

Factors affecting Household Intention to Use Solar Photovoltaic Technology in Selangor Malaysia

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Abstract

This paper examines factors influencing households' intentions to adopt solar photovoltaic (PV) technology in Selangor, Malaysia, supporting the national goal of 20% renewable energy by 2025. Using the Technology Acceptance Model (TAM), it analyzes attitudes toward perceived ease of use and usefulness. The model is extended to include relative advantages, environmental awareness, cost, and government initiatives. Data from 150 non-solar users, analyzed with Partial Least Squares Structural Equation Modeling (PLS-SEM), shows limited public awareness as a key barrier. Findings highlight the need for targeted education, cost policies, and interventions to enhance adoption and support Malaysia's renewable energy transition.

Keywords: Solar Photovoltaic; Renewable Energy; Sustainable; Awareness;

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1.0 Introduction

The adoption of renewable energy technologies is critical to addressing global climate challenges and achieving sustainable development goals. In Malaysia, the government has set an ambitious target of 20% renewable energy in its electricity generation mix by 2025, with solar photovoltaic (PV) systems playing a pivotal role (Salleh et al., 2024). Solar PV technology, leveraging Malaysia's abundant solar irradiation, has gained traction through initiatives such as the Large-Scale Solar (LSS) program and the Net Energy Metering (NEM) scheme. Despite these efforts, the adoption of solar PV systems, particularly among residential and small-scale users, has not yet reached its full potential. Understanding the factors influencing technology acceptance is essential to accelerating the adoption of solar PV.

The need for Malaysians to adopt solar panels is underscored by several compelling factors, including environmental sustainability, economic benefits, and the country's favorable climatic conditions for solar energy generation (Alkawsu et al., 2024). Firstly, Malaysia's geographical location near the equator provides it with abundant solar irradiance, averaging between 4.7 to 6.5 kWh/m² daily Vaka et al. (2020). This high level of solar radiation makes solar panels a viable and efficient energy source. The potential for solar energy utilization is significant, as solar photovoltaic (PV) systems can convert sunlight into electricity, contributing to the country's energy needs

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while reducing reliance on fossil fuels (Izam et. al., 2022). The Malaysian government has recognized this potential, setting ambitious targets to increase the share of renewable energy in the national energy mix, aiming for 23% by 2025 (Ilham et al., 2022).

The environmental benefits of solar energy are substantial. Solar panels produce clean, renewable energy that does not emit greenhouse gases during operation, thus helping to mitigate climate change (Hamid et al., 2022). The transition to solar energy can significantly reduce Malaysia's carbon footprint, as it is estimated that one square meter of solar panel can lead to a reduction of approximately 40 kg of CO₂ emissions annually (Khorasanizadeh et al., 2015). This aligns with global efforts to combat climate change and promotes a sustainable energy future.

Economic considerations also play a crucial role in the adoption of solar panels. The implementation of government incentives, such as the Feed-in Tariff (FiT) scheme, has encouraged the installation of solar PV systems by allowing homeowners and businesses to sell excess electricity back to the grid. This not only provides a potential income stream for solar panel owners but also contributes to energy security and stability in electricity prices. Moreover, the decreasing cost of solar technology makes it increasingly accessible for Malaysians, enhancing the feasibility of solar energy adoption (Sarker, 2023).

Public awareness and education regarding solar energy's benefits are essential for increasing adoption rates and this is the aim of this research. This aim also lead to objective on this research to analyse factors effecting Selangor's household intention to use solar panel as part of research finding to see level of acceptance on solar panel in Malaysia.

2.0 Literature Review

The Technology Acceptance Model (TAM) is a widely recognized framework for understanding user acceptance of technology, particularly in the context of information systems and digital services. This model posits that two primary factors—perceived usefulness (PU) and perceived ease of use (PEOU)—significantly influence users' attitudes toward technology, which in turn affect their behavioral intentions to use it and actual usage behavior (Husain et. al., 2025). The foundational premise of TAM is derived from the Theory of Reasoned Action (TRA), which emphasizes the role of beliefs and attitudes in shaping intentions and behaviors (Syarwani & Yuliana, 2022;).

The Technology Acceptance Model (TAM) has been extensively validated across various domains, including education, e-commerce, and mobile applications, demonstrating its robustness and adaptability. Recent studies have continued to affirm the model's relevance, particularly in the context of mobile health applications, where perceived ease of use and perceived usefulness remain critical factors influencing user acceptance. For instance, Nadal et al. conducted a scoping review that highlighted the application of TAM in mobile health, noting that additional context-related constructs were integrated to enhance the model's applicability in specific scenarios, such as telemedicine and mHealth (Nadal et al., 2020). Similarly, Saare et al. found that among older adults in Iraq, perceived ease of use significantly impacted their intention to adopt mobile health applications, reinforcing the importance of TAM in understanding user behavior in this demographic (Saare et al., 2019).

Moreover, the adaptability of TAM has been further illustrated in the e-commerce sector, where researchers have expanded the model to include variables such as trust and perceived risk. Çelik and Özköse's investigation into mobile banking applications revealed that by incorporating these additional factors, the extended TAM could explain approximately 78% of the variance in users' behavioral intentions, significantly enhancing the model's predictive power compared to the original TAM, which typically accounts for around 40% (Çelik & Özköse, 2023). This extension of TAM to include trust and perceived risk is crucial, especially in environments where user confidence is paramount for technology adoption.

Empirical evidence supports the assertion that TAM effectively predicts user acceptance across various technologies. For example, Hardiyanto et al. applied an extended TAM to analyze the adoption of mobile business applications among culinary SMEs in Indonesia, demonstrating the model's robustness in different contexts (Hardiyanto et al., 2022). Furthermore, the model's simplicity and clarity continue to make it an attractive choice for researchers and practitioners. Lavidas et al. emphasized that TAM remains a robust framework with good predictive capabilities across diverse settings, including learning management systems (Lavidas et al., 2022). This adaptability is essential for researchers aiming to enhance user engagement with new technologies

2.1 Perceived ease of use and perceived usefulness

Perceived ease of use and perceived usefulness are foundational constructs in the Technology Acceptance Model (TAM), which posits that these perceptions directly influence users' attitudes toward technology adoption. Studies have shown that when consumers perceive solar PV systems as easy to use and beneficial, their intention to adopt such technologies increases significantly (Bouaguel & Alsulimani, 2022). For instance, Bouaguel and Alsulimani highlight that perceived usefulness and ease of use are critical factors influencing consumer intentions to shift to solar energy technology (Bouaguel & Alsulimani, 2022).

Hypothesis 1: Perceived ease of use has significant positive affect on intention use of Solar PV

Hypothesis 2: Perceived usefulness has significant positive affect on intention use of Solar PV

2.2 Relative advantage

Relative advantages, defined as the perceived benefits of solar PV over traditional energy sources, also significantly impact consumer attitudes. Research indicates that when consumers recognize the advantages of solar energy—such as cost savings and environmental benefits—they are more likely to develop a positive attitude toward its adoption (Pathania et al., 2017). Alam and Rashid's study supports this by demonstrating that relative advantages positively attitudes towards renewable energy, which in turn influences the intention to

use (Alam & Rashid, 2012). Furthermore, the findings from Kumar et al. emphasize that perceived benefits, including compatibility and government incentives, significantly affect the intention to adopt solar-powered systems (Kumar et al., 2020).

Hypothesis 3: Relative advantage has a significant positive effect on the intention to use Solar PV.

2.3 Environmental awareness

Environmental awareness is another critical factor influencing attitudes toward solar PV adoption. Increased awareness of environmental issues correlates with a greater intention to adopt renewable energy technologies. For example, Huang and Cheng found that ecological lifestyles and consumer innovativeness, which are closely tied to environmental awareness, significantly impact attitudes toward solar installations (Huang & Cheng, 2022). This aligns with the findings of Akinola, who noted that awareness campaigns can enhance consumer understanding of solar technology benefits, thereby fostering a more favourable attitude toward its adoption (Akinola, 2023).

Hypothesis 4: Environmental awareness has a significant positive effect on the intention to use Solar PV.

2.4 Cost Installation Solar PV

Cost considerations are a critical factor influencing attitudes toward the adoption of solar photovoltaic (PV) systems. High upfront costs associated with purchasing and installing solar PV technology often present a significant barrier, particularly for low- to middle-income households. These financial constraints can deter potential adopters, despite the long-term economic benefits offered by solar energy. However, government initiatives designed to reduce these costs, such as subsidies, tax incentives, and financing schemes, have demonstrated the ability to significantly enhance consumer adoption intentions (Atulkar, 2022). These policy measures not only lower the initial financial burden but also increase the perceived affordability and attractiveness of solar PV systems, thereby motivating households to consider transitioning to renewable energy.

Empirical studies support the critical role of financial support mechanisms in shaping consumer attitudes. Research by Bektı et al. (2021) highlights that price value has a substantial positive relationship with attitudes toward solar PV use, indicating that consumers place significant importance on the perceived financial returns and cost-effectiveness of the technology. Financial incentives, such as those offered through Malaysia's Green Technology Financing Scheme (GTFS), provide tangible benefits that make solar PV systems more accessible and appealing. Additionally, Ndiwe (2023) emphasizes that a lack of awareness about government subsidies and financial support mechanisms remains a considerable barrier to adoption. This finding underscores the need for effective communication strategies to raise public awareness about available incentives, ensuring that households can make informed decisions.

Hypothesis 5: Cost has a significant negative effect on the intention to use Solar PV.

2.5 Government initiatives

Government initiatives are pivotal in driving the adoption of solar photovoltaic (PV) technologies by creating an enabling environment that facilitates consumer transition to renewable energy. Policies such as subsidies, tax rebates, and financing programs effectively lower financial and logistical barriers, making solar PV systems more accessible to households and businesses. Research underscores the significant impact of such initiatives on consumer attitudes and intentions to adopt solar technologies. For instance, Huang and Cheng (2022) highlight that well-designed government incentives can positively shape perceptions of solar PV, fostering higher adoption rates. This research demonstrates that policy support significantly influences behavioral intentions by reducing perceived risks and enhancing the economic viability of solar energy systems.

In addition to financial incentives, public engagement and awareness campaigns play an essential role in complementing government policies. Wuebben and Peters (2022) emphasize the importance of integrating policy measures with efforts to promote solar prosumerism, where consumers actively participate in energy production. By fostering a sense of ownership and involvement, such campaigns can enhance consumer willingness to invest in solar technologies. For example, community outreach programs that highlight the environmental and economic benefits of solar energy can address common misconceptions and build trust in renewable energy solutions. This dual approach—combining financial incentives with public engagement—ensures that government initiatives not only address economic barriers but also cultivate a broader cultural shift toward sustainable energy practices.

Hypothesis 6: Government initiatives have a significant positive effect on the intention to use Solar PV.

Analysis on factors perceived ease of use, perceived usefulness, relative advantages, environmental awareness, cost considerations, and government initiatives significantly shapes consumer attitudes toward the intention to use solar photovoltaic systems. These factors collectively create a framework that explains how consumers perceive and respond to solar PV technologies, offering valuable insights into the mechanisms driving adoption. Analyzing these relationships provides an in-depth understanding of their interdependencies, enabling the formulation of targeted strategies to effectively promote solar energy adoption.

3.0 Methodology

This research will use Partial Least Squares Structural Equation Modeling 4.0 (PLS-SEM 4.0) to analyze the collected data and evaluate the relationships between key factors influencing the intention to adopt solar photovoltaic (PV) systems among households in Selangor. The study specifically examines the effect of perceived ease of use (PEOU), perceived usefulness (PU), relative advantages, environmental awareness, cost, and government initiatives on consumer intentions. By utilizing PLS-SEM, the research aims to test the significance relationship of these factors within a theoretical framework, providing robust insights into their contributions to shaping adoption behaviors.

The focus on households in Selangor is significant due to the region's substantial potential for solar energy adoption and its alignment with national renewable energy goals since Selangor is having highest population households in Malaysia (Data of statistics Malaysia, 2024). The adoption of PLS-SEM is justified by its suitability for exploring complex relationships among latent variables and its ability to handle constructs measured with multiple indicators. This methodological approach enables the study to identify the direct and indirect effects of the identified factors, offering a comprehensive understanding of how these elements collectively influence the behavioral intention to adopt solar PV systems. The findings will contribute to developing targeted strategies to enhance solar PV adoption in Selangor and similar regions. Figure 1 are the research framework adopted from Bilal et. al., (2023) and content of the variables Perceive ease of use, perceived usefulness, environmental awareness, relative advantage, cost and government initiatives as factors to be test on intention to use Solar PV on household in Selangor, Malaysia.

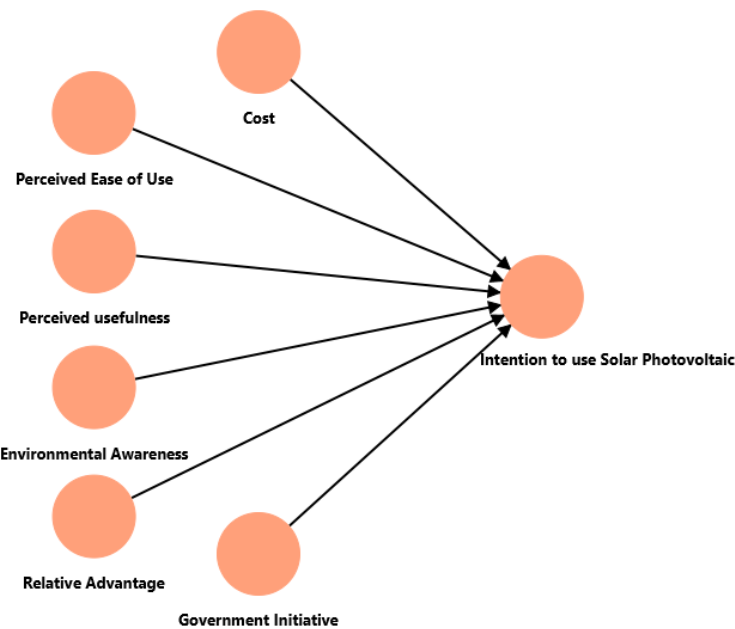


Fig. 1: Conceptual Research Framework

This study adopts a convenience non-probability sampling method, focusing on data collected from the public housing sector in the Selangor region. To reach a broader audience, an online survey was selected as the primary data collection method. The survey was administered using Google Forms, with settings configured to limit responses to one per participant. This feature ensured the independence of the data by preventing respondents from submitting multiple entries. Online surveys were preferred over face-to-face methods, as they are less intrusive and allow respondents to complete the questionnaire at their convenience, thereby improving response quality and reducing potential biases associated with time constraints or social pressure during in-person interactions.

The survey was designed in two sections. The first section captured participants' sociodemographic information (details provided in Table 1), offering insights into the characteristics of the sampled population. The second section comprised items related to the study model's variables, including perceived ease of use, perceived usefulness, relative advantages, environmental awareness, cost considerations, and government initiatives (table 2). Responses were recorded using a seven-point Likert scale, ranging from 1 ("Strongly Disagree") to 7 ("Strongly Agree"), allowing for a nuanced measurement of participants' perceptions and attitudes. This approach ensured the collection of comprehensive and reliable data for subsequent analysis.

Table 1. Sociodemographic characteristic

Attributes	Modalities
Gender	Female
	Male
Age	18-25
	26-33
	34-41
	42-49
	50 and above
Occupation	Unemployed
	Self-employed
	Public Sector employee
	Private Sector employee
	Others
Marital Status	Married
	Single
	Other

Yearly Income (In Ringgit Malaysia)	1,500-10,000 10,001-20,000 20,001-30,000 30,0001 and above
Accommodation type	Apartment Double storey Single storey Others
Accommodation Ownership	Owner Rental Others

Table 2. Factors description for the study model's variables.

Variables	Factors
Perceived ease of use	PEOU1 PEOU2 PEOU3 PEOU4
Perceived usefulness	PU1 PU2 PU3 PU4 PU5
Costs	C1 C2 C3
Environmental awareness	EA1 EA2 EA3
Relative advantage	RA1 RA2 RA3
Intention to use solar Photovoltaic	ITU1 ITU2

4.0 Discussion

The adoption of solar photovoltaic (PV) technology in Selangor represents both opportunities and challenges in Malaysia's transition toward renewable energy. This conceptual paper explores the key determinants influencing household intentions to adopt solar PV systems, using the Extension Technology Acceptance Model (TAM) as a theoretical framework. The study identifies perceived ease of use (PEOU), perceived usefulness (PU), relative advantages, environmental awareness, cost considerations, and government initiatives as critical constructs shaping adoption behaviors.

Perceived ease of use (PEOU) is a fundamental factor in reducing barriers to solar PV adoption. When households perceive the technology as simple to understand, install, and maintain, their willingness to adopt increases. Similarly, perceived usefulness (PU), emphasizing the economic and environmental benefits of solar PV, fosters positive attitudes toward adoption. Households that recognize long-term cost savings and the contribution to environmental sustainability are more likely to consider solar PV as a viable energy source. These constructs align with prior research, suggesting that ease of use and perceived benefits enhance technology acceptance.

Relative advantages, such as cost-effectiveness and energy independence, further strengthen the case for solar PV adoption. These advantages position solar energy as a superior alternative to conventional electricity sources and address concerns over rising energy costs. Additionally, increasing environmental awareness plays a crucial role in adoption decisions, as households acknowledge the significance of renewable energy in mitigating climate change and reducing carbon footprints. Public campaigns and community engagement initiatives can enhance awareness and cultivate a culture of sustainability.

Despite these drivers, cost considerations remain a substantial barrier. Although solar PV system prices are declining, the initial investment required may deter adoption, particularly among lower-income households. Government initiatives, including subsidies, tax incentives, and financing programs, play a pivotal role in mitigating these costs. Policies such as the Green Technology Financing Scheme (GTFS) and the Net Energy Metering (NEM) initiative offer economic incentives and reduce financial risks for potential adopters, emphasizing the necessity of policy interventions in fostering a supportive adoption environment.

Implication by addressing knowledge gaps through targeted educational campaigns can empower consumers to make informed decisions regarding solar PV adoption. In conclusion, Malaysia's transition to solar energy is driven by its abundant solar resources, the environmental benefits of renewable energy, and government-backed economic incentives. As the country strives for energy sustainability, increasing solar technology adoption will be essential in achieving energy independence and reducing greenhouse gas emissions. This conceptual paper underscores the importance of integrating policy support, technological innovation, and public awareness to facilitate a successful energy transition.

5.0 Conclusion

This study is conceptual paper lead idea on examines the factors influencing solar photovoltaic (PV) adoption in Selangor, Malaysia, using the Technology Acceptance Model (TAM). Findings highlight psychological, economic, and structural factors shaping household intentions. Perceived ease of use and usefulness influence individual attitudes, while relative advantages, environmental awareness, and government initiatives foster adoption. Addressing cost considerations remains crucial, underscoring the need for targeted policy interventions and financial support.

As Malaysia aims for a 20% renewable energy target by 2025, promoting solar PV adoption is vital. Increasing public awareness through education and engagement can empower households to make informed decisions. Technological advancements and policy measures must address cost and accessibility barriers. Expanding financing options, offering incentives for residential installations, and improving public understanding of government support programs can enhance adoption.

This study's focus on Selangor Malaysia's most populous state offers a replicable model for other regions. Policymakers can develop strategies tailored to specific demographic and geographic contexts, contributing to Malaysia's renewable energy goals and reinforcing its leadership in sustainable energy transitions within Southeast Asia.

However, limitations exist. Due to time constraints, data collection was limited to Selangor, restricting a broader analysis. Future research should expand to other states for a more representative dataset. Logistical and resource constraints precluded in-depth qualitative analysis, which could have provided deeper insights. Additionally, factors such as policy changes, economic fluctuations, and technological advancements may affect long-term applicability.

Advancing solar PV adoption requires integrating education, policy, and innovation. Collaboration among stakeholders' government, industry, and communities is essential. By addressing barriers and leveraging drivers, Malaysia can progress toward a sustainable energy future, reduce greenhouse gas emissions, and enhance energy security. This study lays the foundation for further research and policy initiatives in renewable energy adoption.

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