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FROM AWARENESS TO ACTION: FACTORS DRIVING HOUSEHOLD ADOPTION OF SOLAR ENERGY IN SRI LANKA

Kajenthiran, K[a]*, Umakanth, N[b]

[a]Department of Marketing, Faculty of Management Studies and Commerce, University of Jaffna

[b]Department of Commerce, Faculty of Management Studies and Commerce, University of Jaffna

kkajenthiran@univ.jfn.ac.lk, umakanth@univ.jfn.ac.lk*

**Corresponding Author*

ABSTRACT

The global transition to renewable energy is crucial for addressing climate change, enhancing energy security, and promoting sustainable development. Solar energy, in particular, has gained prominence due to its scalability and decreasing costs. However, the adoption of Renewable Energy Technologies (RET) is influenced by a complex interplay of technical, financial, social, and psychological factors. This study investigates the determinants of RET adoption among households in the Northern Province of Sri Lanka, integrating the Technology Acceptance Model and the Theory of Planned Behavior to explore the roles of perceived ease of use (PEU), perceived usefulness (PU), social influence, attitude towards RET, and perceived behavioral control (PBC). Additionally, the study examines the moderating effects of knowledge of RET and environmental concerns on these relationships. Data was collected through an online survey of 268 households and analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The findings reveal that perceived usefulness and social influence are the most significant predictors of attitude towards RET and adoption of RET, respectively. Knowledge of RET moderates the relationships between PEU, PU, and attitude towards RET, while environmental concern moderates the relationship between social influence and RET adoption. However, environmental concern does not significantly moderate the relationships between attitude, PBC, and RET adoption. The study provides valuable insights for policymakers and marketers aiming to enhance RET adoption by addressing key psychological and social factors, particularly in emerging economies.

Keywords: Renewable Energy Technologies, Perceived Ease of Use, Perceived Usefulness, Social Influence, Household Adoption

1. Introduction

The world is urgently transitioning to renewable energy to combat climate change, enhance energy security, and support sustainable growth (Belaïd et al., 2023; Elkhatat & Al-Muhtaseb, 2024). Among renewable energy sources, solar power is particularly prominent due to its decreasing costs, scalability, and ability to reduce carbon emissions (Hayat et al., 2019). However, the adoption of solar energy varies, influenced not only by technical and financial barriers but also by social and psychological factors (Shahsavari & Akbari, 2018). To fully understand the adoption process, it is essential to consider multiple dimensions, such as technology acceptance, personal motivations, and social influences. Research indicates that the novelty of solar technology, combined with expectations of rapid improvements and cost

reductions, often leads to uncertainty and hesitation among potential adopters (Kyere et al., 2024; Shahzad et al., 2023). Addressing these challenges requires a deeper exploration of the household decision-making process regarding capital-intensive technologies like solar photovoltaic systems (Sleiti et al., 2022; Wolske et al., 2018). Despite some progress, there remains a significant gap in understanding how the information context interacts with potential adopters' motivations in the context of renewable energy technologies (RET). This gap impacts key factors such as the duration of the decision-making process and the mode of adoption, which are essential for overcoming barriers to the widespread adoption of RET.

A study on household attitudes in central England found that while the "early majority" holds positive views on solar energy's environmental benefits, financial, economic, and aesthetic concerns hinder adoption (Balcombe et al., 2013). Similarly, reframing solar photovoltaics' financial advantages did not significantly increase its appeal or affect the likelihood of responding to solar marketing (Wolske et al., 2017). Thus, marketers need to identify key differences in consumer adoption profiles to better understand preferences and tailor strategies for promoting RET (Bergek & Mignon, 2017; Reyes-Mercado & Rajagopal, 2017). It found that, even with substantial subsidies, solar energy appeals most to individuals who align with the "early adopter" profile—typically affluent, educated, and environmentally-conscious (Arora & Singh, 2024; Kopalle et al., 2024; Sivarajah, 2024).

While existing studies on RET adoption, particularly solar energy, have predominantly focused on isolated theoretical frameworks like the Technology Acceptance Model (TAM) and the Theory of Planned Behavior (TPB), there has been limited integration of these models (Fleiß et al., 2024; Ma et al., 2024; Shahsavari & Akbari, 2018). TAM focuses on technological perceptions (perceived usefulness, ease of use) (Abdullah et al., 2016; He et al., 2018), while TPB addresses behavioral intentions (social norms, attitude, behaviour control) (Waris et al., 2023). Few studies attempt to integrate these frameworks to comprehensively explain adoption dynamics in different sectors (Han et al., 2024; Pham Thi et al., 2024). Although studies have examined the components of Perceived Ease of Use (PEU) and Perceived Usefulness (PU), there is limited understanding of how these two factors interact to shape attitudes toward RET adoption in different socio-economic contexts (Bhatia et al., 2024; Kotilainen & Saari, 2018). Therefore, this study integrates the TAM and the TPB to explore RET adoption, specifically focusing on households in the Northern Province of Sri Lanka. By examining the unique socio-economic and cultural context of this region, the study aims to provide a deeper understanding of how these two theoretical frameworks interact to influence adoption behaviors and decisions regarding solar energy.

This study also explores the moderating role of knowledge of renewable energy technology (RET), particularly its influence on the relationship between Perceived Ease of Use (PEU) and attitude toward RET, as well as Perceived Usefulness (PU) and attitude toward RET. While knowledge about RET has the potential to reduce uncertainty and boost confidence in adopting the technology (Ali et al., 2022; Bhatia et al., 2024), its impact on shaping adoption decisions remains insufficiently explored in existing research (Mustafa et al., 2023). Besides,

environmental concern, as a moderating variable, is crucial in shaping the adoption of RET (De Canio et al., 2021; Hartmann & Apaolaza-Ibáñez, 2012). While social influence is widely acknowledged as a key determinant in adoption intentions (Graf-Vlachy et al., 2018; Leow et al., 2021), further research is needed to investigate how it interacts with environmental concern and Perceived Behavioral Control (PBC) within different social contexts (Salifu et al., 2024). The moderating effect of environmental concern on the relationship between social influence and RET adoption, as well as its influence on attitudes and PBC, has not been adequately examined in the literature (Qalati et al., 2022; Wong et al., 2024). Environmental concerns can drive RET adoption (Irfan et al., 2021), especially in situations where practical barriers such as financial constraints and technological complexity persist (Juszczyk et al., 2022). Moreover, the role of PBC in adoption behavior and its interaction with factors like attitude and social influence, moderated by environmental concern, requires more in-depth analysis to fully comprehend the complexities of RET adoption. Thus, this study aims to fill these gaps by examining how environmental concern interacts with key variables to influence RET adoption, focusing on household adoption in Sri Lanka's Northern Province.

2. Literature Review

2.1 Theoretical Underpinning

The adoption of RETs, such as solar energy, is shaped by a confluence of sociopsychological, technological, and ethical factors. This study draws on two foundational theories to explain these dynamics: the Technology Acceptance Model (TAM) and the Theory of Planned Behavior (TPB). TAM, developed by Davis in 1989, explains why individuals adopt new technologies (Davis, 1989). The model posits that if a technology is perceived as easy to use and useful, users will have a more positive attitude toward it, which, in turn, increases their intention to adopt it (Bhatia et al., 2024; He et al., 2018). In the context of renewable energy technologies, people are more likely to adopt them if they find these technologies simple to use and perceive clear benefits (Zeng et al., 2022). According to this model, individuals are more likely to adopt a technology if they find it easy to use and believe it provides value. Over time, numerous studies have tested and expanded upon TAM, further demonstrating its relevance in understanding technology adoption behaviors (Asif, Zhongfu, Ahmad, et al., 2023; Wong et al., 2024).

Further, TPB, developed by Ajzen in 1991, is a key framework used to understand human behavior, including technology adoption (Yadegari et al., 2024). TPB suggests that a person's behavior is driven by their intention to engage in that behavior, which is influenced by three primary factors: attitudes, subjective norms, and perceived behavioral control (Kashif et al., 2018; La Barbera & Ajzen, 2021). TPB highlights how these factors shape the individual's intention and, ultimately, their behavior (Al-Mamary & Alraja, 2022). While TPB has been widely applied to understand pro-environmental behaviors (Abdelwahed et al., 2022; Alzubaidi et al., 2021), its integration with the TAM in the context of renewable energy technologies (RET) remains limited (Arora & Varah, 2025; Wong et al., 2024). This creates gaps in understanding how perceptions of technology interact with social influences, attitudes and perceived behavioural control, which are essential in explaining the adoption of RET.

2.2 Attitudes Towards Renewable Energy Technology

The adoption of RETs is essential for addressing global challenges like climate change, energy security, and sustainable development (Chen et al., 2024). Despite benefits such as reduced emissions, lower energy costs, and energy independence, adoption rates are inconsistent due to technical, financial, social, and psychological barriers (Borragán et al., 2024; Schulte et al., 2022). Consumer attitudes play a critical role in shaping decisions on RET adoption (Gârdan et al., 2023; McCarthy & Liu, 2022). As per Ajzen (1991), attitudes reflect an individual's evaluation of specific behaviors. For RET, attitudes are influenced by environmental awareness, perceived benefits, costs, and familiarity with the technology (Fleiß et al., 2024; Gârdan et al., 2023; Huang & Cheng, 2023). This literature review examines key factors such as technological perceptions, social influences, environmental concerns, and economic considerations, aiming to offer a comprehensive understanding of the drivers and barriers to RET adoption.

2.3 PEU and Attitudes Towards Renewable Energy Technology

PEU plays a crucial role in shaping customer attitudes and behaviors toward new technologies (Ianole-Călin & Druică, 2022; Latreche et al., 2024), including RETs (Zeng et al., 2022). According to the TAM, PEU directly influences users' attitudes and their intention to adopt a technology (Bhatia et al., 2024). When RET is perceived as easy to use, such as with simple installation or operation, individuals are more likely to view it positively and consider adoption (Fleiß et al., 2024; Reyes-Mercado & Rajagopal, 2017). Therefore, users who find RET user-friendly are more likely to foster positive attitudes, further promoting adoption. Existing literature strongly supports that PEU is a significant predictor of attitudes toward RETs (He et al., 2018; Schulte et al., 2022; Wong et al., 2024). Thus, we proposed the following hypothesis:

H_1: PEU positively influences attitudes towards RETs

2.4 PU and Attitudes Towards Renewable Energy Technology

In the **TAM**, the concept of PU plays an important role in shaping an individual's attitude toward technology. Specifically, in the context of **RETs**, the more a person perceives renewable energy technology (such as solar panels, wind turbines, or energy-efficient systems) to be useful, the more likely they are to develop a positive attitude towards adopting and using it. When individuals believe that RET can improve their energy efficiency, reduce costs, or help them contribute to environmental sustainability, they are more likely to view it as useful. In addition, this PU leads to a more positive attitude towards the RET. A favorable attitude is crucial because it enhances the intention to adopt the RET. For instance, if a person believes that installing solar panels will not only lower their energy bills but also help reduce their carbon footprint, their attitude towards adopting solar technology becomes more positive. Based on the preceding discussion, we hypothesize the following:

H2: PU positively influences attitudes towards RETs

2.5 Social influence and adoption of RET

Social influence emerges as a key factor driving the adoption of technological decisions (Beldad & Hegner, 2018; Graf-Vlachy et al., 2018). In particular, social influence, representing the social expectations of family, friends, or broader society, plays a crucial role in shaping adoption intentions (Choudrie et al., 2018; Lazaric et al., 2020; Tunçgenç et al., 2021). Based on theoretical frameworks such as the TPB, it is evident that individuals are more inclined to adopt RET when they perceive it as a socially endorsed behavior (Wolske et al., 2020; Wong et al., 2024). This influence operates through various mechanisms, including peer pressure (Hu et al., 2019), social norms (Lin & Niu, 2018), word-of-mouth (Hameed et al., 2024), and public initiatives by governments or communities (Hooda et al., 2022). When individuals recognize that their social circles, whether personal or societal, expect them to adopt RET, their intention to do so is heightened (Elmustapha et al., 2018; Irfan et al., 2021; Wong et al., 2024; Zhang et al., 2022). Based on the discussion above, social influence, particularly through the alignment with perceived societal and peer expectations, significantly increases individuals' intentions to adopt RETs. This study posits:

H_3: Social influence positively influences adoption of RET

2.6 Attitudes towards RET and Adoption of RET

An individual's attitude refers to their overall evaluation or predisposition toward a particular behavior or technology, which is significantly shaped by their beliefs and perceptions (Ajzen et al., 2018; Ankiewicz, 2019). In the context of RETs, individuals who perceive these technologies as advantageous and align their attitudes with their perceived benefits are more likely to develop an intention to adopt them (Elahi et al., 2022; Kapoor & Dwivedi, 2020). Positive attitudes toward RET adoption typically arise from the recognition of key benefits such as environmental sustainability, cost savings, and energy independence (Akroush et al., 2019). As a result, individuals who maintain favorable attitudes toward RET are more likely to form strong intentions to adopt these technologies (Ali et al., 2019; Gerli et al., 2022; Irfan et al., 2020; Koirala et al., 2018). Given that attitudes toward the benefits of RET play a central role in adoption decisions, the following hypothesis is proposed:

H_4: Attitudes towards RET positively influence adoption of RET

2.7 Perceived Behavioral Control and Adoption of RET

Perceived Behavioral Control (PBC) refers to an individual's belief in their ability to perform a specific behavior, shaped by their perception of available resources, knowledge, and control over external factors (Ajzen, 1991; Ru et al., 2018). PBC is a key factor in determining individuals' intentions to adopt RET (Gangakhedkar & Karthik, 2022; Wong et al., 2024). Individuals who perceive themselves as having the necessary resources, skills, and support—such as financial means or technical knowledge, are more likely to intend to adopt RET (Gârdan et al., 2023; Geddes, 2021). Empirical research consistently confirms that PBC is a strong predictor of adoption intentions (Gangakhedkar & Karthik, 2022; Geddes, 2021; Ru et al., 2018; Wong et al., 2024). Based on these findings, we propose the following hypothesis:

H_5: Perceived behavioral control positively influences adoption of RET

2.8 Moderation effect of knowledge of RET

The level of knowledge an individual possesses regarding RETs significantly shapes their attitudes toward adopting these technologies (Asif, Zhongfu, Dilanchiev, et al., 2023; Zeng et al., 2022). When individuals have a comprehensive understanding of RET, they are better positioned to recognize the advantages and practicality of these technologies, thereby enhancing the influence of PEU and PU on their attitudes (Bandara & Amarasena, 2020; Caffaro et al., 2020; Wong et al., 2024). In contrast, a lack of sufficient knowledge may lead to the perception that RET is complex or difficult to utilize, resulting in more negative attitudes toward adoption (Baharoon et al., 2016; Oluoch et al., 2020). However, when individuals possess detailed knowledge about the functionality of RET, such as the operation of solar panels or wind turbines, they gain greater confidence in their ability to operate and benefit from these technologies (Lucas et al., 2021; Zeng et al., 2022).

This knowledge helps bridge the gap between the PEU and favorable attitudes toward RET adoption, thereby strengthening the influence of PEU on attitudes (Alam et al., 2021; Malik & Ayop, 2020) . Additionally, knowledge helps individuals recognize the broader benefits of RET, such as long-term financial savings, energy independence, and environmental impact (Brummer, 2018; Hammami et al., 2016; Li & Umair, 2023). Consequently, individuals with a deeper understanding of RET are more likely to appreciate its usefulness, resulting in stronger positive attitudes (Cousse, 2021; Elahi et al., 2022). Based on this argument, knowledge of RET may act as a moderating factor in the relationship between PEU, PU and attitudes toward RETs. Therefore, we propose the following hypotheses:

H_{6a}: Knowledge of RET moderates the relationship between PEU and attitude towards RETs

H_{6b}: Knowledge of RET moderates the relationship between PU and attitude towards RETs

2.9 Moderation Effect of Environmental Concern

Environmental concern reflects an individual's awareness and care about environmental issues like climate change and pollution, motivating efforts to preserve the environment (Aprile & Fiorillo, 2017; Helm et al., 2018). It is a key psychological factor influencing the adoption of RETs by shaping attitudes, intentions, and behaviors (Liao et al., 2020). This concern encourages positive views of RET as a solution to environmental challenges. Thus, environmental concern can moderate the relationships between social influence, attitude, perceived behavioral control, and RET adoption. Environmental concerns can strengthen the relationship between social influence and the adoption of RET (Kirakozian, 2016; Liao et al., 2020; Sibtain et al., 2024). When individuals are highly concerned about the environment, they are more likely to be influenced by social norms and pressures that advocate for sustainable practices (Hosta & Zabkar, 2021; Lin & Niu, 2018). This heightened concern can make them more receptive to adopting RET when they perceive that their social circle values such technologies. In light of this, we propose the following hypothesis:

H_{7a}: Environmental concern moderates the relationship between social influence and adoption of RET

Existing studies suggest that environmental concern can enhance the positive relationship between a favorable attitude toward RET (Lin & Syrgabayeva, 2016; Szakály et al., 2021) and its adoption of RET (Mahalik et al., 2021; Szakály et al., 2021). Individuals who are environmentally concerned are likely to have a more positive attitude towards RET because they see it as a way to mitigate environmental issues (García Alcaraz et al., 2025; Gârdan et al., 2023). This positive attitude, combined with their concern, can lead to a stronger intention and actual adoption of RET (García Alcaraz et al., 2025; Lin & Syrgabayeva, 2016). Thus, we advance the following hypothesis:

H_{7b}: Environmental concern moderates the relationship between Attitude towards RET and adoption of RET

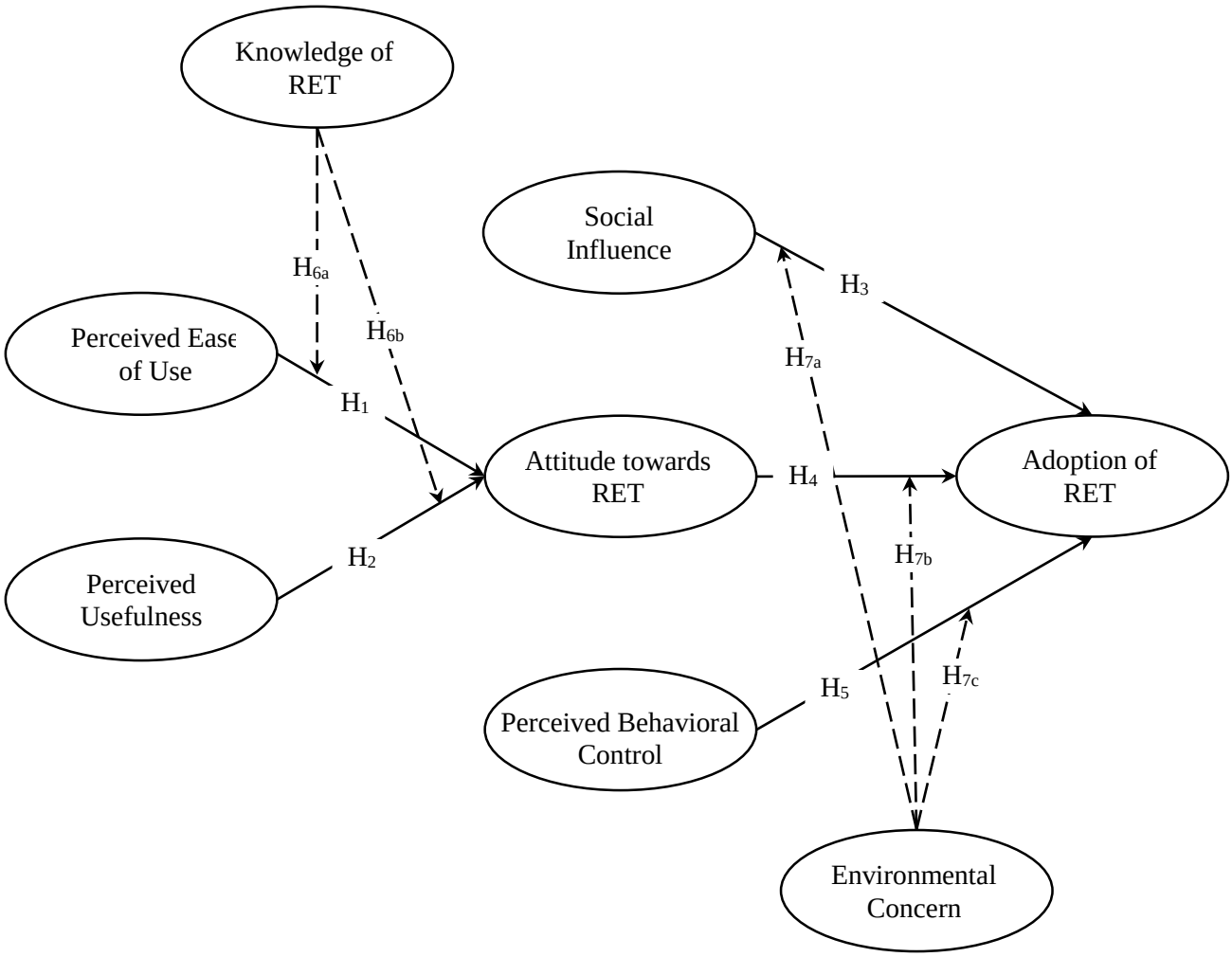

Figure 01: Theoretical Framework

(Source: Authors own creation)

Further, environmental concerns can also moderate the relationship between perceived behavioral control and the adoption of RET (Burgos Espinoza et al., 2024; Fathima M.S et al., 2023). When individuals are highly concerned about the environment, they may be more motivated to overcome perceived barriers to adopting RET (Wolske et al., 2017). Their concern can drive them to seek out resources, information, and support to facilitate the adoption process, thereby strengthening the relationship between perceived control and actual adoption (Jabeen et al., 2019; Schulte et al., 2022). Consequently, we present the following hypothesis:

H_{7c}: Environmenatal concern moderates the relationship between perceived behavioral control and adoption of RET.

In conclusion, the arguments and hypotheses discussed provide the foundation for the theoretical framework, as shown in Figure I.

3. Methodology

3.1 Research design

This study employs an online survey method to investigate the factors influencing the adoption of RET among households in the Jaffna district. The research framework incorporates key constructs such as perceived ease of use, perceived usefulness, social influence, attitude towards RET and perceived behavioral control. Additionally, this study examines the moderating role of knowledge on RET and environmental concerns. The study targeted households in the Jaffna district. To ensure accurate responses, the focal point of each respective household was identified as the primary respondent responsible for energy-related decisions. The survey was distributed via email, social media platforms, and community networks using a convenience sampling method to reach a broad audience. A structured questionnaire was designed and programmed into a web-based application system (Google Forms) to facilitate electronic data collection over a period of three months from April to May 2023.

Before implementing the final questionnaire, a pilot test was conducted with three academic experts and ten household participants to evaluate its clarity and effectiveness. The primary objective of this pretest was to identify potential errors, assess comprehension of the survey items, and ensure that the measurement scales were well understood by respondents. No significant issues emerged during the pilot phase; however, minor refinements were made to enhance clarity and precision. A total of 268 respondents aged 18 and above were recruited from the households through an online survey. Before proceeding to the questionnaire, participants were required to check a consent box, indicating their voluntary agreement to take part in the study. Only those who provided consent were able to complete the survey. A detailed summary of the respondents' demographic characteristics is provided in Table 01.

Table 01: Summary of respondent's characteristics (*n*=268)

Characteristics	No.	%	Characteristics	No.	%
Age			**Gender**		
18 - 30	78	29.1	Male	157	58.6
31 - 45	93	34.7	Female	111	41.4
46 - 60	94	35.1	**Family Income**		
above 60	3	1.1	Less than LKR 75000	42	15.7
Family size			LKR 75000 - LKR 100,000	36	13.4
1 - 3	30	11.2	LKR 100,000 - LKR 125,000	41	15.3
4 - 6	200	74.6	LKR 125,000 - LKR 150,000	72	26.9
above 7	38	14.2	LKR 150,000 - LKR 175,000	44	16.4
Employment status			LKR 175,000 - LKR 200,000	21	7.8
Government	54	20.1	Above LKR 200,000	12	4.5
Semi-Government	45	16.8	**Education level**		
Private	102	38.1	GCE ol and below	45	16.8%
Self-employment	20	7.5	A/L	76	28.4%
studying	35	13.1	Graduate	67	25.0%
Unemployed	7	2.6	Post Graduate	32	11.9%
Retired	5	1.9			

Source: Survey data

3.2 Research Instrument

A structured questionnaire served as the primary data collection instrument, designed for completion within 10 to 15 minutes. It comprised two sections; Part A: Demographic information—collected details on age, family size, employment status, gender, income, and education level. Part B: Study variables—utilized a Five-Point Likert Scale to measure relationships between the dependent and independent variables. All the constructs in the questionnaire were developed based on previously validated scales to ensure reliability and validity. Perceived ease of use was evaluated using a five-item scale adapted from Alam et al. (2014), while perceived usefulness was measured with seven items sourced from Masukujjaman et al. (2021). To examine social influence, a four-item scale was adopted from Onel and Mukherjee (2016) and Konalingam et al. (2024). In addition, four-item scales for attitude toward RET and five-item scales for perceived behavioral control were adapted from Bouman et al. (2018) and Chang and Chen (2022). While knowledge on RET was measured through a five-item scale developed by Park and Ohm (2014) and Alam et al. (2014). Similarly, environmental concern was evaluated using a four-item scale, adapted from Bang et al. (2000) and Lin and Syrgabayeva (2016). Finally, The adoption of RET was measured using a four-item scale modified from Park and Ohm (2014) All constructs were assessed using a five-point Likert-type scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

3.3 Data Analysis

This study employed Partial Least Squares Structural Equation Modeling (PLS-SEM) using Smart PLS v4.1 to test the hypothesized relationships. Given its ability to handle complex models and extend structural theory (Hair et al., 2019), PLS-SEM was chosen for assessing key constructs such as attitude towards RET, adoption of RET, and influencing factors. The

analysis followed two steps: First, the PLS algorithm determined the significance of loadings, weights, and path coefficients (measurement model). Second, bootstrapping validated the statistical significance of the proposed hypotheses, ensuring reliability in the findings (structural model).

4. Result

4.1 Common Method Bias Testing

To address potential common method bias, Harman's single-factor test was conducted, ensuring that the study was not significantly affected by single-source bias (Das et al., 2022). Principal component factor analysis indicated that the largest variance explained was 42.63%, which is below the 50% threshold suggested by Podsakoff et al. (2003). As the variance explained by a single factor did not dominate the results, common method bias is unlikely to pose a significant issue in this study.

4.2 Measurement model assessment

To assess the reflective measurement models, the study evaluated several validity and reliability criteria. Convergent validity was determined by examining factor loadings and the average variance extracted (Reyes-Mercado & Rajagopal). Internal consistency was assessed using composite reliability (Hickman & Silva) and Cronbach's alpha. Discriminant validity was verified through the Fornell–Larcker criterion and the Heterotrait-Monotrait ratio (HTMT). As outlined in Table 02, all factor loadings surpassed the threshold of 0.7 validity (Diamantopoulos et al., 2012; Hair et al., 2019). AVE, representing the proportion of indicator variance explained by the latent construct, met the recommended minimum of 0.5 50 (Hair et al., 2019). CR and Cronbach's alpha, which measure the reliability of construct indicators in representing their respective latent variables, both exceeded 0.7 (Hair et al., 2019).

Table 02: Summary of the measurement model

Dimensions and items	M	SD	FL
Perceived Ease of Use (α=0.817, CR=0.821 , AVE=0.580)			
peu1: Renewable energy products are easy to setup	3.286	1.287	0.807
peu2: RET setup should be transparent and understandable	2.998	1.303	0.782
peu3: It would be easy to learn how to use renewable energy	3.532	1.179	0.814
peu4: I will become skillful at using renewable energy quickly	4.035	0.961	0.659
peu5: The use of RET for us is relatively safe	3.403	1.228	0.735
Perceived Usefulness (α=0.909 , CR=0.912 , AVE=0.648)			
Pus1: RET eliminates air pollution	3.048	1.353	0.823
Pus2: RET helps to decrease energy production pressure	3.622	1.156	0.800
Pus3: RET is saving our country's underground resources	3.691	1.154	0.750
Pus4: RET will help us prevent disruptions in energy	3.179	1.210	0.842
Pus5: RET is going to relieve us from typical energy price changes.	3.468	1.196	0.789
Pus6: Using RET saves time compared to traditional household jobs	2.330	1.489	0.767
Pus7: When using RET, my electricity costs will be minimized	3.161	1.266	0.858

Knowledge on RET (α=0.870 , CR=0.882 , AVE=0.657)			
Kno1: I am knowledgeable about the sources and technologies used for renewable energy	3.894	0.977	0.793
Kno2: I have a strong understanding of the benefits and applications of RET	3.699	1.046	0.838
Kno3: I know where to find reliable information about RET	3.948	0.981	0.849
Kno4: I am aware of financing options, such as bank loans, for purchasing RET	3.835	0.993	0.816
Kno5: I understand the significant environmental advantages of adopting RET	4.079	0.948	0.752
Social Influence (α=0.964 , CR=0.967 , AVE=0.902)			
Soi1: Most people who are important to me think that I should use RET at home	2.653	1.540	0.968
Soi2: Most people who are important to me would approve the RE technological thoughts and Behaviors at home	2.798	1.484	0.937
Soi3: My family members believe I should engage in RET behaviors	2.608	1.616	0.931
Soi4: My friends/colleagues believe I should adopt RET at home	2.655	1.555	0.962
Attitude towards RET (α=0.946 , CR=0.946 , AVE=0.860)			
Att1: I am personally committed to adopting RET to reduce environmental problems	3.303	1.317	0.887
Att2: The adoption of renewable energy technologies is not as important as many other global issues today	3.209	1.306	0.949
Att3: I support RET because of their potential benefits for my lifestyle	3.294	1.288	0.958
Att4: I support RET because of their potential benefits for my community	3.497	1.264	0.914
Perceived Behavioral Control (α=0.906 , CR=0.912 , AVE=0.727)			
Pbc1: I believe that I can adapt to environmental preservation	3.798	1.068	0.797
Pbc2: I believe that as long as I intend to, I can take action to adapt to environmental preservation	3.785	0.991	0.852
Pbc3: I believe it is useful to act in a pro-environmental manner	3.687	1.064	0.828
Pbc4: I have the resources, time and willingness to protect the environment	3.585	1.059	0.894
Pbc5: It is mostly up to me whether or not to protect the environment	3.631	1.108	0.889
Adoption of RET (α=0.927 , CR=0.937 , AVE=0.826)			
Aret1: In a short time, I would like to adopt RET	3.582	1.208	0.776
Aret2: Within a short time, I expect/want to implement RET in my home	2.564	1.488	0.954
Aret3: I intend to adopt RET soon	2.695	1.501	0.957
Aret4: I predict that our society will soon transition to RET	2.701	1.487	0.935
Environmental Concern (α=0.863 , CR=0.874 , AVE=0.709)			
Enc1: I am deeply concerned about environmental issues and believe RET can help address them	3.676	1.064	0.767
Enc2: I consider adopting RET as an important step toward reducing environmental problems	3.537	1.067	0.872
Enc3: I am concerned about the negative impacts of fossil fuels and see renewable energy as a solution	3.712	0.980	0.866
Enc4: The potential consequences of environmental problems motivate me to support the adoption of RET	3.729	1.015	0.860

Note*: α=Cronbach's alpha , CR=Composite reliability, AVE=Average variance extracted, M=Mean, SD=Standard deviation, FL=Factor Loadings*

Source: Survey data

Furthermore, Table 03 illustrates that the square root of AVE for each construct was higher than its correlations with other constructs (Fornell & Larcker, 1981), ensuring discriminant validity. Additionally, HTMT remained below the 0.85/0.9 threshold (Henseler et al., 2015) reinforcing this validity. Based on these findings, the measurement model demonstrated strong internal consistency, as well as satisfactory convergent and discriminant validity.

Table 03: Assessment of Discriminant Validity

Constructs	Fornell-Larcker criterion								Heterotrait-monotrait ratio (HTMT)							
	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
1. Adoption of RET	**0.909**															
2. Attitude Towards RET	0.758	**0.928**							0.816							
3. Environmental Concern	0.493	0.495	**0.842**						0.551	0.542						
4. Knowledge on RET	0.534	0.510	0.716	**0.810**					0.592	0.554	0.821					
5. Perceived Behavioral Control	0.591	0.556	0.676	0.774	**0.853**				0.647	0.599	0.760	0.855				
6. Perceived Ease of Use	0.730	0.661	0.572	0.570	0.673	**0.762**			0.840	0.752	0.680	0.669	0.779			
7. Perceived Usefulness	0.808	0.739	0.603	0.642	0.730	0.792	**0.805**		0.877	0.794	0.676	0.711	0.802	0.869		
8. Social Influence	0.825	0.689	0.424	0.462	0.507	0.643	0.725	**0.950**	0.864	0.721	0.458	0.496	0.539	0.719	0.766	

Note: Bold font = square root of AVE

Source: Survey data

4.3 Structural model assessment

After validating the measurement model and confirming that all statistical thresholds were met, the relationships between the constructs were examined through a bootstrapping procedure with 5,000 resampling iterations (Chin et al., 2008). This process generated beta coefficients, standard errors, t-values, p-values, and effect sizes. Additionally, the study assessed the explained variance (R^2), effect size (f^2) and predictive relevance (Q^2) (Hair Jr et al., 2023). Figure II presents the results of the bootstrapping analysis.

The R^2 values for the endogenous constructs in the proposed model, attitude towards RET and adoption of RET were 0.568 and 0.768, respectively. According to common benchmarks, R^2 values of 0.75, 0.50, and 0.25 are categorized as substantial, moderate, and weak, respectively respectively (Hair et al., 2019; Henseler et al., 2015). Based on these benchmarks, the R^2 values in this model indicate a moderate level of predictive accuracy for attitude towards RET and a substantial level for adoption of RET.

In terms of effect size, Social Influence ($f^2 = 0.575$) was identified as the most significant predictor of Adoption RET, indicating a large effect. Perceived usefulness ($f^2 = 0.239$) had a medium-to-large effect on attitude Towards RET, however perceived ease of use ($f^2 = 0.025$) exhibited small but meaningful effects on attitude towards RET. Additionally, attitude towards RET ($f^2 = 0.152$) demonstrated a moderate effect on adoption of RET. Meanwhile, perceived behavioral control ($f^2 = 0.044$) exhibited small but meaningful effects on adoption of RET. In contrast, Environmental Concern ($f^2 = 0.002$) and Knowledge on RET ($f^2 = 0.002$) had negligible effects on both adoption of RET and attitude towards RET, suggesting that these factors play a minimal role in influencing adoption decisions (Cohen, 1988).

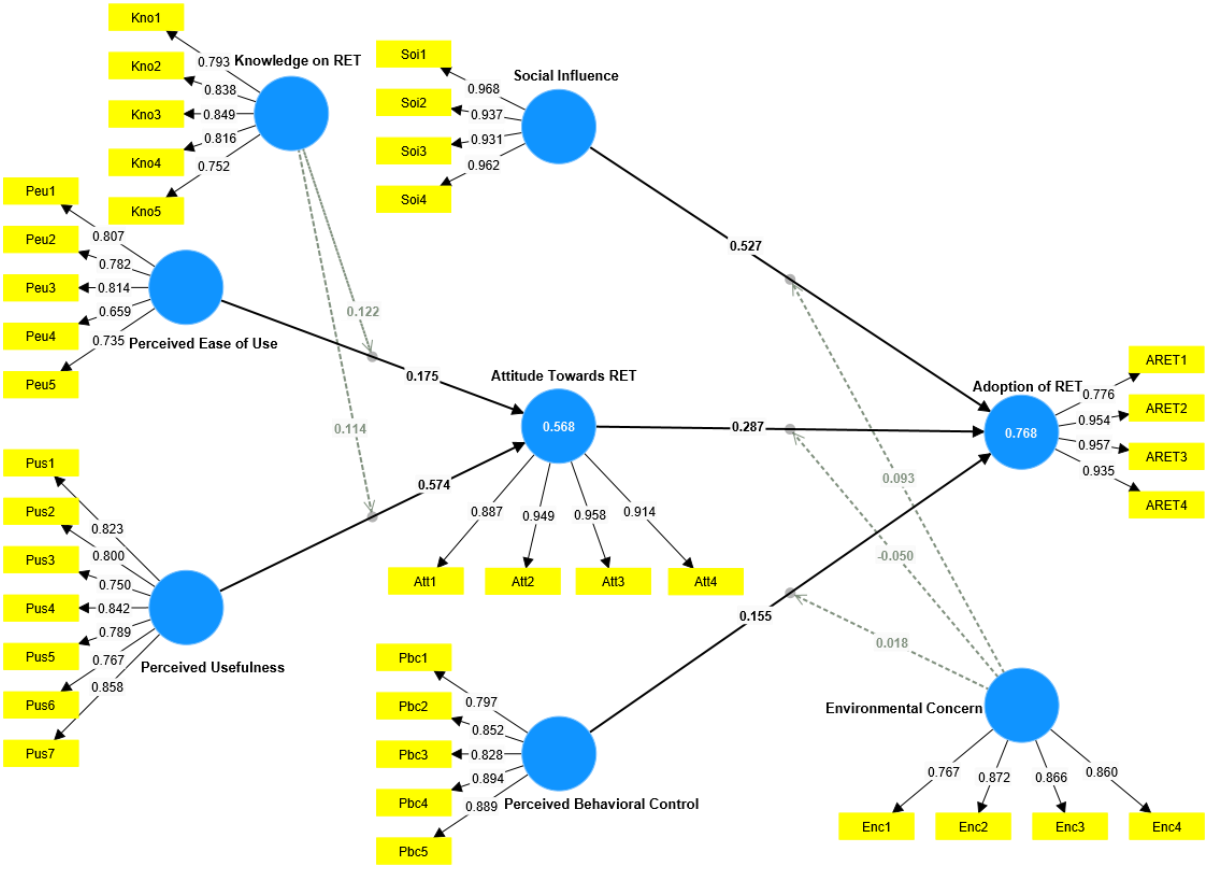

Figure 02: Bootstrapping results of the structural model

Source: Authors own creation

Table 04: Path estimates for the structural model

Hypothesis	Path	Original sample (O)	M	SD	T statistics	P values	Decision
Direct effect							
H_1	Perceived Ease of Use → Attitude Towards RET	0.175	0.177	0.049	3.575	0.001	Supported
H_2	Perceived Usefulness → Attitude Towards RET	0.574	0.572	0.052	11.082	0.001	Supported
H_3	Social Influence → Adoption of RET	0.527	0.528	0.039	13.537	0.001	Supported
H_4	Attitude Towards RET → Adoption of RET	0.287	0.287	0.038	7.493	0.001	Supported
H_5	Perceived Behavioral Control → Adoption of RET	0.155	0.153	0.045	3.462	0.001	Supported
Moderated effect							
H_{6a}	Knowledge on RET x Perceived Ease of Use → Attitude Towards RET	0.122	0.122	0.046	2.658	0.008	Supported
H_{6b}	Knowledge on RET x Perceived Usefulness → Attitude Towards RET	0.114	0.113	0.048	2.356	0.019	Supported
H_{7a}	Environmental Concern x Social Influence → Adoption of RET	0.093	0.093	0.038	2.446	0.014	Supported
H_{7b}	Environmental Concern x Attitude Towards RET → Adoption of RET	-0.050	-0.049	0.036	1.407	0.160	Not Supported
H_{7c}	Environmental Concern x Perceived Behavioral Control → Adoption of RET	0.018	0.017	0.032	0.578	0.563	Not Supported

Source: Survey data

In addition to the R^2 value, the predictive sample reuse technique (Q^2) serves as a criterion for assessing predictive relevance (Akter et al., 2011; Chin, 2010). According to Fornell and Cha (1993), a Q^2 value greater than 0 indicates that the model has predictive relevance, while a value below 0 suggests otherwise. The results revealed that the Q^2 values for adoption of RET and attitude towards RET were 0.628 and 0.484, respectively. Since both values are greater than 0, this confirms that the model possesses acceptable predictive relevance.

The path coefficients and significance levels for the hypothesized relationships are presented in Table 04. The results indicate that Perceived Ease of Use ($\beta = 0.175$, $t=3.575$, $p < .001$) and Perceived Usefulness ($\beta = 0.574$, $t=11.082$, $p < .001$) positively influence attitude towards RET. Similarly, social influence ($\beta = 0.527$, $t=13.537$, $p < .001$), attitude towards RET ($\beta = 0.287$, $t=7.493$, $p < .001$) and Perceived Behavioral Control ($\beta = 0.155$, $t=3.462$, $p < .001$) demonstrated significant positive effects on adoption of RET. Thus all our direct hypotheses (H1, H2, H3, H4 and H5) are supported.

The moderation effect of knowledge on RET in the relationship between perceived ease of use and attitude towards RET ($\beta = 0.122$, $t = 2.658$, $p < 0.01$) and perceived usefulness and attitude towards RET ($\beta = 0.144$, $t = 2.356$, $p < 0.05$) was found to significantly influence attitude towards RET. Additionally, the moderation effect of environmental concern in the relationship between social influence and adoption of RET ($\beta = 0.093$, $t = 2.446$, $p < 0.05$) was also significant. Therefore, the study supports hypotheses H6a, H6b, and H7a. However, the moderation effects of environmental concern in the associations between attitude towards RET and adoption of RET ($\beta = -0.050$, $t = 1.407$, $p = 0.160$) and Perceived Behavioral Control and Adoption of RET ($\beta = 0.018$, $t = 0.578$, $p = 0.563$) were not significant. As a result, hypotheses H7b and H7c are not supported.

5. Conclusion

This study aimed to investigate the factors influencing the adoption of RET among households in the Jaffna district. Through a structured methodology involving an online survey and questionnaire, key determinants such as perceived ease of use, perceived usefulness, social influence, attitude towards RET, and perceived behavioral control were examined. The findings revealed that perceived usefulness and social influence were the most significant predictors of attitude toward RET and adoption of RET respectively. Furthermore, the study identified the moderation effects of knowledge on RET and environmental concern in shaping attitudes and adoption behaviors, although not all hypotheses related to environmental concern were supported.

This research offers valuable insights into the behavioral drivers of RET adoption in Sri Lanka, highlighting the pivotal roles of social influence and perceived usefulness in shaping pro-environmental decisions. The findings emphasize the need for policy interventions that promote knowledge dissemination about RET and address environmental concerns to enhance adoption rates. Additionally, the study's theoretical framework and methodological approach provide a strong foundation for future research and can be extended to similar contexts in emerging economies to deepen the understanding of renewable energy adoption dynamics.

5.1 Theoretical Implications

This study offers key theoretical insights by integrating the TAM and TPB to understand Renewable Energy Technology (RET) adoption. It highlights the moderating role of environmental concern, showing that individuals with higher concern are more likely to adopt RET when influenced by social norms. Additionally, it emphasizes the importance of knowledge of RET, which strengthens attitudes toward adoption. The study also reveals that environmental concern does not significantly affect the relationship between attitude, perceived behavioral control, and adoption, suggesting that other factors, like financial or technical barriers, may play a stronger role. These findings enrich the theoretical frameworks of TAM and TPB in the context of RET adoption, offering a more nuanced understanding of the socio-psychological dynamics in emerging economies.

5.2 Practical implications

The practical implications of this study offer actionable insights for policymakers, businesses, and organizations aiming to promote RET adoption, particularly in developing regions like Sri Lanka. First, the findings emphasize the importance of perceived usefulness and social influence in driving RET adoption. Policymakers should design campaigns that highlight the practical benefits of RET, such as cost savings, energy independence, and environmental impact, while leveraging social networks to encourage adoption. Community-based programs and peer influence strategies, such as testimonials from early adopters, can be effective in creating a ripple effect. Second, the study underscores the critical role of knowledge in shaping attitudes toward RET. Governments and organizations should invest in educational initiatives, workshops, and awareness campaigns to improve public understanding of RET benefits, installation processes, and long-term advantages. Third, addressing financial and technical barriers is essential to enhance perceived behavioral control. Policymakers can offer subsidies, low-interest loans, and technical support to make RET more accessible, while simplifying installation processes to reduce perceived complexity. Fourth, the study highlights the need to tailor strategies to local contexts, considering socio-economic and cultural factors. For instance, in regions with lower income levels, financial incentives and community engagement may be more effective than purely environmental messaging. Finally, while environmental concern strengthens the link between social influence and RET adoption, its impact on other factors is limited. This suggests that environmental messaging should be complemented by practical and financial incentives to drive adoption.

5.3 Limitations and Future Directions

While this study provides valuable insights into the factors influencing RET adoption, it has certain limitations that offer opportunities for future research. First, the study focuses on households in the Northern Province of Sri Lanka, which may limit the generalizability of the findings to other regions or countries with different socio-economic and cultural contexts. Future studies could expand the scope to include diverse geographical areas to validate and extend the findings. Second, the study relies on self-reported data, which may introduce biases such as social desirability or recall bias. Future research could incorporate objective measures, such as actual adoption rates or energy consumption data, to complement self-reported intentions. Third, the study examines only a limited set of moderating variables (knowledge of RET and environmental concern). Future research could explore additional moderating variables, such as government policies, financial incentives, or technological literacy, to better understand their impact on RET adoption. Moreover, the study does not investigate mediating variables that could further explain the relationships between key constructs. For example, the role of trust in technology or perceived risk could mediate the relationship between perceived usefulness and adoption intentions. Additionally, future studies could explore the mediating role of behavioral intentions in the relationship between attitudes and actual adoption behavior. Lastly, the study's cross-sectional design limits the ability to infer causality. Longitudinal studies could provide deeper insights into how attitudes and behaviors evolve over time, particularly in response to policy changes or technological advancements. By addressing these

limitations and exploring new mediating and moderating variables, future research can build on this study to develop a more comprehensive understanding of RET adoption dynamics.

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