

**Factors Influencing Green Purchase Intention and Behaviour Towards Solar Technology:
The Role of Green Brand Knowledge**

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ABSTRACT

This study investigates the determinants of Green Purchase Intention (GPI) and Green Purchase Behavior (GPB) among residential and commercial users of solar technology in Pakistan by integrating the Theory of Planned Behavior (TPB) and Technology Readiness Index (TRI). Using a quantitative, cross-sectional survey of 385 respondents and analyzing the data through SPSS and Smart PLS by using Structural Equation Modeling (SEM) and Hayes' PROCESS macro. The study examines the effects of green attitude (GA), subjective norms (SN), perceived behavioral control (PBC), and technological factors (TF). Green Brand Knowledge is used as moderating variable between TPB predictors; green attitude (GA), subjective norms (SN) and perceived behavioral control (PBC) along with the technological factors (TF) and GPI. In this study GPI is used as mediator between TPB predictor (GA, SN, PBC), TF and GPB.

Keywords: green attitude; subjective norms; perceived behavioural control; Technology Readiness Index; green purchase intention; green purchase behaviour; green brand knowledge; solar technology; Pakistan; Theory of Planned Behaviour

INTRODUCTION

The global imperative for sustainable development has placed renewable energy at the forefront of both governmental agendas and consumer discourse (Talwar, Alshaghдали, Gupta, & Battisti, 2025). Pakistan, a nation grappling with chronic energy shortages, load shedding, and escalating electricity costs, has witnessed a remarkable surge in the adoption of solar photovoltaic (PV) technology over the past decade (Ahmed, Khalique, & Khan, 2025). Both household and commercial consumers have increasingly turned to solar energy solutions not merely as a pragmatic response to grid unreliability (Suffian, 2025), but also as an expression of environmental consciousness and long-term economic planning (IEA, 2022). Despite this observable trend, the psychological, social, and technological antecedents that underpin the decision to purchase solar technology within the Pakistani consumer context remain insufficiently explored in the academic literature.

Green marketing, broadly defined as the promotion of products and services based on their environmental benefits, has emerged as a pivotal field of inquiry at the intersection of consumer behaviour and sustainability (Sarwar & Loureiro, 2025). Central to this discourse is understanding what motivates consumers to engage in green purchase behaviour which reflects the actual acquisition of environmentally friendly products. Existing literature has largely applied (Weihrach, Wolff, Stein, Kuonath, & Frey, 2025). Theory of Planned Behaviour (TPB) as a robust theoretical lens for predicting green purchase intentions and behaviour (Hoang, Tung, & Hoa, 2025). However, the majority of these studies have focused on

developed-economy contexts, leaving a significant lacuna in our understanding of green consumer behaviour within the socio-cultural and economic milieu of South Asian emerging markets.

The Technology Readiness Index (TRI), originally conceptualized by Parasuraman (2000) and refined by Parasuraman and Colby (2015), offers a complementary theoretical perspective by capturing consumers' propensity to embrace new technologies. In the context of solar PV systems, which represent not only an environmental choice but also a significant technological investment. The TRI constructs such as optimism, innovativeness, discomfort, and insecurity are particularly salient in shaping consumer adoption decisions. The integration of TRI into a TPB framework thus represents a theoretically enriching and practically relevant contribution to the green marketing literature (S. Kumar et al., 2025).

A further critical construct in this study is green brand knowledge, which refers to the consumer's awareness, recognition, and perceived associations with a brand's environmental credentials (Vinoth, Srivastava, & Mittal, 2024). Green brand knowledge is posited here as a moderating variable that amplifies or attenuates the relationships between the study's independent variables, green attitude (GA), subjective norms (SN), perceived behavioural control (PBC), and technological factors (TF) and green purchase intention (Manalu, 2025). Consumers who possess higher green brand knowledge are expected to be more responsive to pro-environmental attitudinal and normative influences, as well as more discerning in their evaluation of the technological attributes of solar products (Butt & Ahmad, 2025).

Recent studies have yielded conflicting results regarding the relationship between attitude, subjective norms (SN), perceived behavioral control (PBC), and green purchase intention (GPI). According to certain research, consumers' intentions to buy green items are only slightly influenced by attitude, SN, and PBC, indicating that other factors may be more important in influencing green purchasing decisions (Duong, Doan, Vu, Ha, & Dam, 2025; Ridwan & Prananta, 2025). In contrast, other research has found that these factors have a substantial and positive impact on GPI, indicating that favorable attitudes toward environmental sustainability, social pressure from important others, and consumers' perceived ability to engage in green purchasing strongly encourage their intention to buy environmentally friendly products (Arifin, Yudha, & Narmaditya, 2025). These inconsistent findings highlight the need for further investigation to better understand the conditions under which attitude, SN, and PBC influence green purchase intention.

LITERATURE REVIEW

Theory of Planned Behaviour (TPB)

The Theory of Planned Behaviour (Ajzen, 1991), an extension of the Theory of Reasoned Action (Ajzen & Fishbein, 1975), posits that behavioural intentions—and, by extension, behaviours—are jointly determined by three antecedent constructs: attitude toward the behaviour, subjective norms, and perceived behavioural control (Ferasari et al., 2025). In the green consumer behaviour literature, TPB has been extensively applied and empirically validated across diverse product categories and cultural contexts (Synodinos, do Prado, & Moraes, 2025; Zafar & Jafar, 2025). The theory is particularly apt for understanding solar technology adoption because such a decision involves complex trade-offs between environmental values, social influence, and perceptions of financial and technical feasibility (AlQaryouti, Alhamdi, Rahebi, Ramos-Hernanz, & Lopez-Guede, 2025).

Green attitude, the first TPB construct, refers to an individual's overall positive or negative evaluative affect toward engaging in pro-environmental behaviours or purchasing eco-friendly products (Xiaoqin, Abbasi, Hooi, & Ahmad, 2025). Prior research consistently demonstrates a significant positive relationship between

green attitude and green purchase intention (Radhakrishnan, Krishnan, Parayitam, & Cristofaro, 2025). In the solar energy context, a favourable attitude toward environmental preservation and renewable energy is expected to translate into a stronger intention to purchase solar systems (Gatri, 2025).

Subjective norms represent the perceived social pressure from significant referents—family, friends, colleagues, and broader societal opinion—to engage or not engage in a particular behaviour (Abayase, Dzansi, & Dalene, 2025). In collectivist societies such as Pakistan, subjective norms are anticipated to exert a particularly pronounced influence on consumer decision-making (Jalees, Bhutto, Zaman, & Khan, 2025). The growing social visibility of solar panel installations in urban and peri-urban areas, alongside government advocacy and media coverage, reinforces the normative salience of solar adoption (Akomolafe, Ayambire, & Clarke, 2025).

Perceived behavioural control (PBC) reflects an individual's belief about their capacity and ease of performing a given behaviour, encompassing both internal capabilities and external facilitating conditions (Rijal & Shariffuddin, 2025). In the context of solar technology, PBC encompasses perceptions of financial affordability, technical installation complexity, availability of after-sales support, and access to government subsidies or net metering schemes (Oliva & Atehortua Santamaria, 2025). Research has consistently demonstrated PBC as a significant predictor of green purchase intention and behaviour (Sriramaneni, Kotni, Babu, & Sriramneni, 2025).

Technology Readiness Index (TRI)

Parasuraman's (2000) Technology Readiness Index conceptualizes consumers' readiness to adopt new technologies as a function of four dimensions: optimism (positive views about technology and its benefits), innovativeness (tendency to be a technology pioneer), discomfort (perceived lack of control over technology), and insecurity in the form of distrust of technology (Ismail, Ong, Mokhtar, Abd Rahman, & Jaafar, 2025). The TRI has been employed across diverse technology adoption contexts, including e-commerce, mobile banking, and smart home devices (Matlakala & Tsatsimpe, 2025). Solar PV systems, as complex technological products requiring substantial capital investment and ongoing maintenance, represent an ideal context for the application of TRI constructs (Pamunkkaz & Adi, 2025).

Technological optimism and innovativeness are expected to positively predict green purchase intention among solar technology consumers, as individuals who view technology favorably and enjoy being early adopters are more likely to embrace the novelty and complexity of solar systems (Saleem, Zhang, Bashir, & Rafiq, 2025). Conversely, technological discomfort and insecurity may impede purchase intention by amplifying perceived risks associated with system reliability, installation quality, and long-term performance (Singh, 2025). By incorporating TRI as a supporting theoretical framework alongside TPB, this study acknowledges that the decision to adopt solar technology is simultaneously an environmental choice and a technological investment, requiring a dual theoretical lens.

Green Brand Knowledge

Green brand knowledge, drawing on Keller's (1993) customer-based brand equity framework, encompasses consumers' awareness of a brand's green credentials and the associations they hold regarding the brand's environmental performance (Tiwari & Pal, 2024). Consumers with higher green brand knowledge are better equipped to evaluate the environmental claims of solar technology brands, thereby making more informed and confident purchasing decisions (Rama & Susanto, 2024). Prior research suggests that green brand knowledge enhances the effectiveness of green marketing communications and strengthens the attitude-intention link (Manalu, 2025).

The association between the TPB/TRI antecedents and green purchasing intention is suggested to be moderated by green brand knowledge in the current study. Customers are expected to show stronger attitudinal and normative influences on their intentions and to give more weight to technological attributes in their decision calculus when they have a thorough understanding of a brand's environmental identity, including its certifications, sustainability initiatives, and eco-design features. On the other hand, because they lack the informational scaffolding necessary to assess green claims in a meaningful way, customers with little understanding of green brands may show weaker connections between these antecedents and their purchase intentions.

Green Purchase Intention and Green Purchase Behaviour

Green purchase intention refers to the consumer's expressed likelihood of purchasing a product or service based on its environmental benefits (X. Chen, Wang, Chen, & Yang, 2025). Within the TPB framework, intention serves as the proximal determinant of behaviour (Amin, Ting, & Basra, 2025). Empirical research has consistently supported the intention-behaviour link in the context of green consumerism, though the strength of this relationship varies across cultures, product categories, and individual characteristics (Sivapalan, Jebarajakirthy, Maseeh, Sangroya, & Kumar, 2025).

Green purchase behaviour, the ultimate outcome variable in this model, refers to the actual purchase of environmentally friendly products or services (Chao, 2025). In the present study, it is operationalized as the consumer's reported adoption and/or continued use of solar PV technology for household or commercial purposes. The mediated pathway from attitudinal, normative, control, and technological antecedents through purchase intention to purchase behaviour moderated by green brand knowledge constitutes the core structural model under investigation.

Conceptual Framework

Drawing on the theoretical synthesis presented above, the following conceptual model and research hypotheses are proposed. The model posits green attitude (GA), subjective norms (SN), perceived behavioural control (PBC), and technological factors (TF) as independent variables predicting green purchase intention (GPI), which in turn predicts green purchase behaviour (GPB). Green brand knowledge (GBK) is proposed as a moderator between the independent variables and green purchase intention. This constitutes a moderated-mediation model, wherein GPI mediates the IV-DV relationships and GBK moderates the IV-mediator pathways.

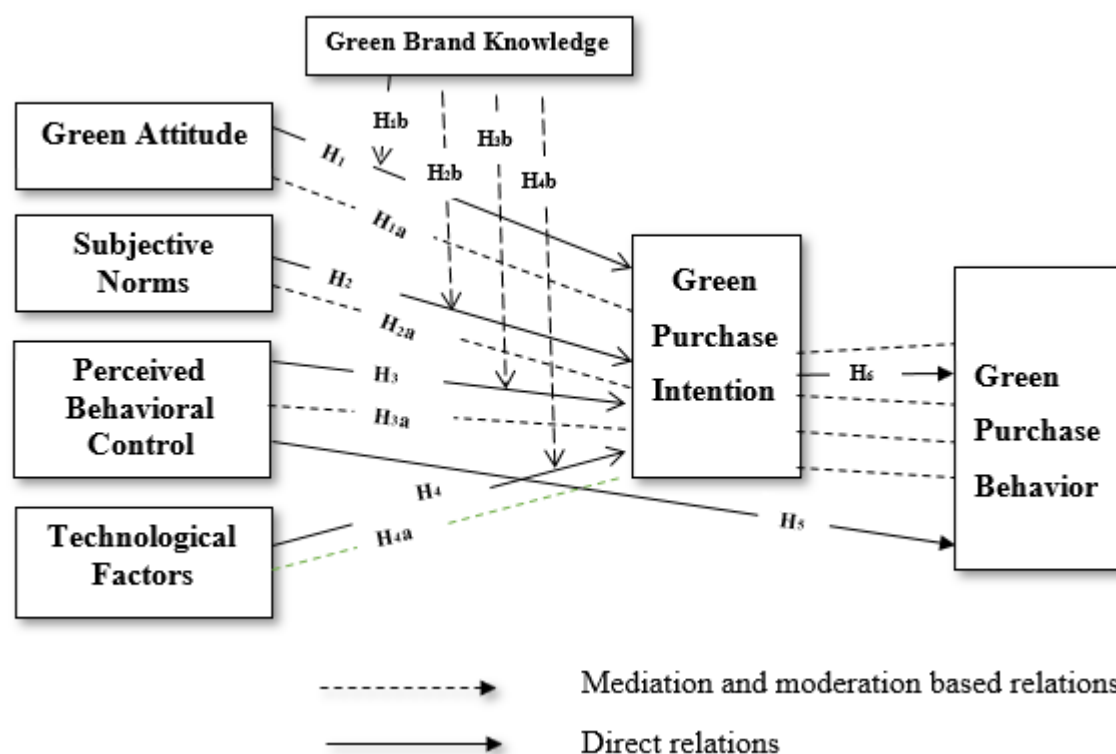


Figure 1: Conceptual framework

RESEARCH HYPOTHESES

Green Attitude and Green Purchase Intention

Green purchase intention (GPI) is positively impacted by green attitude, a key element of the Theory of Planned Behavior (TPB). Customers are more likely to form plans to buy eco-friendly products if they have positive attitudes about sustainable consumption and environmental conservation (Senooane & Chabata). Green purchase intention (GPI) has been found to be favorably influenced by green attitude (GA) in the context of solar energy adoption. This implies that consumers' purchasing intentions are significantly influenced by favorable environmental ideas and perceptions of the efficiency and worth of solar energy (Gatri, 2025). On the basis of above evidence, it is proposed that:

H₁: Green attitude has a significant positive effect on green purchase

Subjective Norms and Green Purchase Intention

The literature has produced conflicting results regarding the relationship between subjective norms (SN) and green purchase intention (GPI) in the context of solar energy adoption. According to certain research, SN significantly improves GPI (Ilyas, Ahmad, & Siddiqi, 2020). On the other hand, other studies have discovered a negative correlation between SN and GPI, indicating that social pressures or disparate social expectations may deter people from planning to buy or use solar energy technologies (Fathima MS, Batcha, & Alam, 2023). These divergent findings invite further study on the topic.

H₂: Subjective norms have a significant positive effect on green purchase intention

Perceived Behavioural Control and Green Purchase Intention

According to a Jordanian study, green purchasing intention (GPI) is significantly positively impacted by perceived behavioral control (PBC). According to this research, customers are more likely to create intents to purchase environmentally friendly products when they feel they have enough resources, knowledge, opportunities, and abilities to do so (Almrafee & Akaileh, 2024). Consistent with previous findings, another study by Hoang et al. (2025) also reported that perceived behavioral control (PBC) has a positive and significant impact on green purchase intention (GPI). The study suggests that consumers are more likely to intend to purchase environmentally friendly products when they perceive that they possess the necessary resources, knowledge, and opportunities to engage in green purchasing behavior (Hoang et al., 2025). On the basis of above discussion, we hypothesises:

H₃: Perceived behavioural control has a significant positive effect on green purchase intention

Technological Factors and Green Purchase Intention

Technological factors (TF) significantly impact GPI (Nguyen et al., 2024). A person's general attitude, intention, and propensity to accept new technologies are shaped by technological factors (AlSaied & McLaughlin, 2024). Technology based innovativeness and optimism are positively associated with GPI. The GPI is typically greater for people who are receptive to and excited about embracing new technology (Alhammadi, Marashdeh, & Hussain, 2023). Higher levels of innovativeness therefore help firms create sustainable solutions and improve their environmental performance, which benefits the GPI as a whole (Lihong, Qie, Memon, & Yesuf, 2021). Innovativeness positively influences GPI by enabling firms and consumers to adopt new ideas, products, and technologies more readily (Al-Jundi, Shuhaiber, & Augustine, 2019). On the basis of above discussion, we can hypothesis that:

H₄: Technological factors have a significant effect on green purchase intention

Perceived Behavioral Control and Green Purchase Behaviour

Perceived behavioral control positively impact green purchase behavior through mediation of GPI but it also directly effects GPB (Xu et al., 2022b). Green purchase behavior is influenced by a person's belief in their capacity to carry out a particular behavior, both directly and indirectly through the mediation of GPI (Ngo et al., 2025). Empirical studies consistently show that when consumers perceive a higher level of control over purchasing green products, they are more likely to form strong intentions to engage in such behavior (Noureddine, Majid, Mohammed, & Faycal, 2025). All three core factors of TPB named attitude, SN and PBC influence GPI which further influence GPB (Agustina, Yuniaristanto, & Sutopo, 2025). Normally we observe that PBC impacts GPB but multiple studies based on green products found that there is insignificant influence of PBC on GPB (Irine & Lady, 2023). Based on the above discussion, we may hypothesis that:

H₅: There is direct effect of PBC on GPB.

Green Purchase Intention and Green Purchase Behaviour

According to a research conducted in Islam Abad and Rawalpindi purchase intention positively influence the purchase behavior (Shakeel et al.). Green purchasing behavior is then significantly influenced by the enhanced intention to make green purchases (Vironika & Maulida, 2025). Within the framework of the Theory of Planned Behavior, stronger intentions are associated with a higher probability of behavioral execution (Ha & Le-Anh, 2025). Furthermore, empirical data indicates that there may be context-specific

variations in the link between GPI and GPB. For example, it was discovered that there was a substantial correlation between green purchasing intention and green buy behavior in Canada, but not in Brazil (Ferraz, Buhamra, Laroche, & Veloso, 2017). On the basis of above discussion, we may hypothesis that:

H₆: Green purchase intention has a significant positive effect on green purchase behaviour

Mediation Role of Green Purchase Intention

Green purchase intention plays a mediator role between TPB predictors and GPB (Hassan, Mahmood, & Khakwani, 2025; Marhadi, Sudibyo, Priatmoko, & Suyastri, 2024). Attitude plays vital role in developing GPI further influencing GPB (Imiru, 2023). Positive attitude of green items influence both their intentions to buy and their actual purchasing behavior (Selvanathan, Samy, Jumbe, & Zeni, 2025). Thus, intention is the nucleus in TPB theory that mediates between the TPB predictors and GPB (Apiradee, Lin, Wirojratana, Lin, & Shu, 2025). Green purchase intention (GPI) positively and significantly mediate the relationship between GA and GPB (Irine & Lady, 2023; Margariti, Hatzithomas, & Boutsouki, 2024; Meili, 2025; Yuan, Rasiah, Hou, & Li, 2023).

According to the statement, Green Purchase Behavior (GPB) and the antecedent elements are mediated by Green Purchase Intention (GPI). To put it another way, customers' intentions to buy green products are shaped by Green Attitude (GA), Subjective Norms (SN), and Perceived Behavioural Control (PBC), which then influence real green purchasing behavior. Customers who have strong social support, positive environmental attitudes, and confidence in their ability to buy eco-friendly products are more likely to develop a strong intention to buy, which eventually translates into green purchasing behavior, according to GPI's significant mediating role (Butt & Ahmad, 2025; Kumar & Sinha, 2025).

Based on above discussion we may design the following hypothesis:

H_{1a}: GPI mediates the relationship between GA and GPB

H_{2a}: GPI mediates the relationship between SN and GPB

H_{3a}: GPI mediates the relationship between PBC and GPB

It was explored that how technology-based elements, particularly optimism and innovativeness, affect GPI and GPI further affects GPB (Srisathan, Ketkaew, Jantuma, & Naruetharadhol, 2024). In some studies, such as Yacob, Ali, and Roslim (2025), green purchase intention (GPI) does not significantly mediate the relationship between technological factors (TF) and green purchase behavior (GPB) (Yacob, Ali, & Roslim, 2025). These contradictory findings, in which green purchase intention (GPI) demonstrates both significant and minor mediating effects between technological factors (TF) and green purchase behavior (GPB). On the basis of above evidences, we purpose that GPI plays mediation role between TF and GPB.

H_{4a}: GPI mediates the relationship between TF and GPB

Moderating Role of Green Brand Knowledge

Moderation effect of GBK between GA-GPI, SN-GPI, PBC-GPI, and TF-GPI is still unexplored. According to (Butt & Ahmad, 2025) moderation effect of GBK between SN-GPI and TF-GPI could not produce significant impact but it was significant between GA-GPI and PBC-GPI. On the basis of above discussion, we can hypothesis that:

H_{1b}: GBK moderates the relationship between GA and GPI

H_{2b}: GBK moderates the relationship between SN and GPI

H_{3b}: GBK moderates the relationship between PBC and GPI

H_{4d}: GBK moderates the relationship between TF and GPI

RESEARCH DESIGN AND METHODOLOGY

A quantitative research design was used with deductive approach. Survey method was used to collect data from domestic and commercial users of solar energy with purposive a non-probability sampling technique. SPSS and Smart PLS software were used to analyze data. Sample size was 385 to collect data from all over Pakistan.

Measurement Instrument

All research constructs were measured using a five-point Likert scale (1 = strongly disagree to 5 = strongly agree). Green Attitude (GA), Subjective Norms (SN), Perceived Behavioral Control (PBC), Technological Factors (TF), Green Brand Knowledge (GBK), Green Purchase Intention (GPI), and Green Purchase Behavior (GPB) questionnaire items were adapted from validated earlier research. For current study four (4) items were adapted from the previous study (Ajzen, 1985), these items are further used in (Lavuri, 2022) for GPB. Four (4) items were adapted from (Ajzen, 1985), these items are again included in (Asif et al., 2023) for GA. Four (4) items were adapted from (Ajzen, 1985), these items are again included in (Asif et al., 2023) for SN. Four (4) items were adapted from (Ajzen, 1985), these items are again included in (Asif et al., 2023) for PBC. Ten (10) items were adapted from (Basiago, 1994), these items are again included in (Hasheem et al., 2022) for TF. Four (4) items were adapted from (Ajzen, 1985), these items are again included in (Hasheem et al., 2022) for GPI. Five (5) items were adapted from (Keller, 1993), these items are again included in (Siyal et al., 2021) for GBK.

Results

Demographics

Table 1: Demographics of study variables

Demographics	Categories	Frequency	Percentage
Gender	Male	211	54%
	Female	176	46%
Age	≤ 30 years	121	31%
	31 – 50 years	186	48%
	≥ 51 years	80	21%
Qualification	Under Graduate	95	25%
	Graduate	156	40%
	Post Graduate	136	35%
Marital Status	Married	236	61%
	Single	151	39%
Residential Area	Urban	187	48%
	Semi Urban	122	32%
	Rural	78	20%

Income Level	Less than 2 lakhs	159	41%
	Between 2 lacs and 4 lakhs	118	30 %
	Between 4 lacs and 6 lakhs	46	12 %
	More than 6 lacs	64	17%

Among the 387 respondents, 54% were male and 46% were female. Most respondents were aged 31–50 years (48%), married (61%), and graduates or postgraduates (75%). Nearly half resided in metropolitan areas (48%), followed by semi-urban (32%) and rural areas (20%). Regarding income, 41% earned less than ₹2 lakhs annually, while 30% earned between ₹2–4 lakhs. Overall, the sample was predominantly composed of middle-aged, married, educated individuals from metropolitan and semi-urban areas.

Measurement Model Assessment

The measuring model assessment assesses the study constructs' validity and reliability. To make sure the measurement scales are valid, dependable, and appropriate for structural model analysis, it looks at factor loadings, Cronbach's Alpha, Composite Reliability (CR), Average Variance Extracted (AVE), HTMT, and VIF.

Table 2: Measurement model assessment

Variables	Items	Factor Loadings	C. A	C. R	AVE
Environmental Factors	EF01	0.760	0.927	0.932	0.568
	EF02	0.775			
	EF03	0.863			
	EF04	0.656			
	EF05	0.548			
	EF06	0.724			
	EF07	0.665			
	EF08	0.791			
	EF09	0.829			
	EF10	0.816			
	EF11	0.764			
	EF12	0.743			
Green Attitude	GA01	0.815	0.831	0.854	0.673
	GA02	0.773			
	GA03	0.831			
	GA04	0.811			
Subjective Norms	SN01	0.878	0.875	0.887	0.781
	SN02	0.878			
	SN03	0.867			
Perceived Behavioral Control	PBC01	0.864	0.831	0.876	0.669
	PBC02	0.891			
	PBC03	0.836			
	PBC04	0.619			
Technological Factors	TF01	0.550	0.914	0.929	0.571
	TF02	0.717			
	TF03	0.594			
	TF04	0.830			

	TF05	0.852			
	TF06	0.826			
	TF07	0.797			
	TF08	0.870			
	TF09	0.672			
	TF10	0.772			
Green Brand Knowledge	GBK01	0.847	0.843	0.895	0.680
	GBK02	0.852			
	GBK03	0.811			
	GBK04	0.789			
Green Purchase Intention	GPI01	0.852	0.888	0.923	0.750
	GPI02	0.913			
	GPI03	0.866			
	GPI04	0.831			
Green Purchase Behavior	GPB01	0.849	0.783	0.859	0.604
	GPB02	0.753			
	GPB03	0.715			
	GPB04	0.773			

The measurement model results demonstrate satisfactory reliability and validity. Factor loadings ranged from **0.548 to 0.913**, exceeding the recommended threshold of 0.50. Cronbach's Alpha values (**0.783–0.927**) and Composite Reliability values (**0.854–0.932**) were above 0.70, confirming internal consistency reliability. Furthermore, all AVE values (**0.568–0.781**) exceeded the minimum threshold of 0.50, establishing convergent validity. Overall, the measurement model is reliable and valid for further structural model analysis.

Heterotrait-Monotrait Ratio (HTMT) – Matrix

Table 3: HTMT matrix

	EF	GA	GBK	GBP	GPI	PBC	SN	TF
EF								
GA	0.872							
GBK	0.850	0.843						
GBP	0.810	0.798	0.864					
GPI	0.795	0.832	0.776	0.835				
PBC	0.760	0.825	0.747	0.831	0.879			
SN	0.759	0.815	0.715	0.751	0.742	0.793		
TF	0.813	0.792	0.853	0.754	0.858	0.785	0.817	

In order to evaluate the discriminant validity of the study constructs, an HTMT analysis was performed. The HTMT values ranged from 0.715 to 0.879, all of which were below the recommended threshold of 0.90, indicating satisfactory discriminant validity. The highest HTMT value was found between GPI and PBC (0.879), followed by EF and GA (0.872) and GBK and Green Purchase Behavior (GPB) (0.864). The lowest HTMT value was found between Green Brand Knowledge (GBK) and Subjective Norms (SN) (0.715).

Collinearity (VIF)

In order to make sure that the predictor variables were not overly linked with one another, multi-collinearity was evaluated in this study using the Variance Inflation Factor (VIF). According to a widely recognized criterion, VIF levels below 5 are considered acceptable, values above 5 indicate possible multi-collinearity issues, and values above 10 indicate significant problems that need to be fixed.

Table 4: Variance Inflation factor (VIF)

Variables	Items	Average VIF
Environmental Factors (EF)	EF1–EF12	4.71
Green Brand Knowledge (GBK)	GBK1–GBK4	2.01
Green Purchase Behavior (GPB)	GPB1–GPB4	1.68
Green Purchase Intention (GPI)	GPI1–GPI4	2.57
Green Attitude (GA)	GA1–GA4	1.83
Subjective Norms (SN)	SN1–SN4	2.83
Technological Factors (TF)	TF1–TF9	2.89

The absence of multi-collinearity problems was indicated by the VIF values, which varied from 1.68 to 4.71 and were all below the suggested threshold of 5.0. These findings verify that the measurement model is appropriate for additional structural analysis and that the constructs are sufficiently distinct.

R Square (R^2) Analysis

Table 5: R^2 analysis

	R-square	R-square adjusted
GPB	0.551	0.548
GPI	0.534	0.531

According to the R^2 analysis, the model accounts for 53.4% of the variance in GPI and 55.1% of the variance in GPB. Good model stability and moderate explanatory power are shown by the modified R^2 values, which are extremely near to the R^2 values.

Q-Square Analysis

Table 6: Q^2 Predict

	Q^2 Predict	RMSE	MAE
GPI	0.745	0.497	0.417
GPB	0.726	0.548	0.423

With Q^2 values of 0.745 for GPI and 0.726 for GPB, both significantly above zero, the Q^2 Predict results show good predictive relevance for the model. The model's high ability to predict green buy intention and green purchase behavior is further supported by the comparatively low RMSE and MAE values, which indicate good predictive accuracy.

PLS SEM Analysis

Because of its adaptability and resilience, smart PLS (PLS-SEM) is frequently utilized for exploratory and predictive research. It is ideal for examining intricate models with numerous constructs, variables, and mediation or moderation effects because it does not necessitate rigorous data normalcy assumptions, in contrast to covariance-based SEM. For analyzing theoretical correlations and producing predicting insights, Smart PLS is a suitable analytical method.

Direct Relations

Table 7: Direct relations

Hypotheses	Relations	Beta (β)	T Values	P values	Results
H ₁	GA ➤ GPI	-0.337	6.216	0.000	Supported
H ₂	SN ➤ GPI	0.218	2.734	0.002	Supported
H ₃	PBC ➤ GPI	-0.245	6.543	0.000	Supported
H ₄	TF ➤ GPI	0.276	2.781	0.003	Supported
H ₅	PBC ➤ GPB	0.246	6.678	0.000	Supported
H ₆	GPI ➤ GPB	0.714	23.673	0.000	Supported

All of the proposed paths are statistically significant and supported, according to the direct association analysis. Green Purchase Intention (GPI) is considerably influenced by Green Attitude (GA), Subjective Norms (SN), Perceived Behavioral Control (PBC), and Technological Factors (TF). Green Purchase Behavior (GPB) is notably positively impacted by both GPI and PBC. The greatest effect among the associations is GPI → GPB ($\beta = 0.714$), which emphasizes how important purchase intention is in influencing real green purchasing behavior. All things considered, the findings strongly support the suggested structural model.

Mediation Analysis

Table 8: Mediation analysis

Hypotheses	Relations	Beta (β)	T Values	P Values	Results
H _{1a}	GA ➤ GPI ➤ GBP	-0.165	5.154	0.000	Supported
H _{2a}	SN ➤ GPI ➤ GBP	0.167	2.763	0.001	Supported
H _{3a}	PBC ➤ GPI ➤ GBP	-0.198	6.239	0.000	Supported
H _{4a}	TF ➤ GPI ➤ GBP	0.217	2.564	0.003	Supported

The findings of the mediation study show that the associations between Green Attitude (GA), Subjective Norms (SN), Perceived Behavioral Control (PBC), Technological Factors (TF), and Green Purchase Behavior (GPB) are significantly mediated by Green Purchase Intention (GPI). Every indirect impact is supported and statistically significant ($p < 0.01$). TF → GPI → GPB ($\beta = 0.217$) has the strongest positive indirect effect among the mediated relationships, whereas PBC → GPI → GPB ($\beta = -0.198$) and GA → GPI → GPB ($\beta = -0.165$) have significant negative indirect effects. Overall, the results support the idea that GPI mediates the relationship between the antecedent variables and green buying behavior.

Moderation Relations

Table 9: Moderation analysis

Hypotheses	Relations	Beta (β)	T Values	P values	Results
H _{1b}	GBK x GA ➤ GPI	-0.308	5.763	0.000	Supported
H _{2b}	GBK x SN ➤ GPI	-0.074	0.754	0.341	Not Supported
H _{3b}	GBK x PBC ➤ GPI	0.242	4.157	0.000	Supported
H _{4b}	GBK x TF ➤ GPI	0.293	2.178	0.000	Supported

As all corresponding interaction effects are statistically significant and supported, the moderation analysis shows that Green Brand Knowledge (GBK) significantly moderates the relationships between Green Attitude (GA), Perceived Behavioral Control (PBC), Environmental Factors (EF), and Green Purchase Intention (GPI). In particular, there are notable moderating effects for $GBK \times GA \rightarrow GPI$ ($\beta = -0.308$), $GBK \times PBC \rightarrow GPI$ ($\beta = 0.242$), and $GBK \times EF \rightarrow GPI$ ($\beta = 0.293$). Nevertheless, these hypotheses were rejected because the moderating effects of GBK on the associations between Technological Factors (TF) and GPI and Subjective Norms (SN) and GPI were not significant. Overall, the results imply that certain antecedent associations with green buying intention are either strengthened or modified by GBK.

DISCUSSION

By combining psychological, environmental, and technological aspects with the moderating effect of green brand knowledge (GBK), this study investigated the factors impacting green purchase intention (GPI) and green purchase behavior (GPB). The robustness of the constructs utilized in the analysis was confirmed by the measurement model's acceptable reliability, convergent validity, and discriminant validity. The results of the structural model showed that while GPI and PBC had a major impact on GPB, Green Attitude (GA), Subjective Norms (SN), Perceived Behavioral Control (PBC), and Technological Factors (TF) had a substantial impact on GPI. GPI had the most impact on GPB of all the direct interactions, underscoring the significance of purchase intention in converting consumers' environmental concerns into real purchasing behavior.

The mediator GPI is a key mechanism by which GA, SN, PBC, and TF influence GPB, according to the mediation study. Furthermore, GBK significantly moderated the correlations between GA, PBC, EF, and GPI, indicating that customers who are more knowledgeable about green brands are better able to convert positive attitudes, environmental concerns, and perceived control into stronger buy intentions. Additionally, the model showed excellent predictive relevance and moderate explanatory power, demonstrating its efficacy in explaining and forecasting green purchase decisions.

CONCLUSION

According to the study's findings, GPI is crucial in influencing consumers' green purchasing decisions. The results offer empirical proof that customers' intents to buy eco-friendly products are greatly influenced by GA, SN, PBC, and TF, and that buying intention has a major impact on actual purchasing behavior. Additionally, GBK strengthens a number of these connections, highlighting the significance of customer knowledge and comprehension of green brands in encouraging sustainable consumption. The model's strong predictive capacity and ability to explain more than half of the variance in both GPI and GPB confirmed that it is appropriate for comprehending GPB. In order to promote sustainable purchasing practices and support environmental sustainability, policymakers, marketers, and green product providers

should concentrate on raising environmental awareness, bolstering GBK, and enhancing technological acceptance.

THEORETICAL CONTRIBUTIONS

This study contributes significantly to theory in a number of ways. First, it expands the theory's relevance in sustainable consumption research by applying the TPB to the context of GPB. Second, it provides a more thorough understanding of the psychological and technology factors of GPI and GPB by highlighting the significance of combining technological considerations with conventional TPB variables through TRI theory. Third, by demonstrating how consumers' awareness of green brands affects the strength of relationships between important antecedents and GPI, the study adds to the body of knowledge on green marketing and brand equity by introducing and empirically validating Green Brand Knowledge (GBK) as a moderating variable. These contributions deepen our understanding of consumer decision-making in green product markets and strengthen the explanatory power of TPB.

PRACTICAL IMPLICATIONS

The results have a number of useful ramifications for green product manufacturers, legislators, and marketers. First, as these elements have a big impact on customers' intentions to make green purchases, marketing tactics should highlight social influence, environmental advantages, and consumers' perceived capacity to embrace green products. Second, the substantial impact of technological aspects emphasizes the necessity of educating consumers about the usability, dependability, and functionality of environmentally friendly products and green technologies. Third, companies could improve their understanding of green brands by using eco-labeling, sustainability certifications, transparent environmental information, and successful green marketing initiatives. Increasing customers' knowledge and comprehension of green businesses can boost their intentions to make purchases and promote the adoption of more sustainable goods and practices.

LIMITATIONS AND FUTURE RESEARCH

Current study is based on cross-sectional design but in future longitudinal studies should examine the temporal dynamics of the intention-behaviour relationship in solar adoption. Self-selection bias may be introduced by the online survey methodology, which could over represent more environmentally conscious and technology based consumers. Although the sample's geographic stratification improves representativeness, more research should look at regional and urban-rural variations in green consumer behavior. Future research may potentially expand the model by adding more moderating factors, such as policy awareness, income level, or environmental concern, and by using qualitative techniques to offer a deeper contextual understanding of the associations found.

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