they do not always act accordingly (Ajzen, 1985). To address this issue, Ajzen (1985) suggested that behavioural intention should be measured before the actual behaviour occurs and that the behaviour being studied should be under the individual's voluntary control.

H6: Attitude positively influences intention to install rooftop solar systems.

3. Methodology and Data Collection

3.1. Research design

This study adopted a quantitative research approach. A structured questionnaire was developed by adapting measurement items from previous studies to ensure their relevance to the research context. The questionnaire included items representing each construct used in the study. Primary data were collected from respondents and analysed using Statistical Package for the Social Sciences (SPSS) and Analysis of Moment Structures (AMOS). SPSS was used for data screening, descriptive statistics, and reliability analysis.AMOS was employed to validate the measurement model and test the structural model using Structural Equation Modeling (SEM). The proposed research hypotheses were tested based on the relationships among the constructs. Model fit was assessed using commonly accepted fit indices, including the Goodness-of-Fit Index (GFI), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and Root Mean Square Error of Approximation (RMSEA), and the results were compared with the recommended threshold values to evaluate the adequacy of the model.

3.2 Data collection

A cross-sectional descriptive quantitative research design was adopted to examine consumers' intention to adopt solar rooftop systems. Primary data were collected using a structured questionnaire from households that had not yet adopted solar rooftop systems in the rural areas of North Kerala. The head of each household was considered the sampling unit. A combination of convenience sampling and judgmental sampling techniques was used to select

the respondents. The questionnaire was administered to individuals who expressed an interest in solar rooftop systems. A total of 270 questionnaires were received. After excluding 14 incomplete and invalid responses, 256 valid questionnaires were retained for the final analysis.

4.Results and Discussion

Table 1 **Demographic Profile of the Respondents (N = 256)**

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	134	52.3
	Female	122	47.7
	Total	**256**	**100.0**
Age	Below 25 years	39	15.2
	26–35 years	38	14.8
	36–45 years	31	12.1
	46–55 years	62	24.2
	Above 55 years	86	33.6
	Total	**256**	**100.0**
Education	Up to SSLC	106	41.4
	Higher Secondary	71	27.7
	Graduation	31	12.1
	Post Graduation	29	11.3
	Others	19	7.4
	Total	**256**	**100.0**
Occupation	Government Employee	29	11.3
	Private Employee	130	50.8
	Business	57	22.3
	Others	40	15.6
	Total	**256**	**100.0**
Monthly Income	Below ₹25,000	55	21.5
	₹25,000–₹50,000	85	33.2
	₹50,001–₹75,000	60	23.4
	₹75,001–₹100,000	35	13.7
	Above ₹100,000	21	8.2
	Total	**256**	**100.0**

Table 1 presents the demographic characteristics of the 256 respondents. The sample consisted of 134 male (52.3%) and 122 female respondents (**47.7%)**. The largest proportion of respondents belonged to the above 55 years category (33.6%,), followed by those aged 46-55 years (24.2%). Respondents aged below 25 years accounted for 15.2% , while those aged 26–35 years and 36-45 years represented 14.8% and 12.1% respectively. With respect to educational qualifications, 41.4% of the respondents had education up to the SSLC level, followed by Higher Secondary education (27.7%,). Graduates and postgraduates constituted 12.1% and 11.3% of the sample, respectively, while 7.4% reported other educational qualifications. The private sector employees formed the largest occupational group, accounting for 50.8% of the respondents. Individuals engaged in business activities represented 22.3%, whereas respondents categorized under other occupations constituted

15.6%. Government employees accounted for the smallest proportion of the sample (11.3%). In case of monthly income, the largest group of respondents reported an income between ₹25,000 and ₹50,000 (33.2%), followed by those earning ₹50,001–₹75,000 (23.4%,) and below ₹25,000 (21.5%,).

4.2 Measurement of Reliability

Table 2: Reliability Analysis

Constructs	Cronbach Alpha	Items
Environmental Concern	.880	4
Government Subsidy Awareness	.859	3
Cost-Benefit Perception	.899	3
Attitude	.906	4
Perceived Behavioural Control	.867	4
Subjective Norms	.903	4
Intention	.910	4

The internal consistency of the measurement scales was assessed using Cronbach's alpha, and all constructs exceeded the recommended threshold of 0.70 (Nunnally & Bernstein), indicating good reliability. Environmental Concern (α = .880), Government Subsidy Awareness (α = .859), Cost–Benefit Perception (α = .899), Attitude (α = .906), Perceived Behavioural Control (α = .867), and Subjective Norms (α = .903) all demonstrated high internal consistency. Intention recorded the highest reliability coefficient (α = .910), confirming excellent internal consistency across its four measurement items.

Table 3. Discriminant Validity Assessment (Fornell–Larcker Criterion)

Construct	EC	GSA	CBP	ATT	SN	PBC	INT
Environmental Concern (EC)	**0.805**						
Government Subsidy Awareness (GSA)	0.097	**0.822**					
Cost–Benefit Perception (CBP)	0.277	0.159	**0.867**				
Attitude (ATT)	0.263	0.257	0.424	**0.861**			
Subjective Norms (SN)	-0.197	0.102	-0.217	0.116	**0.810**		
Perceived Behavioural Control (PBC)	-0.214	-0.142	-0.181	-0.128	0.033	**0.785**	
Intention (INT)	0.066	0.132	-0.043	0.365	0.350	0.120	**0.844**

The discriminant validity of the measurement model was assessed using the Fornell–Larcker criterion. The square root of the Average Variance Extracted for each construct exceeded its correlations with all other constructs. It indicates satisfactory discriminant validity. The square root of the AVE ranged from 0.785 to 0.867, whereas the highest inter-construct correlation was 0.424 between Cost–Benefit Perception and Attitude. These findings demonstrate that each construct is empirically distinct and measures a unique concept.

4.3 Multicollinearity and Autocorrelation Diagnostics

Prior to regression analysis, Multicollinearity and autocorrelation were examined. The tolerance values ranged from 0.719 to 0.920. The VIF values ranged from 1.087 to 1.391, which are well within the acceptable limits (Tolerance > 0.10; VIF < 5). The maximum Condition Index was 13.070, indicating the absence of multicollinearity among the predictor variables. The Durbin–Watson statistic was 2.086.It suggests that the residuals were independent and free from autocorrelation.

4.4 Measurement Model Assessment

Table 4. Measurement Model Assessment

Factor	Measure	Standardized Loading	p-value	AVE	Composite Reliability (CR)
Environmental Concern (EC)	EC1	0.820	<0.001	0.648	0.880
	EC2	0.742	<0.001		
	EC3	0.844	<0.001		
	EC4	0.811	<0.001		
Government Subsidy Awareness (GSA)	GSA1	0.783	<0.001	0.675	0.861
	GSA2	0.851	<0.001		
	GSA4	0.830	<0.001		
Cost-Benefit Perception (CBP)	CBP1	0.869	<0.001	0.751	0.900
	CBP3	0.860	<0.001		
	CBP4	0.871	<0.001		
Subjective Norms (SN)	SN2	0.820	<0.001	0.656	0.851
	SN3	0.764	<0.001		
	SN4	0.843	<0.001		
Perceived Behavioural Control (PBC)	PBC1	0.782	<0.001	0.616	0.865
	PBC2	0.767	<0.001		
	PBC3	0.820	<0.001		
	PBC4	0.770	<0.001		
Attitude (ATT)	ATT1	0.772	<0.001	0.742	0.919
	ATT2	0.812	<0.001		
	ATT3	0.949	<0.001		
	ATT4	0.900	<0.001		
Intention (INT)	INT1	0.873	<0.001	0.713	0.909
	INT2	0.846	<0.001		
	INT3	0.858	<0.001		
	INT4	0.800	<0.001		

The convergent validity of the measurement model was examined using standardized factor loadings, Average Variance Extracted (AVE), and Composite Reliability (CR). All standardized factor loadings were statistically significant ($p < .001$) and exceeded the recommended threshold of 0.70. It indicates that the observed items were strong indicators of their respective constructs. The AVE values ranged from 0.616 to 0.751, which are above the recommended minimum value of 0.50. It confirms adequate convergent validity for all constructs. The Composite Reliability (CR) values ranged from 0.851 to 0.919.It exceeds the

recommended threshold of 0.70 and demonstrating good internal consistency. Attitude recorded the highest Composite Reliability (CR = 0.919), while Cost–Benefit Perception exhibited the highest AVE (0.751), indicating strong construct reliability and convergent validity. Environmental Concern, Government Subsidy Awareness, Subjective Norms, Perceived Behavioural Control, and Intention also demonstrated satisfactory levels of convergent validity and reliability.

4.5 . Structural Model Results and Hypothesis Testing

Table 5. Structural Model Results and Hypothesis Testing

Relationship	Unstandardized Coefficient	Standardized Coefficient	S.E.	C.R.	p-value	Decision
Environmental Concern → Attitude	0.143	0.150	0.058	2.453	0.014	Supported
Government Subsidy Awareness → Attitude	0.232	0.249	0.055	4.209	<0.001	Supported
Cost-Benefit Perception → Attitude	0.343	0.386	0.057	5.968	<0.001	Supported
Subjective Norms → Intention	0.370	0.358	0.068	5.449	<0.001	Supported
Perceived Behavioural Control → Intention	0.195	0.172	0.072	2.711	0.007	Supported
Attitude → Intention	0.441	0.389	0.071	6.241	<0.001	Supported

Structural Equation Modelling is used to examine the hypothesized relationships among the study variables. The result indicates that all six hypothesized relationships were statistically significant ($p < .05$), providing support for all the proposed hypotheses. Environmental concern had a positive and significant effect on attitude towards rooftop solar systems ($\beta = .150$, C.R. = 2.453, $p = .014$). It indicates that individuals who are more concerned about environmental protection tend to develop a more favourable attitude towards adopting rooftop solar systems.The result is consistent with previous studies that identified environmental concern as an important predictor of pro-environmental attitudes (Dunlap & Jones, 2002).Government subsidy awareness showed a positive and significant influence on attitude ($\beta = .249$, C.R. = 4.209, $p < .001$). This shows that consumers who are aware of government subsidies and financial incentives are more likely to hold positive attitudes towards rooftop solar systems. H2 was supported. Cost-benefit perception had the strongest positive effect on attitude among the three antecedents ($\beta = .386$, C.R. = 5.968, $p < .001$). This indicates that consumers who perceive greater economic benefits relative to the costs are more likely to develop favourable attitudes towards rooftop solar systems. It is found that the subjective norms positively influenced consumers' intention to install rooftop solar systems ($\beta = .358$, C.R. = 5.449, $p < .001$). The finding suggests that encouragement and opinions from family members, friends, and neighbours play an important role in influencing consumers' intentions. It is to be noted that perceived behavioural control had a positive and significant effect on intention ($\beta = .172$, C.R. = 2.711, $p = .007$). Major finding of the study is that attitude had a

positive and significant influence on consumers' intention to install rooftop solar systems (β = .389, C.R. = 6.241, $p < .001$). Among the predictors of intention, attitude emerged as the strongest determinant. It indicates that favourable evaluations of rooftop solar systems substantially increase consumers' intention to adopt the technology. The structural model explained 30.3% of the variance in Attitude ($R^2 = .303$) and 26.8% of the variance in consumers' intention to install rooftop solar systems ($R^2 = .268$). These results indicate that the extended Theory of Planned Behaviour model has moderate explanatory power in predicting consumers' attitudes and intentions towards rooftop solar system adoption.

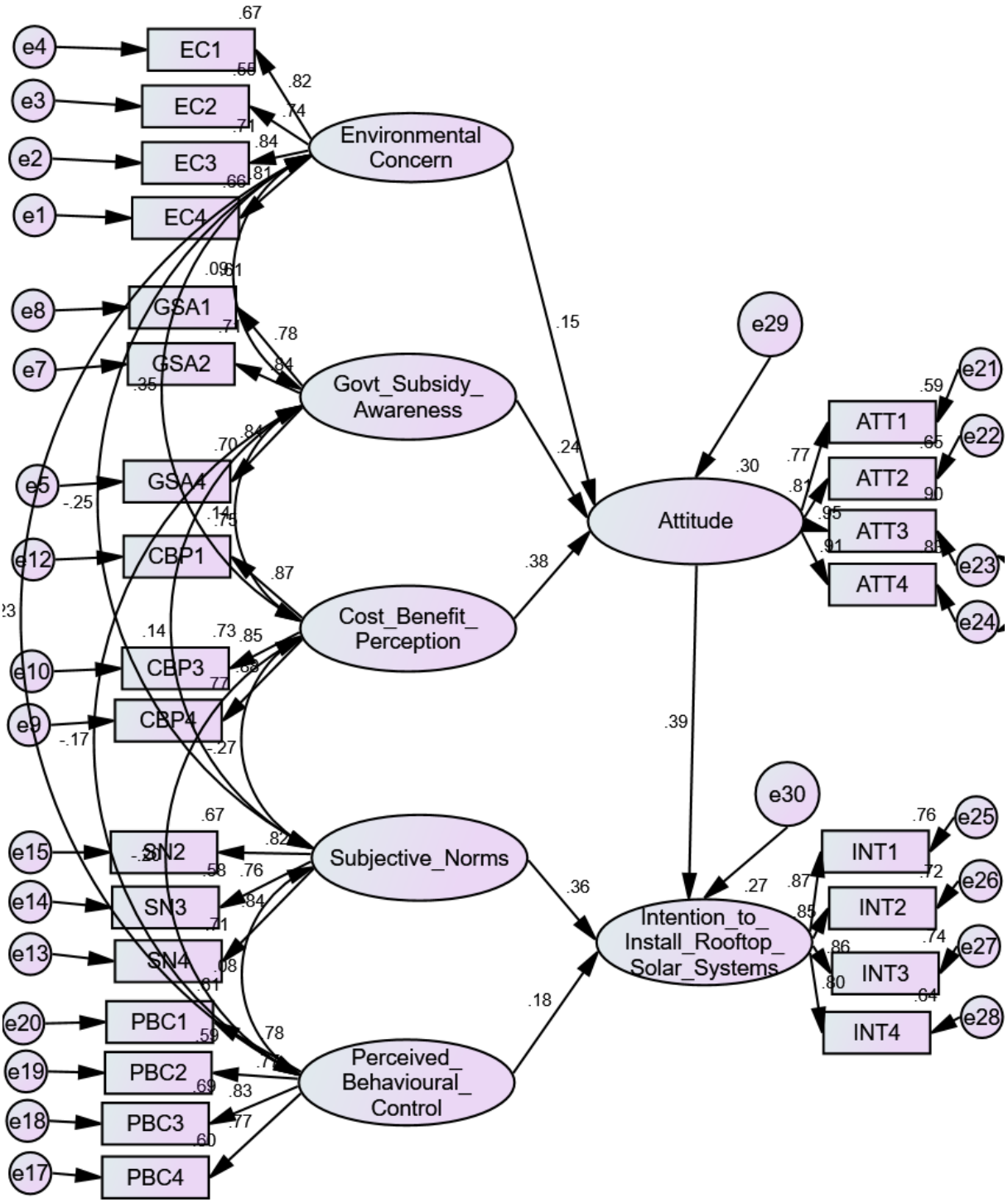

Figure 1. Structural Equation Model Showing the Factors Influencing Consumers' Intention to Install Rooftop Solar Systems

4.6 Model Fit Indices

To evaluate the proposed structural model and examine the factors influencing consumers' intention to install rooftop solar systems at the household level, model fit indices were assessed. The model examined the effects of environmental concern, government subsidy awareness, cost-benefit perception, attitude, subjective norms, and perceived behavioural control on consumers' intention. The adequacy of the model was evaluated using commonly accepted fit indices, including Chi-square/degrees of freedom (CMIN/DF), Goodness-of-Fit Index (GFI), Adjusted Goodness-of-Fit Index (AGFI), Normed Fit Index (NFI), Comparative Fit Index (CFI), Root Mean Square Residual (RMR), and Root Mean Square Error of Approximation (RMSEA). The below given presents the values of each model fit index along with the recommended fit criteria for evaluating the adequacy of the proposed structural model.

Table 6 Model Fit Indices

Index	**CMIN/DF**	**GFI**	**AGFI**	**IFI**	**CFI**	**RMR**	**RMSEA**
Value	2.592	0.911	0.901	0.903	.902	0.067	0.079
Criteria	< 5 (Hair et al., 1998)	> 0.90 (Hu & Bentler0., 1999)	> 0.90 (Hair et al., 2006)	> 0.90 (Hu & Bentler, 1999)	> 0.90 (Hooper et al., 2008)	< 0.08 (Hair et al., 2006)	< 0.08 (Hair et al., 2006)

As per Table 6 it can be observed that all the fit indices such as CMIN/DF, GFI, AGFI, NFI, CFI, RMR and RMSEA have secured the values well within the criteria. So, it can be declared that the model indicating the impact of the factors influencing consumers' intention to install rooftop solar systems at the household level by analyzing the effects of environmental concern, government subsidy awareness, cost-benefit perception, attitude, subjective norms, and perceived behavioural control.

5.Conclusion

The findings of this study indicate that consumers' intention to install rooftop solar systems is influenced by both psychological and economic factors. Environmental concern, government subsidy awareness, and cost-benefit perception were found to significantly influence consumers' attitudes. Similarly factors like attitude, subjective norms, and perceived behavioural control significantly influence the intention of customers to adopt rooftop solar

systems. It is found that attitude emerged as the strongest predictor of intention. The study also confirms the applicability of the Theory of Planned Behaviour in explaining household adoption of rooftop solar systems in the North Kerala. The results suggest that increasing public awareness, and emphasizing the economic and environmental benefits of rooftop solar systems can enhance consumer adoption.

References

1. Butturi, M.A., Lolli, F., Sellitto, M.A., Balugani, E., Gamberini, R., Rimini, B., 2019. Renewable energy in eco-industrial parks and urban-industrial symbiosis: a literature review and a conceptual synthesis. Appl. Energy 255, 113825.
2. Nguyen, H.V., Vu, T.D., Greenland, S., Nguyen, T.M.N., Vu, V.H., 2022a. Promoting sustainable renewable energy consumption: Government policy drives record rooftop solar adoption in Vietnam. In Environmental Sustainability in Emerging Markets: Consumer, Organisation and Policy Perspectives. Springer Nature Singapore, Singapore, pp. 23–45
3. Marchi, M., Niccolucci, V., Pulselli, R.M., Marchettini, N., 2018. Environmental policies for GHG emissions reduction and energy transition in the medieval historic centre of Siena (Italy): the role of solar energy. J. Clean. Prod. 185, 829–840.
4. Joshi, Y., Rahman, Z., 2015. Factors affecting green purchase behaviour and future research directions. Int. Strateg. Manag. Rev. 3 (1–2), 128–143
5. Sadiq, M., Adil, M., Paul, J., 2022. Eco-friendly hotel stay and environmental attitude: a value-attitude-behaviour perspective. Int. J. Hosp. Manag. 100, 103094.
6. Vu, T. D., Nguyen, H. V., & Nguyen, T. M. N. (2023). Extend theory of planned behaviour model to explain rooftop solar energy adoption in emerging market: Moderating mechanism of personal innovativeness. *Journal of Open Innovation: Technology, Market, and Complexity, 9*(2), Article 100078. https://doi.org/10.1016/j.joitmc.2023.100078
7. Ajzen, I., 1991. The theory of planned behaviour. Organ. Behav. Hum. Decis. Process. 50 (2), 179–211.
8. Nguyen, T.N., Lobo, A., Greenland, S., 2016. Pro-environmental purchase behaviour: the role of consumers' biospheric values. J. Retail. Consum. Serv. 33, 98–108.
9. Sun, P.C., Wang, H.M., Huang, H.L., Ho, C.W., 2020. Consumer attitude and purchase intention toward rooftop photovoltaic installation: the roles of personal trait, psychological benefit, and government incentives. Energy Environ. 31 (1), 21–39.
10. Nguyen, H.V., Vu, T.D., Greenland, S., Nguyen, T.M.N., Vu, V.H., 2022a. Promoting sustainable renewable energy consumption: Government policy drives record rooftop solar adoption in Vietnam. In Environmental Sustainability in Emerging Markets: Consumer, Organisation and Policy Perspectives. Springer Nature Singapore, Singapore, pp. 23–45.
11. Ministry of new and renewable energy ,2024.Annual report 2023-24.Government of India.https:/mnre.gov.in
12. Annual Report,2025. Ministry of new and renewable energy ,2024.Govt of India. https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2025/04/20250416715431493.pdf

13. Zulu, S., Zulu, E., & Chabala, M. (2021). Factors influencing households' intention to adopt solar energy solutions in Zambia: Insights from the theory of planned behaviour. *Smart and Sustainable Built Environment, 11*(4), 951–971. https://doi.org/10.1108/SASBE-01-2021-0008
14. Aklin, M., Cheng, C.-Y. and Urpelainen, J. (2018), "Social acceptance of new energy technology in developing countries: a framing experiment in rural India", Energy Policy, Vol. 113, pp. 466-477. Bridge to India (2018), India Rooftop Solar Map.
15. Parkins, J.R. (2018), "Predicting intention to adopt solar technology in Canada: the role of knowledge, public engagement, and visibility", Energy Policy, Vol. 114, pp. 114-122.
16. Casaló, L. V., & Escario, J. J. (2018). Heterogeneity in the association between environmental attitudes and pro-environmental behaviour: a multilevel regression approach. J Clean Prod, 175, 155–163. https://doi.org/10.1016/j.jclepro.2017.11.237
17. Di Falco, S., & Sharma, S. (2018). Investing in Climate Change Adaptation: Motivations and Green Incentives in the Fiji Islands. Ecological Economics, 154, 394–408. https://doi.org/10.1016/j.ecolecon.2018.08.015
18. Greaves, M., Zibarras, L. D., & Stride, C. (2013). Using the theory of planned behaviour to explore environmental behavioural intentions in the workplace. J Environ Psychol, 34, 109–120. https://doi.org/10.1016/j.jenvp.2013.02.003.
19. Tan, C. S., Ooi, H. Y., & Goh, Y. N. (2017). A moral extension of the theory of planned behaviour to predict consumers' purchase intention for energy-efficient household appliances in Malaysia. Energy Policy, 107, 459–471. https://doi.org/10.1016/j.enpol.2017.05.027.
20. Abreu, J., Wingartz, N., & Hardy, N. (2019). New trends in solar: A comparative study assessing the attitudes towards the adoption of rooftop PV. Energy Policy, 128, 347–363. https://doi.org/10.1016/j.enpol.2018.12.038
21. Aggarwal, A. K., Syed, A. A., & Garg, S. (2019a). Factors driving Indian consumer's purchase intention of roof top solar. International Journal of Energy Sector Management, 13(3), 539–555. https://doi.org/10.1108/IJESM-07-2018-0012
22. Kumar, V., Syan, A. S., & Kaur, K. (2022). A structural equation modeling analysis of factors driving customer purchase intention towards solar water heater. Smart and Sustainable Built Environment, 11(1), 65–78. https://doi.org/10.1108/SASBE-05-2020-0069
23. Ajzen, I. (1985). From intentions to actions: A theory of planned behaviour. In J. Kuhl & J. Beckmann (Eds.), Action control: From cognition to behaviour (pp. 11–39). Springer. https://doi.org/10.1007/978-3-642-69746-3_2
24. Ajzen, I. (1991). The theory of planned behaviour. Organizational Behaviour and Human Decision Processes, 50(2), 179–211. https://doi.org/10. 1016/0749-5978(91)90020-T
25. Ajzen, I. (2005). Attitudes, personality and behaviour. McGraw-Hill Education.
26. Kwon, H. R., & Silva, E. A. (2020). Mapping the landscape of behavioural theories: Systematic literature review. Journal of Planning Literature, 35(2), 161–179. https://doi.org/10.1177/0885412219881135

27. Rozenkowska, K. (2023). Theory of planned behaviour in consumer behaviour research: A systematic literature review. *International Journal of Consumer Studies, 47*(6), 2670–2700. https://doi.org/10.1111/ijcs.12970
28. Ajzen, I. (2001). Nature and operation of attitudes. Annual Review of Psychology, 52, 27–58. https://doi.org/10.1146/annurev.psych.52.1.27
29. Ajzen, I. (2001). Nature and operation of attitudes. Annual Review of Psychology, 52, 27–58. https://doi.org/10.1146/annurev.psych.52.1.27
30. Pacho, F. T., & Batra, M. M. (2021). Factors influencing consumers' behaviour towards organic food purchase in Denmark and Tanzania. Studies in Agricultural Economics, 123(2), 62–75. https://doi.org/10.7896/j. 2127
31. Ajzen, I. (2002). Perceived behavioural control, self-efficacy, locus of control, and the theory of planned behaviour. Journal of Applied Social Psychology, 32(4), 665–683. https://doi.org/10.1111/j.1559-1816.2002. tb00236.x
32. Bandura, A. (1977a). Self-efficacy: Toward a unifying theory of behavioural change. Psychological Review, 84(2), 191–215. https://doi.org/10. 1037/0033-295X.84.2.191
33. Bandura, A. (1986). Social foundations of thought at action: A social cognitive theory. Prentice Hall.
34. Bandura, A. (1999). Social cognitive theory: An agentic perspective. Asian Journal of Social Psychology, 2, 21–41.
35. Fishbein M, Ajzen I. 1975. Belief, attitude, intention, and behaviour: An introduction to theory and research. Addison-Wesley: Reading, MA
36. Smith, S., Paladino, A., 2010. Eating clean and green? Investigating consumer motivations towards the purchase of organic food. Aust. Mark. J. 18 (2), 93–104.
37. Claudy, M. C., Michelsen, C., & O'Driscoll, A. (2013). The diffusion of microgeneration technologies – Assessing the influence of perceived product characteristics on home owners' willingness to pay. *Energy Policy, 61*, 207–216. https://doi.org/10.1016/j.enpol.2013.06.018
38. Rai, V., & Robinson, S. A. (2013). Effective information channels for reducing costs of environmentally-friendly technologies: Evidence from residential PV markets. *Environmental Research Letters, 8*(1), 014044. https://doi.org/10.1088/1748-9326/8/1/014044
39. Zulu, S., & Zulu, E. (2023). Factors influencing households' intention to adopt solar energy solutions in Zambia: Insights from the theory of planned behaviour. *Smart and Sustainable Built Environment, 13*(2), 361–381. https://doi.org/10.1108/SASBE-01-2021-0008
40. Dunlap, R. E., & Jones, R. E. (2002). Environmental concern: Conceptual and measurement issues. In R. E. Dunlap & W. Michelson (Eds.), *Handbook of environmental sociology* (pp. 482–524). Greenwood Press.
41. Smith, S., & Paladino, A. (2010). Eating clean and green? Investigating consumer motivations towards the purchase of organic food. *Australasian Marketing Journal, 18*(2), 93–104. https://doi.org/10.1016/j.ausmj.2010.01.001
42. Yadav, R., & Pathak, G. S. (2016). Young consumers' intention towards buying green products in a developing nation: Extending the theory of planned behaviour. *Journal of Cleaner Production, 135*, 732–739. https://doi.org/10.1016/j.jclepro.2016.06.120
43. Claudy, M. C., Michelsen, C., & O'Driscoll, A. (2013). The diffusion of microgeneration technologies: Assessing the influence of perceived product

characteristics on homeowners' willingness to pay. *Energy Policy, 61*, 207–216. https://doi.org/10.1016/j.enpol.2013.06.018

44. Islam, T., Meade, N., & Wüstenhagen, R. (2013). How does solar energy diffuse in the UK? A review of solar photovoltaic adoption research. *Renewable and Sustainable Energy Reviews, 24*, 300–312. https://doi.org/10.1016/j.rser.2013.03.012
45. Vu, T. D., Nguyen, H. V., & Nguyen, T. M. N. (2023). Extend theory of planned behaviour model to explain rooftop solar energy adoption in emerging market: Moderating mechanism of personal innovativeness. *Journal of Open Innovation: Technology, Market, and Complexity, 9*(3), 100078. https://doi.org/10.1016/j.joitmc.2023.100078
46. epartment of Power, Government of Kerala. (2024). *Draft Kerala Power Policy, 2025* (Draft version). Government of Kerala. https://anert.gov.in/assets/ckeditor/ckfinder/uploads/files/policy/policy%203/Kerala%20-%20Power%20Policy%202024%20-v13_2024-12-18_WM.pdf
47. Sidiras, D.K. and Koukios, E.G. (2004) 'Solar systems diffusion in local markets', Energy Policy, Vol. 32, No. 18,pp. 2007-2018.
48. **Ali, M. I., & Yadav, M. (2019).** Factors influencing the consumer intention towards solar rooftop system at household level. *IIMS Journal of Management Science, 10*(1–2), 1–19. https://doi.org/10.5958/0976-173X.2019.00001.0
49. Cass, N. and Walker, G. (2009) 'Emotion and rationality: The characterisation and evaluation of opposition to renewable energy projects', Emotion, Space and Society, Vol. 2, No. 1, pp. 62-69
50. Hair, J. F., Black, B., Babin, B., Anderson, R. E., & Tatham, R. L. (2006). *Multivariate Data Analysis, 6th Edition*. Pearson Prentice Hall.
51. Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (1998). *Multivariate Data Analysis with Readings*. Englewood Cliffs.
52. Hooper, D., Coughlan, J., & Mullen, M. (2008). Structural Equation Modelling: Guidelines for Determining Model Fit. *Electronic Journal on Business Research Methods, 6*(1). https://doi.org/10.21427/D7CF7R
53. Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal, 6*(1), 1–55. https://doi.org/10.1080/10705519909540118