Concerns Affecting the Decision-Making Process for Installing Residential Solar PV Rooftop Systems in Thailand

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ABSTRACT

This study investigates concerns influencing the decision-making process for installing solar rooftop systems up to 10 kW in Thailand and the role of insurance in mitigating these concerns. Using an online survey of 118 residents with purposive sampling, statistical analyses, including ANOVA, identify key demographic and experiential factors affecting perceptions. Results show that age ($p = 0.014$), occupation ($p = 0.004$), and prior experience with solar systems ($p = 0.001$) significantly influence concerns. Younger respondents (44.9%) prioritize long-term benefits, while older individuals emphasize reliability. Occupation impacts confidence, with private-sector employees (44.9%) showing higher concern levels. Notably, respondents with over three years of solar experience (26.3%) report fewer apprehensions. The education level ($p = 0.065$), average household income ($p = 0.664$), and region of installation ($p = 0.368$) are not statistically significant, reflecting universal challenges such as system cost, maintenance, and safety. Financial risks, including potential repair costs and uncertainties during system operation, were commonly cited concerns. Insurance tailored for solar rooftop systems, particularly for components like repair coverage, replacement guarantees, and extended warranties, emerged as a potential solution to alleviate these worries and build consumer confidence. The findings underscore the importance of insurance products addressing installation risks and operational uncertainties to support Thailand's renewable energy adoption goals.

1. INTRODUCTION

Investing in the renewable energy sector, especially in producing electricity from solar panels, is a good option for generating energy [1, 2] and income and promoting understanding of renewable energy in Thailand [3]. The Ministry of Energy has a policy to promote renewable energy, particularly the production of electricity from photovoltaic (PV) systems, which has led to several entrepreneurs investing in establishing solar panel factories to meet the increasing demand in the country [4, 5]. Entrepreneurs interested in the renewable energy sector, especially in the PV business, must learn PV system design principles and applications in industry and daily life. This promotes using alternative energy sources, which can help reduce expenses for individuals and organizations. Furthermore, it trains personnel to acquire knowledge and skills in applying PV systems for their utilization [6, 7]. Additionally, it can create jobs and career opportunities for new entrepreneurs, enhance existing businesses, and compete effectively [8, 9].

The development of the PV business in Thailand also requires the creation of fundamental knowledge [3] and understanding of solar cell business operations, sound business planning, investment strategies, financial support, the development of new technologies, installation, system deployment, and maintenance, as well as addressing challenges and having close contact with successful experiences in the PV industry [10]. Training and education for individuals or entities interested in owning and operating PV businesses is essential. A growing number of dedicated entrepreneurs aspire to enter the solar energy business, and this trend is expected to continue. Therefore, those interested in the company above should emphasize the PV system. This is because most of the population has behavior patterns in decision-making regarding installing PV systems, and some reasons influence people's decisions to install or not install PV systems. What factors lead consumers to install PV systems, ultimately leading to investment [11, 12]. There is an increasing demand for installing PV systems on roofs and various buildings [5, 10]. Thailand has the potential for solar radiation for all solar rooftop system sizes, especially in the central region [13]. However, concerns about the impact of these installations, particularly in terms of electrical issues and potential house fires, as well as the

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maintenance required to ensure the system's efficiency, continue to exist. Financial risk is also one of the key concerns for rooftop solar PV investment in Thailand, arising from unfavorable loan terms, repayment-focused lenders, and volatile exchange rates [14] and concern for operational issues that arise after the adoption [15]. These concerns affect decision-making, leading some homeowners not to install solar PV rooftop systems [16-23]. Solar rooftop system insurance is another option to help alleviate these concerns and encourage homeowners to install solar rooftop systems. No companies have ventured into this area, meaning installers' concerns persist.

From the issues above, this research investigates the concerns affecting the decision to install residential solar PV rooftop systems with a capacity of up to 10 kW. This capacity installed is proposed by the Energy Regulatory Commission (ERC) and approved and announced for the purchase of electricity production for the residential sector, which has been continuous since 2013 [5] and from 2021 to 2030, with an annual target of 10 MW [24]. The objective is to explore the concerns and challenges associated with solar rooftop systems, focusing on understanding public needs, perceptions, and decision-making factors related to purchasing insurance. By identifying key motivations and barriers, this study aims to provide actionable insights for designing insurance solutions that address consumer concerns, enhance confidence, and promote the widespread adoption of solar rooftop systems. This information can be used to develop, improve, and refine solar rooftop systems and services, improving their ability to meet consumer demands.

2. METHODOLOGY

2.1. Statistical Methodology

The statistical methodology is divided into 4 steps as follows.

1) Data collection and gathering involve collecting news, information, or facts from a population with the required characteristics according to the research objectives. This data collection and gathering process is considered the most crucial step in statistical methodology because unreliable data collection can result in low credibility of the subsequent analysis and interpretation. Therefore, this step requires careful planning for data collection, control over the collection process, and thorough data verification to ensure its suitability for analysis.

2) Data presentation displays statistical information collected to make it understandable and ready for further analysis by the general public. Depending on the nature and quantity of the data, various methods are used to present it.

3) Data analysis involves processing collected data according to predetermined objectives, hypotheses, and research questions.

4) Interpreting or summarizing data involves deriving conclusions from the analysis and presenting them in a report.

2.2. Concepts and theories

The concepts and theories related to purchasing decisions [25] state that the consumer decision-making process consists of the following steps:

Step 1: Awareness of the Necessity or Desire for a Product or Service is an internal stimulus within the consumer. It is the realization that one desires to consume a particular product or service to satisfy one's needs. External factors may also trigger consumers to develop a need or desire for a product or service.

Step 2: Information Search After consumers have developed a need or desire for a specific product or service, they search for information to support their purchase decision. Consumers may gather information by reading books, seeking advice from others, searching for information online, or reading blog posts and articles about the product or service.

Step 3: After consumers have gathered information, the next step involves evaluating alternatives to compare various factors between two or more options. Common factors that consumers often evaluate include the brand reputation, the price of the product, the quality of the product, the popularity of the product or service, and more.

Step 4: Making a Purchase Decision. In this step, consumers decide to purchase a product or use a service to satisfy their needs. Consumers plan how, when, and where to buy during this step.

Step 5: Purchasing This step is considered crucial because it is the stage where the consumer buys and consumes the product or service.

Step 6: Sales or Service Follow-up: this step is considered customer-oriented as it involves paying attention to customers. It is an activity aimed at building good customer relationships to create a positive perception of the product, organization, and brand. This ultimately leads to repeat purchases in the future.

This research concludes with decision-making regarding the experience (internal factor) and environmental (external factor) factors. [26].

2.3. Conceptual framework of the research

From the research data, theories, and various articles mentioned earlier, the researcher has used information from the literature review to establish the conceptual framework of the research. This framework serves as a guideline for researching the concerns affecting decision-making in ensuring the installation of solar rooftop systems that are less than 10 kW, as follows the research framework in Fig.1.

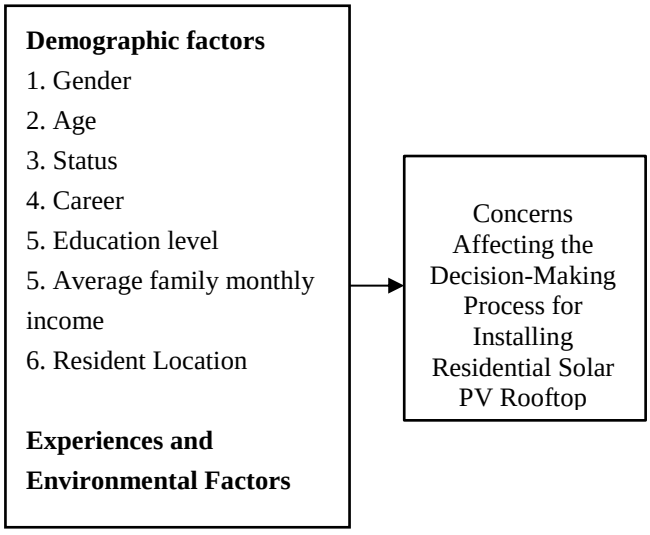

Fig. 1. Research Framework.

2.4. Research Methodology

This research is survey research, and the details are as follows. The study is quantitative research conducted as a survey. It employed a questionnaire for data collection from June to July 2023 and statistical analysis through processing with Excel. The research findings are summarized and presented in tables and descriptions—the solar PV rooftop with less than 10 kWp capacity population registered in 2022 [24]. The sample was calculated with a 95% confidence level and a margin of error of about ± 5%. The sampling is 118 residents from the Krejcie & Morgan [27] sample size table. The tools used in this research include questionnaires for data collection. The data collection tool for this quantitative research is a questionnaire focusing on concerns about installing residential solar rooftop systems with a capacity of up to 10 kW. After reviewing relevant literature, the questionnaire ensures it aligns with the research objectives. It is divided into three sections for comprehensive data collection, as detailed below.

Section 1 consists of questions related to the personal information of the questionnaire respondents, including gender, age, marital status, education level, monthly income, and location of the resident.

Section 2 contains data regarding the concerns and factors in the decision-making process for installing residential solar rooftop systems.

Section 3 consists of questions about the purchasing behavior of solar rooftop system insurance in the voluntary sector.

The data analysis in sections 2 and 3 employs a questionnaire that utilizes a rating scale based on the Likert Scale format. The rating scale comprises 20 items, and respondents can select only one answer for each item. It comprises a 5-point Likert scale: strongly agree, strongly Agree, Neutral, Strongly Disagree, and Strongly Disagree.

The researchers tested the questionnaire created for this study to determine its validity and reliability. The questionnaire was submitted to the advisor for feedback and content validity. After being reviewed and revised based on the advisor's feedback, the questionnaire aimed to ensure its content was accurate, complete, and comprehensive. The questionnaire was assessed for the tool's quality, and the researchers tested its reliability using Cronbach's Alpha Coefficient statistical method. The questionnaire was considered reliable if the reliability coefficient obtained was more significant than or equal to 0.70. The researchers calculated Cronbach's Alpha Coefficient and obtained a value of 0.83.

The researchers took the questionnaire, developed and refined it to a high standard, and administered it through Google Forms. They also distributed the questionnaire links through various online channels, with purposive sampling, to a sample group of Thailand's residential Solar PV Rooftop installations up to 10 kWp capacity. After collecting the questionnaire responses, the researchers verified their accuracy and completeness. Subsequently, they recorded and analyzed the data.

The data analysis is conducted after collecting complete and sufficient data as required. The researchers analyze the data using statistical calculations and analysis. The descriptive statistical techniques employed for data analysis include frequency, percentage, average, mean, and standard deviation.

3. RESULTS AND DISCUSSION

3.1. Demographic Group

The analysis of the questionnaire data revealed that the demographic characteristics of the sample group showed a higher proportion of males than females, with males comprising 70% and females 25% of the respondents. Additionally, most participants were under 40 years old, representing 44.9% of the sample group. Regarding marital status, 52.5% of the respondents were married. Furthermore, most of the sample group held a bachelor's degree, accounting for 58.5% of the participants. Most respondents were employed in private companies (44.9%), and the most significant proportion (48.3%) had an average monthly household income of less than 50,000 baht. Most respondents resided in the central region of Thailand, with 52.5% indicating this as their location. In terms of experience with solar rooftop systems, the majority had less than one year of experience, comprising 34.7% of the sample. Further details are provided in Table 1.

Table 1. Data of the demographic respondents

Category	Respondents (%)
Gender	
Male	83 (70.3)
Female	30 (25.4)
Age	
Lower and equal to 40 years	53 (44.9)
41-50 Years	43 (36.4)
51-60 Years	22 (18.6)
Marital status	
Married	62 (52.5)
Single	56 (47.5)
Highest level of education	
Undergraduate	23 (19.5)
Bachelor's degree	69 (58.5)
Postgraduate	26 (22.0)
Occupation	
Civil servants/government Employees	22 (18.6)
Private business/entrepreneur	43 (36.4)
Private company employees	53 (44.9)
Average household monthly income	
Below 50,000 baht	57 (48.3)
50,001 – 100,000 baht	44 (37.3)
100,001 – 150,000 baht	13 (11.0)
150,001 baht or more	4 (3.4)
Resident location	
Middle	62 (52.5)
East	10 (8.5)
Northeast	14 (11.9)
South	15 (12.7)
North	17 (14.4)
Experiences in Solar Rooftop	
One Year	41 (34.7)
Two Years	28 (23.7)
Three Years	12 (10.2)
More than three years	31 (26.3)

3.2. Experiences and environmental factors

From the analysis of data related to market factors that influence the decision-making process for purchasing solar cells and selecting insurance for installing Solar Rooftop Systems with a capacity of up to 10 kW.

Table 2. Comparison of concerns about decision-making in installing Solar Rooftop systems among respondents

Concerns	Gender				t	Sig
	Male		Female			
	X	S.D.	X	S.D.		
Concern about decision-making in installing solar rooftop systems	2.98	.89	2.87	1.39	.424	.674
	Married		Single			
	2.91	1.15	2.83	1.02	.414	.680

*p<.05

Table 2 shows no statistically significant difference in concerns about decision-making in installing small solar rooftop systems between male and female respondents, and there are different marital statuses, with a confidence level of 95%.

Table 3. Analysis of variance comparing concerns about decision-making in installing Solar Rooftop systems

Concerns	df	Sum of Squares	Mean Square	F	Sig
-Concerns by different respondents in "Age"					
Between Groups	2	9.924	4.962	4.453*	.014
Within Groups	115	128.154	1.114		
Total	117	138.078			
-Concerns by different respondents in "Occupation"					
Between Groups	2	12.915	6.458	5.933*	.004
Within Groups	115	125.163	1.088		
Total	117	138.078			
--Concerns by different respondents in "Education Level"					
Between Groups	3	8.427	2.809	2.470	.065

Within Groups	114	129.651	1.137		
Total	117	138.078			
--Concerns by different respondents in "household Income"					
Between Groups	3	1.894	.631	.528	.664
Within Groups	114	136.184	1.195		
Total	117	138.078			
-Concerns by different respondents in "Residential Location"					
Between Groups	4	5.100	1.275	1.083	.368
Within Groups	113	132.978	1.177		
Total	117	138.078			
-Concerns by different respondents in "Experiences with Solar Rooftop System"					
Between Groups	3	19.813	6.604	6.162*	.001
Within Groups	108	115.747	1.072		
Total	111	135.560			

*p<.05

Table 3 shows that respondents of different age groups, occupations, and experience levels with solar systems have statistically significant differences in concerns about decision-making in installing small solar rooftop systems at the 0.05 level. In contrast, respondents of different education levels, household income levels, and residential locations show no statistically significant differences in concerns, with a confidence level of 95%.

Table 3 presents an analysis of variance (ANOVA) assessing whether demographic factors influence respondents' concerns about installing small solar rooftop systems. The findings highlight that age, occupation, and prior experience with solar systems significantly affect these concerns, while education level, household income, and installation region do not show statistical significance.

The results indicate that age notably impacts decision-making concerns ($p = 0.014$). This suggests that different age groups perceive the challenges of adopting solar rooftop systems differently, potentially due to varying levels of familiarity with the technology or differing financial priorities. Similarly, occupation significantly influences concerns ($p = 0.004$), implying that professional background, exposure to energy systems, or technical expertise may shape perceptions of solar system adoption. Respondents' experience with solar systems is the most significant factor ($p = 0.001$), highlighting that those with prior exposure or knowledge of solar rooftops tend to feel less apprehensive about making installation decisions. This underscores the importance of hands-on familiarity and awareness in reducing adoption barriers.

On the other hand, the analysis shows no significant differences in concerns based on education level ($p = 0.065$), household income ($p = 0.664$), or region of installation ($p = 0.368$). These results suggest that concerns about solar adoption are relatively consistent across these groups. Regardless of educational background, financial status, or geographic location, respondents share similar worries, possibly due to common factors like system cost, maintenance, or energy reliability. Overall, the findings emphasize the need for targeted strategies to address concerns among specific groups, particularly those less experienced or in occupations with limited exposure to solar technology. Educational campaigns and demonstration projects could bridge knowledge gaps, increasing adoption rates across diverse demographics.

4. CONCLUSION

The analysis reveals significant insights into the factors influencing concerns about deciding to install small solar rooftop systems. Key demographic variables, including age, occupation, and prior experience with solar systems, significantly impact respondents' levels of concern, as evidenced by p-values below the 0.05 threshold. This suggests that these groups have varying perceptions of the challenges associated with adopting solar rooftops, likely driven by differences in familiarity, technical expertise, and risk assessment.

Age significantly influences concerns, with different age groups possibly reflecting diverse priorities and capacities for adopting solar systems. Younger individuals may focus on long-term environmental and financial benefits, while older individuals might emphasize immediate feasibility and reliability. Occupation also plays a critical role, suggesting that professional exposure and technical knowledge can shape perceptions. For example, individuals in technical or energy-related fields may feel more confident about decision-making than those in other sectors. Experience with solar systems is the most significant factor, underscoring the importance of hands-on familiarity in alleviating concerns. Those with prior exposure are likely better informed about the technology's benefits and limitations, making them more confident in their decisions.

Interestingly, the study finds no significant differences in concerns based on education level, household income, or installation region. These results highlight the universality of specific challenges, such as cost considerations, maintenance, and system reliability, irrespective of formal education or income brackets. Regional factors, such as differences in infrastructure or local policy, do not appear to strongly influence respondents' concerns, suggesting that these issues are more likely tied to national or global perceptions of solar adoption challenges.

In conclusion, the findings highlight the need to focus on specific demographic segments to address concerns effectively. Understanding the nuanced influences of age, occupation, and prior experience can help policymakers and stakeholders develop tailored strategies to promote solar rooftop adoption. The lack of significant differences across education, income, and region suggests that universal challenges must be addressed to foster widespread adoption.

5. RECOMMENDATIONS

Based on the findings, several recommendations can be proposed to address the concerns and promote the adoption of small solar rooftop systems:

Targeted Awareness Campaigns: Develop age-specific and occupation-focused awareness programs. For younger individuals, emphasize long-term benefits like cost savings and environmental impacts. For older groups, highlight system reliability and immediate advantages—tailor messaging for non-technical occupations to simplify technical concepts.

Hands-On Training and Demonstrations: Organize workshops and demonstration projects to familiarize potential adopters with solar rooftop systems. Providing firsthand experience can reduce uncertainty and build confidence among users, particularly those with no prior exposure.

Subsidy Programs and Incentives: Implement financial support schemes to make solar rooftops more affordable across all income groups. Addressing universal cost concerns can significantly boost adoption.

Universal Messaging: Through nationwide campaigns, Address shared challenges, such as system maintenance and reliability. Develop easily accessible resources explaining how to manage and maintain solar systems effectively.

Future Research: Investigate specific factors within the age and occupation categories to design even more refined interventions. Additionally, explore regional differences further to ensure equitable adoption across various locales.

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