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Exploring the Determinants of Solar Energy Technology Intention to adopt: Evidence from Egyptian Households

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Abstract
Purpose: *This research examines the key drivers shaping Egyptian households' intentions to adopt solar energy technology which is a key pillar of Egypt's Vision 2030 for sustainable development. Despite the country's vast solar potential, residential uptake lags, underscoring the need to unpack the psychological and demographic influences on consumer choices*

Design/methodology/ approach:*The research applies the Theory of Planned Behavior (TPB) through a deductive quantitative design. Primary data came from an online survey of 253 non-adopter households in Cairo and Giza, gathered via convenience sampling from November to December 2025.*

Findings: *The findings reveal that consumer innovativeness, environmental consciousness, perceived behavioral control, and solar energy beliefs significantly and positively predict adoption intentions. Peer influence and public media exposure further normalize the technology's appeal. However, age does not moderate the relationship between consumer innovativeness and the adoption intention of solar energy technology among Egyptian households. Whereas income negatively moderates the environmental consciousness intention relationship, indicating lower-to-middle-income households prioritize solar's practical cost benefits more than affluent groups.*
Implications: *Policymakers and marketers should implement segmented strategies, such as providing low-interest "green loans" for budget-conscious families and leveraging community-based social proof for risk-averse older demographics.*
Originality: *This research fills a significant contextual gap by examining the interplay between psychological determinants and demographic moderators specifically within the urban Egyptian cultural setting, providing actionable insights for the acceleration of the renewable energy transition.*
Paper type: *Research paper.*
Keywords: *Key Drivers, Solar Energy Technology, Adoption Intention, Theory of Planned Behavior, Egyptian Households.*

1. Introduction

Global energy reliance spans nonrenewable fuels alongside renewables, but both developed and developing nations must transition to renewables for sustainability and economic benefits (Farghali et al., 2023). Despite rising renewable adoption, fossil fuels dominate due to intermittency and high upfront costs.

Egypt's Vision 2030 prioritizes balancing renewable and non-renewable resources to fuel economic growth, competitiveness, social justice, environmental protection, and global sustainability leadership (Misko et al., 2023). Solar energy, abundant and eco-friendly, could meet annual global needs in 90 minutes, yet it forms a

minor share of the energy mix (Huseynli, 2023). Egypt ranks second globally (after South Africa) for solar potential.

Limited Egyptian research exists on consumer solar panel purchase behavior, with one study limited to millennials' sustainable product attitudes (Kumar et al., 2024; Uz et al., 2024). High costs and operations distinguish solar panels, preventing direct generalization from Western or other contexts to Egypt (Azazz et al., 2024). This study fills empirical and contextual gaps by examining non-adopter purchase intentions in Egypt's cultural setting.

1.1 Problem

Despite Egypt's abundant solar potential and the global push for renewables to combat climate change and cut emissions, household adoption of solar technology remains limited. Understanding the key drivers behind this low uptake is crucial for devising strategies to boost solar use and meet national sustainability goals. This study analyzes factors shaping Egyptian households' intentions to adopt solar energy technology, while also exploring how demographics like age and income moderate these intentions—particularly which age groups show the strongest inclination toward these green solutions.

1.2 Research Gap

Research on Egyptian consumers' purchase intentions for solar energy panels remains scarce, underscoring the need for deeper exploration into local adoption of renewable technologies. While one Egyptian study examined millennials' attitudes toward sustainable products alongside business perspectives, this group differs markedly from other generations in psychographic and demographic traits that shape buying behavior (Moreno et al., 2017). Moreover, solar panels differ from other green household items due to their elevated costs and technical demands (Kumar et al., 2024; Uz & Mamkhezri, 2024), limiting the applicability of prior findings to this domain.

Egyptian consumers also possess distinct socioeconomic profiles compared to Western counterparts (Azazz et al., 2024), rendering results from Western or other cultural settings unreliable for generalization here. This study bridges these empirical and contextual gaps by analyzing factors driving purchase intentions among non-adopting Egyptian prospects, with a focus on their unique cultural backdrop.

1.3 Questions

Building on the foregoing discussion, this study addresses the following research questions:

RQ1: Are specific factors such as consumer innovativeness, environmental consciousness, perceived behavioral control, belief of solar energy, peer influence, and public media influence associated with Egyptian households' intentions to adopt solar energy technology?

RQ2: What is the significance of the interrelationships among factors influencing Egyptian households' intentions to adopt solar energy technology?

RQ3: Does age moderate the relationships between consumer innovativeness, perceived behavioral control, solar energy beliefs, and peer influence on Egyptian households' solar technology adoption intentions?

RQ4: Do income levels moderate the relationship between environmental consciousness and Egyptian households' intentions to adopt solar energy technology?

1.4 Egypt Context

Renewable energy sources like solar, hydro, wind, and biomass have advanced sustainability in numerous countries. Yet Egypt's progress lags due to political hurdles, insufficient financial incentives, and battery storage limitations, fostering heavy reliance on subsidized fossil fuels.

The Benban Solar Park, Africa's largest, signals a policy pivot toward renewables. Despite Egypt's 2018 installed capacity of 54.5 GW being only 10% renewable, recent initiatives prioritize solar and wind. Launched in 2015 in Aswan—one of the sunniest regions—the Benban complex invests €3.4 billion across 40 substations and 200,000 panels generating 50 MW, while creating 6,000 jobs (European Training Foundation, 2023).

Smaller efforts include rooftop solar for self-consumption and grid sales. The UNDP-government 'Egypt-PV' initiative deploys decentralized grid-tied PV systems up to 4 MWp, cutting bills, offsetting 0.6 million tons of CO_2 by 2034, and aiding households and firms (European Training Foundation, 2023).

2. Literature Review

2.1 The theoretical Foundation

This study is grounded in the Theory of Planned Behavior (TPB), which effectively predicts Egyptian households' intentions and behaviors toward renewable energy adoption via its core components: attitude, subjective norms, and perceived behavioral control (Fathima et al., 2022).

Arslan (2022) applied TPB to renewable energy intentions, linking peer influence (subjective norms) and perceived behavioral control (PBC) to adoption; studies confirm PBC shapes solar intentions (Fathima et al., 2022; Bandara et al., 2020; Zulu et al., 2022), while rising social discussions boost willingness via norms (Wolske et al., 2020; Rode et al., 2020; O'Shaughnessy et al., 2023).

Key adoption drivers for Egyptian households include: consumer innovativeness, which propels solar popularity and segment-specific decisions (Huang et al., 2024); environmental consciousness, fostering protective behaviors (Anggraini et al., 2022); personal norms shaped by environmental attitudes and cultural beliefs (Asif et al., 2023; Muwanga et al., 2021); and public media influence via marketing tools that motivate photovoltaic adoption (Zeru et al., 2021). Demographic factors like age and income moderate these effects.

2.2 Consumer Innovativeness

Consumer innovativeness is central to market segmentation and forecasting adoption of renewables like solar energy, defined by Huang (2024) as openness to novel experiences that spurs trials of eco-friendly innovations (Esfahani et al., 2021; Tran et al., 2024). This trait fosters positive attitudes and intentions toward sustainable products, elevating adoption rates (Eryigit, 2020; Zhang et al., 2022).

Hedonic innovativeness, pursuit of sensory pleasure and excitement, consistently bolsters attitudes and purchase intentions for green goods (Li et al., 2021; Esfahani et al., 2021). Social innovativeness, driven by prestige and social approval, typically boosts intentions but may sometimes undermine attitudes or actual purchases (Li et al., 2021; Esfahani et al., 2021). In contrast, functional (efficiency-focused) and cognitive (intellect-driven) innovativeness can dampen purchase intent, highlighting complex dynamics across decision phases (Esfahani et al., 2021).

Solar-specific studies confirm this: innovativeness predicts photovoltaic purchase intent in Poland (Angowski et al., 2021) and solar system uptake in Taiwan (Chen, 2014). Early innovative adopters trigger broader diffusion via social networks (Li, 2025), positioning them as prime catalysts for renewable acceleration. Accordingly, the following hypothesis is developed. **H1: Consumer innovativeness positively influences Egyptian households' intentions to adopt solar energy technology.**

2.3 Environmental Consciousness

Environmental consciousness is the awareness of one's ecological footprint, it drives sustainable consumption and green technology adoption, such as solar energy, across regions from Indonesia to Jordan, increasing willingness to pay premiums and fostering pro-environmental behaviors (Firdaus, 2023; Alsmadi, 2007; Ghosh et al., 2024). In the Theory of Planned Behavior framework, it acts as a key antecedent to renewable adoption intentions, spurring action among eco-conscious individuals (Espinoza et al., 2024; Wall et al., 2021).

While environmental knowledge builds positive attitudes, its direct impact on adoption intentions varies, often relying on mediators like tangible benefits or social norms (Bang et al., 2000; Pagiaslis et al., 2014; Guber, 2003; Kesari et al., 2018; Lin et al., 2016). Stronger predictors include accountability, policy backing, and green attitudes (Kesari et al., 2018; Behera et al., 2023); however, awareness alone seldom suffices without incentives, as perceived gains mediate more effectively than concern (Kurniawan et al., 2025). Strategies for residential solar thus stress education, benefit promotion, norm activation, and policy support (Behera et al., 2023). Accordingly, the following hypothesis is developed. **H2: Environmental consciousness positively influences Egyptian households' intentions to adopt solar energy technology.**

2.4 Perceived Behavioral Control

It is an individual's sense of capability to perform a behavior via resources and skills—holds a key, though sometimes debated, role in technology adoption models, especially renewables (Manning, 2009). Most studies affirm its strong positive effect on intentions and behaviors (Dutta et al., 2024; Fatoki, 2022).

Empirical support spans contexts: PBC boosts sustainable energy intentions for small households (Alam et al., 2014), solar purchases in India (Srivastava et al., 2018; Fathima et al., 2022), broad renewable use (Yazdanpanah et al., 2015; Masrahi et al., 2021; Masukujjaman et al., 2021), solar heaters in rural China (Wang et al., 2019; Nelson et al., 2021), Malaysian tech adoption (Wong et al., 2024), and installations like solar heaters or alternative vehicles (Chen et al., 2016; Yun et al., 2015). In Uganda, it ties to perceived value and applicability, enhancing intentions (Muwanga et al., 2021). Contradictions exist when some find no significant PBC-intention link for solar adoption (Zulu et al., 2022; Dutta et al., 2024), varying by fiscal support, tech complexity, or cultural self-efficacy. This underscores context-specific testing despite overall positive trends. Accordingly, the following hypothesis is developed. **H3: Perceived behavioral control positively influences Egyptian households' intentions to adopt solar energy technology.**

2.5 Beliefs of Solar Energy

Beliefs about solar energy technology (SET) benefits show mixed impacts on adoption intentions. Positive evidence highlights specific benefit beliefs drive purchase intentions (Asif et al., 2023); socio-cultural beliefs act as key antecedents (Muwanga et al., 2021; Elmustapha et al., 2018); and behavioral beliefs like impure altruism (warm glow), innovativeness, product knowledge, and social engagement boost attitudes, which precede intentions (Huang, 2024).

Contrasting results emerge in a Pakistani study found renewable benefit beliefs insignificant for implementation intentions (Irvan et al., 2021). These discrepancies suggest moderation by market maturity, accessibility, or financial incentives, limiting universal predictive power across cultural, technological, and social dimensions. Contextual testing remains essential. Accordingly, the following hypothesis is developed. **H4: Beliefs of solar energy positively influence Egyptian households' intentions to adopt solar energy technology.**

2.6 Peer Influence

Peer influence strongly propagates solar photovoltaic adoption, especially in residential segments with visible rooftop systems acting as social signals (Wolske et al., 2020; O'Shaughnessy et al., 2023). Mechanisms include active channels (communication, trust-sharing) and passive ones (observational learning from neighbors), reducing uncertainty and building norms (Barnes et al., 2022; Lam et al., 2025; Palm, 2017; Noll et al., 2014).

U.S. spatial proximity boosts adoption (Graziano et al., 2019; Mehta et al., 2019); Germany sees it aiding uncertain consumers (Morrissey et al., 2024); similar effects in Sweden, Malaysia, and India (Palm, 2017; Abdul Aziz et al., 2017 and Aggarwal et al., 2019).

Contradictions limit generalizability: insignificant in Saudi Arabia and Indonesia, where morals, policy, and economics dominate (Makki et al., 2020 and Norwidina et al., 2021). Effects vary by culture, norms integration, personality (openness/conscientiousness), and interaction quality fostering environmental values (Wolske et al., 2020; Kurniawan et al., 2025). Peer effects enhance but depend on context, not acting independently. Accordingly, the following hypothesis is developed.

H5: Peer influence positively influences Egyptian households' intentions to adopt solar energy technology.

2.7 Public Media Influence

Mass media such as radio, TV, print, and internet—shapes public awareness and behavior toward solar technologies, especially in low-education areas, fostering positive household attitudes via information dissemination (Zeru et al., 2021; Romeo, 2016; Nzamba, 2004). Integrated campaigns motivate adoption, enhance observability through real-life examples, and indirectly boost attitudes via environmental and normative messaging (Zeru et al., 2021; Pathania et al., 2017). Limitations persist where insignificant effects on pleasurability, green behaviors, efficacy, or intentions in some studies, rendering it weak or indirect (Koo et al., 2016; Bieniek-Tobasco, 2019). It supports rather than drives, amplifying best with incentives, demos, education, and peer leadership (Mularczyk et al., 2022; Simpson, 2017).

Media excels contextually in integrated strategies emphasizing visibility, cultural fit, and synergy with education, finance, word-of-mouth, and local champions. Standalone, it often falls short. Accordingly, the following hypothesis is developed.

H6: Public media influence positively influences Egyptian households' intentions to adopt solar energy technology.

2.8 Demographic Factors (Age and Income Level)

a) Age:

Age and generational cohorts yield mixed impacts on renewable energy adoption, with younger groups often linked to higher uptake due to tech familiarity and green inclinations, while older ones leverage financial stability like pensions or home ownership (Shakeel et al., 2023; Willis et al., 2011).

Contradictions abound when some studies show no age significance, as in Indian millennial solar approval (Agarwal et al., 2023); Generation Z and millennials exhibit strong climate awareness yet inconsistent adoption (Arshad et al., 2021; Zahari et al., 2016; Severo et al., 2017). Baby boomers hold high environmental values but not always higher green purchases, and those over 65 resist due to risk aversion and complexity (Squire, 2019; Willis et al., 2011).

Age proxies mediate factors like finances, ownership, tech openness, payback horizons, and norms, varying culturally. Strategies should target enablers and barriers across life stages, not demographics alone, addressing youth enthusiasm alongside practical hurdles. Accordingly, the following hypothesis is developed.

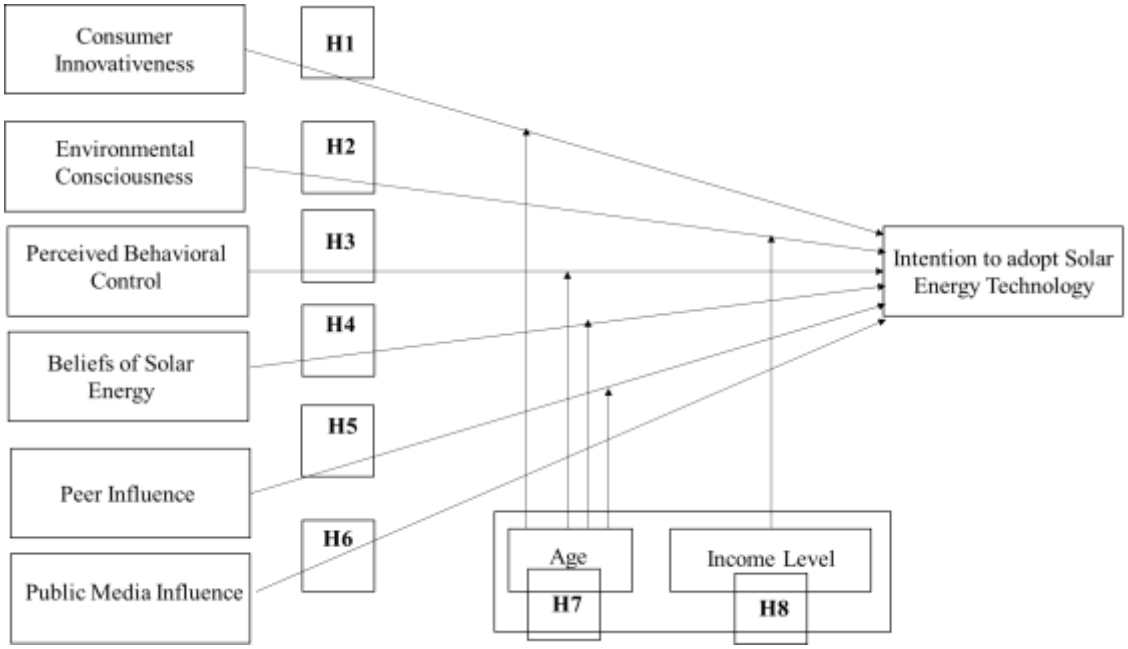
H7: Age positively influences Egyptian households' intentions to adopt solar energy technology.

b) Income Levels

Household income strongly correlates with renewable energy adoption, especially solar photovoltaics, as higher earnings enable upfront investments like PV systems. Studies in Ethiopia, Seychelles, and macro-level data confirm higher-income households adopt more readily, linking per capita GDP positively to green infrastructure in middle/high-income nations (Guta, 2018; Etongo et al., 2022; Twumas et al., 2022; Ergun et al., 2023). Income boosts readiness for premiums and instant electricity via sustainable tech (Bouaguel et al., 2024).

Contradictions arise when insignificant or negative links emerge in Malaysia regarding solar intentions (Abdul Aziz et al., 2017; Bouaguel et al., 2024), and low- and moderate-income groups in multi-unit buildings adopt more due to long-term savings sensitivity (Bashiri et al., 2018). In low-income countries, GDP growth may even reduce renewables by increasing reliance on fossil fuels (Ergun et al., 2023).

Income mediates via motivations such as environmental ethics for high earners, savings/security for low earners, plus policies (grants, LMI programs), housing types, and youth values less bound by finances (Bashiri et al., 2018; Miller, 2021). It enables but does not guarantee adoption; strategies must tailor drives across levels



to convert it from a barrier to an enabler. Accordingly, the following hypothesis is developed. **H8: Income levels positively influence Egyptian households' intentions to adopt solar energy technology.**

The conceptual framework

3. Research Design and Data Collection

This study employs a descriptive, deductive quantitative approach rooted in positivism, testing hypotheses from established theory via survey data and statistical analysis. Data were collected through self-administered

questionnaires ideal for assessing consumer behavior and demographics. The cross-sectional study targets urban Egyptian households (Cairo and Giza) with solar adoption potential, using convenience non-probability sampling due to population size and frame unavailability. A 253-responder sample exceeds the PLS-SEM minimum (180, based on 18 paths × 10 EPV rule) for reliable estimates (Peduzzi et al., 1996; Hair et al., 2009).

Key constructs are consumer innovativeness, environmental consciousness, perceived behavioral control, beliefs, peer influence, public media influence, and adoption intention, measured using 5-point Likert scales (1=strongly disagree to 5=strongly agree); socio-demographics (age, gender, income, education) are measured using nominal scales. An online survey adapts validated scales from the literature, translates them into Arabic for accessibility, and ends with demographic questions. 253 questionnaires distributed via WhatsApp to Cairo/Giza residents yielded completed responses from November 1 to December 7, 2025.

4. Results

The results of the statistical analyses indicated that the measurement instrument demonstrated satisfactory psychometric properties. The validity test using Exploratory Factor Analysis (EFA) confirmed a clear factor structure, with all items loading significantly on their intended constructs and no problematic cross-loadings, indicating good construct validity. The reliability test using Cronbach's alpha showed high internal consistency, as all scales exceeded the commonly accepted threshold, confirming the stability and coherence of the items within each construct. In addition, the normality test revealed that the data distribution fell within acceptable limits, supporting the suitability of parametric analyses. Overall, these findings suggest that the instrument is both valid and reliable, and that the data meet the assumptions required for subsequent statistical testing. To examine the moderating effects, moderation analysis was conducted using hierarchical multiple regression analysis.

Hypotheses Testing Results (H1–H8)

This study examined the determinants of Egyptian households' intention to adopt solar energy technology using simple regression and moderation analyses. Six independent variables were tested for direct effects (H1–H6), followed by the moderating roles of age (H7) and income level (H8).

Direct Effects (H1–H6)

Consumer Innovativeness (H1)

Simple regression analysis showed that consumer innovativeness has a positive and statistically significant effect on adoption intention ($\beta = 0.338$, $t = 4.960$, $p < 0.001$). The model was significant ($F = 24.61$, $p < 0.001$), explaining 8.9% of the variance ($R^2 = 0.089$; $R = 0.298$). This indicates that more innovative households are more willing to adopt solar energy technology, although the explanatory power is modest. Hypothesis 1 is supported.

Environmental Consciousness (H2)

Environmental consciousness demonstrated a stronger positive effect ($\beta = 0.701$, $t = 7.398$, $p < 0.001$). The regression model was highly significant ($F = 54.73$, $p < 0.001$) and explained 17.9% of the variance ($R^2 = 0.179$; $R = 0.423$). This finding highlights environmental concern as a major motivator for adoption decisions. Hypothesis 2 is supported.

Perceived Behavioral Control (H3)

Perceived behavioral control emerged as one of the strongest predictors ($\beta = 0.798$, $t = 13.133$, $p < 0.001$). The model showed very high explanatory power ($F = 172.50$, $p < 0.001$), accounting for 40.7% of variance ($R^2 = 0.407$; $R = 0.638$). Households that feel capable of adopting solar technology—financially, technically, and logistically—are far more likely to intend adoption. Hypothesis 3 is supported.

Beliefs about Solar Energy (H4)

Positive beliefs regarding solar energy benefits, efficiency, and reliability also showed a strong effect ($\beta = 0.836$, $t = 11.147$, $p < 0.001$). The model explained 33.1% of variance ($R^2 = 0.331$; $F = 124.26$, $p < 0.001$). This confirms beliefs as a key cognitive driver of adoption. Hypothesis 4 is supported.

Peer Influence (H5)

Peer influence significantly affected adoption intention ($\beta = 0.613$, $t = 8.280$, $p < 0.001$), explaining 21.3% of the variance ($R^2 = 0.213$; $F = 68.56$, $p < 0.001$). Social norms, recommendations, and shared experiences play an important role in shaping decisions. Hypothesis 5 is supported.

Public Media Influence (H6)

Public media influence also had a significant positive effect ($\beta = 0.571$, $t = 8.515$, $p < 0.001$), explaining 22.6% of the variance ($R^2 = 0.226$; $F = 72.52$, $p < 0.001$). Exposure to media information enhances awareness and favorable attitudes toward solar adoption. Hypothesis 6 is supported.

All six determinants significantly influence adoption intention. Ranked by explanatory power (R^2), the strongest predictors are: Perceived Behavioral Control (0.407), Beliefs about Solar Energy (0.331), Public Media Influence (0.226), Peer Influence (0.213), Environmental Consciousness (0.179), Consumer Innovativeness (0.089)

Moderating Role of Age (H7)

Age did not moderate the effects of Consumer Innovativeness

($\beta = -0.066$, $p = 0.566$; $R^2 = 0.091$),

Age significantly strengthened the effects of Perceived Behavioral Control about Solar Energy Interaction: $\beta = 0.267$, $t = 3.471$, $p = 0.001$; $R^2 = 0.435$

Older individuals show stronger adoption intentions when they feel capable of adopting solar technology.

Age significantly strengthened the effects of Beliefs about Solar Energy Interaction: $\beta = 0.184$, $t = 2.206$, $p = 0.028$; $R^2 = 0.321$

Positive beliefs become more influential with increasing age.

Age significantly strengthened the effects of Peer Influence about Solar Energy Interaction:

$\beta = 0.156$, $t = 2.039$, $p = 0.043$; $R^2 = 0.355$. Older individuals rely more on social confirmation and peer experiences. Importantly, age had no significant direct effect on intention in any model, indicating a conditional (moderating) rather than independent role.

Moderating Role of Income Level (H8) with Environmental Consciousness about Solar Energy Interaction:

$\beta = -0.164$, $t = -2.179$, $p = 0.030$; $R^2 = 0.195$. Income significantly moderates this relationship, but negatively. Environmental concern has a stronger effect on adoption intention among lower- and middle-income households, likely because these groups are more sensitive to long-term cost savings and efficiency benefits. As income increases, the relative influence of environmental concern decreases, with wealthier households considering additional lifestyle or convenience factors. Income level itself showed no significant direct effect on adoption intention in any model.

5. Discussion

The findings of this study demonstrate that the intention to adopt solar energy technology among Egyptian households is driven by a synergistic blend of psychological traits, cognitive beliefs, and social pressures. Specifically, Consumer Innovativeness (H1), Environmental Consciousness (H2), Perceived Behavioral Control (H3), and Beliefs of Solar Energy (H4) all emerged as significant positive predictors, suggesting that households are most likely to adopt when they possess a natural inclination toward novelty, a strong ethical commitment to the environment, and a sense of technical and financial capability. Furthermore, the roles of Peer Influence (H5) and Public Media Influence (H6) underscore the importance of social proof and information dissemination in normalizing renewable energy within the Egyptian cultural context.

The moderation analysis reveals a sophisticated layer of demographic influence, particularly regarding Age (H7) and Income Level (H8). While age does not alter the impact of innovativeness, on the other hand, it significantly strengthens the relationship between adoption intention and factors such as perceived control, solar beliefs, and peer recommendations; this indicates that older consumers rely more heavily on stability, rational utility, and community validation. Conversely, the study found a unique negative moderation effect for income on the relationship between environmental consciousness and adoption intention. This suggests that for lower-to-middle-income households, environmental concern is more intensely linked to the practical necessity of long-term efficiency and cost savings, whereas higher-income households may prioritize a broader array of factors such as status or lifestyle convenience. Ultimately, these results indicate that solar adoption in Egypt is not a uniform process, but rather a conditional one where demographic variables act as proxies for different life stages, financial priorities, and social needs.

6. Implications

This study offers actionable implications for stakeholders to boost solar energy adoption among Egyptian households by addressing economic barriers through targeted subsidies, green financing, and regulatory clarity from policymakers and financial institutions. Energy companies can leverage market segmentation and awareness campaigns emphasizing cost savings and reliability, while fostering community resilience and job creation to align with national sustainability goals.

6.2.1 Public Policy Implications

Policymakers should implement targeted financial incentives like subsidies, low-interest loans, and installment plans to ease upfront costs for middle- and low-income Egyptian households. Expanding net-metering and clear regulations would boost consumer confidence, while awareness campaigns highlight benefits and trust in solar systems. Public-private partnerships can accelerate residential solar scaling.

6.2.2 Energy Companies and Marketers

Energy firms and marketers should segment audiences by income, environmental awareness, and innovativeness to tailor outreach. Promotional messaging must stress long-term savings and energy independence, paired with flexible financing and maintenance packages to lower perceived risks. Building credibility via certifications and transparent performance data enhances appeal.

6.2.3 Financial Institutions

Financial institutions can develop green loans customized for household solar adoption and partner with providers for bundled financing solutions.

6.2.4 Community and Sustainability Benefits

Solar adoption strengthens community resilience by cutting reliance on conventional energy, aligning with Egypt's renewable transition and sustainability goals. It spurs local jobs in installation, maintenance, and manufacturing, bridging awareness to implementation by tackling economic, psychological, and structural barriers.

7. Study Limitions and Future Directions

While this study offers valuable insights into why Egyptian families consider solar energy, it does have some limitations that point toward new areas for future study. First, this research measured intentions (what people plan to do) rather than actual actions (buying and installing the panels). Sometimes, life gets in the way of even the best intentions due to high costs or complicated paperwork. Future studies should follow households over a longer period to see how many actually follow through with their plans.

Second, the study did not fully compare the differences between city and countryside living. Families in Cairo might face different challenges such as living in apartment buildings with shared roofs compared to those in rural areas who might have more space but less ready cash. Future research should look specifically at how location changes a household's ability to go solar.

Third, while we looked at age and income, other factors for instance, owning versus renting a home and government solar subsidies were not explored in detail. Knowing if someone actually owns their roof is a huge factor in whether they can install solar panels. Future work should also investigate how specific government "green loans" or rewards might help people feel more in control of the process.

Finally, because this study used surveys, people might have answered in a way that makes them look more environmentally friendly than they really are. Future research could use real-world data, like electricity bills or local installation records, to get a more accurate picture. Adding "perceived risk" which is the fear that the technology might break or lose money as a factor could also help explain why even the most "innovative" people sometimes hesitate to make the switch.

8. Conclusions

This study concludes that the intention to adopt solar energy technology among Egyptian households is a multifaceted process driven by a combination of personal innovativeness, environmental ethics, and a strong sense of practical capability. Grounded in the Theory of Planned Behavior, the empirical evidence confirms that while psychological factors like Consumer Innovativeness and Environmental Consciousness create a foundation for green interest, the most critical "trigger" for adoption in the Egyptian context is Perceived Behavioral Control. Essentially, households are most likely to move forward when they feel they have the necessary knowledge, financial resources, and technical support to manage the transition. Furthermore, the significant role of Peer Influence and Public Media Influence suggests that solar energy is as much a social and informational phenomenon as it is a technological one; seeing the technology work for others effectively reduces the perceived risk for potential adopters.

The study further highlights that demographic factors such as Age and Income do not act as simple barriers, but rather as "filters" that change how people weigh their options. Older individuals place a much higher value on social confirmation, technical stability, and rational utility. In contrast, the unique negative moderation of income on environmental consciousness reveals that for lower-to-middle-income Egyptian households, "being green" is deeply tied to the practical necessity of long-term efficiency and cost savings. These nuances prove that a "one-size-fits-all" approach to Egypt's renewable transition will be ineffective. Instead, success depends on targeted strategies—such as "green loans" for the budget-conscious and community-led demonstrations for the risk-averse—to bridge the gap between Egypt's vast solar potential and actual household implementation.

Declarations

In accordance with academic and institutional standards at ESLSCA University, the following declarations are made regarding this research:

Data Availability Statement

The raw data supporting the conclusions of this article (253 survey responses) are available from the corresponding author, Rehab Mohamed Abdel Hamid Masoud, upon reasonable request. The data are stored in a secure, anonymized format to protect the privacy of the participants in Cairo and Giza.

Author Contributions

Rehab Mohamed Abdel Hamid Masoud is the sole author of this study, responsible for the conceptualization, methodology, data collection via WhatsApp/Online survey, statistical analysis using SPSS and AMOS, and the final writing of the manuscript.

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