



**AN INTEGRATED MODEL OF CUSTOMERS' PURCHASE
INTENTION TOWARD RESIDENTIAL SOLAR ENERGY SYSTEMS
IN BANGKOK, THAILAND: THE ROLES OF PSYCHOLOGICAL,
ENVIRONMENTAL, AND MARKETING FACTORS**

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AN INDEPENDENT STUDY SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
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This Independent Study Has Been Approved as a Partial Fulfillment of the Requirements
for the Degree of Master of Business Administration

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Residential solar energy systems have become increasingly relevant as Thailand promotes renewable energy and reduces dependence on conventional electricity. This study aimed to examine the influence of Psychological Factors, Environmental Knowledge, and Marketing Mix on Customer Purchase Intention toward residential solar energy systems in Bangkok, Thailand.

A quantitative research design was employed using a structured questionnaire administered to individuals aged 22–60 years residing in Bangkok. Of 450 questionnaires collected, 396 valid responses were retained after data screening. The data were analyzed using descriptive statistics, Cronbach's alpha reliability analysis, Pearson correlation analysis, Pearson's chi-square test of independence, multiple linear regression analysis, and One-Way Analysis of Variance (ANOVA) with Scheffé post hoc comparisons.

The reliability results demonstrated satisfactory internal consistency, with Cronbach's alpha coefficients ranging from .861 to .916. The multiple regression model was statistically significant, $F(3, 392) = 201.039$, $p < .001$, $R^2 = .606$, indicating that the three predictors jointly explained 60.6% of the variance in Customer Purchase Intention. Psychological Factors ($\beta = .197$, $p < .001$) and Marketing Mix ($\beta = .602$, $p < .001$) had significant positive effects on Customer Purchase Intention, whereas Environmental Knowledge was not statistically significant ($\beta = .049$, $p = .336$). Marketing Mix was the strongest predictor, followed by Psychological Factors. The findings suggest that solar energy businesses and relevant stakeholders should emphasize effective marketing strategies and psychological considerations when promoting residential solar energy systems in Thailand.

Keywords: psychological, environmental knowledge, marketing mix, customer purchase intention, residential solar energy systems.

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Fan Yunkang
27 August 2026

DECLARATION

I, Fan Yunkang, hereby declare that this Independent Study entitled “An Integrated Model of Consumers' Purchase Intention toward Residential Solar Energy Systems in Bangkok, Thailand: The Roles of Psychological, Environmental, and Marketing Factors” is an original work and has never been submitted to any academic institution for a degree.



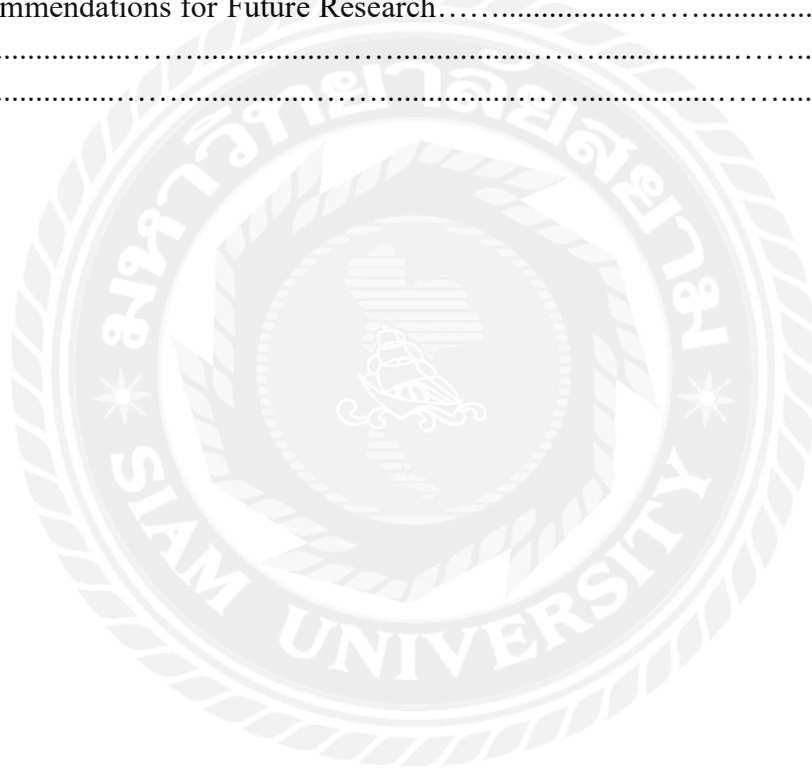
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Chapter 1 Introduction

1.1 Background of the Study

The increasing demand for energy, concerns over climate change, energy security, and the need to reduce dependence on fossil fuels have accelerated the global transition toward renewable energy. Solar photovoltaic (PV) technology has become one of the major drivers of this transition because of its declining costs, scalability, and applicability across utility-scale and distributed applications. The International Energy Agency (IEA, 2024) reported that solar PV and wind are expected to account for approximately 95% of global renewable capacity additions through 2030, while distributed applications, including residential and commercial PV systems, are expected to account for almost 40% of overall PV expansion. More recently, the International Renewable Energy Agency (IRENA, 2026) reported that global renewable power capacity increased by 692 GW in 2025, with solar energy accounting for approximately 511 GW, or about 75% of total renewable capacity additions. These developments demonstrate the growing importance of solar energy in global energy transformation and indicate that residential solar PV is becoming increasingly relevant to household energy consumption and energy security.

Residential solar energy systems can provide households with several potential economic and environmental benefits, including reduced dependence on conventional grid electricity, lower electricity expenditure, reduced greenhouse gas emissions, and greater household energy resilience. The increasing attractiveness of distributed solar PV is also associated with the opportunity for households to generate electricity closer to the point of consumption and increase self-consumption of renewable electricity. However, the expansion of residential solar energy cannot be explained solely by technological progress or economic considerations. The decision to install a residential PV system generally requires a substantial initial investment and involves consideration of system performance, installation quality, expected savings, reliability, maintenance, financing, government policies, and long-term benefits. Recent research on household solar PV adoption has therefore emphasized the importance of consumer perceptions, perceived benefits and costs, awareness, trust, and social responsibility in explaining adoption intention (e.g., 2024 studies on household PV adoption and solar energy consumption behavior).

Thailand has also identified renewable energy and electricity security as important components of its long-term energy planning. The country's Power Development Plan provides the long-term framework for electricity generation, including renewable energy development and grid planning. Thailand has favorable conditions for solar energy because of its geographical location and solar resource availability, creating substantial potential for solar PV deployment. Nevertheless, the development of rooftop solar in Thailand has historically faced technical, economic, social, and regulatory barriers. Research on Thailand's solar PV rooftop sector has identified these four categories of barriers as important constraints on wider implementation,

indicating that the technical potential of rooftop solar does not automatically translate into household adoption.

The current development of Thailand's rooftop solar market further demonstrates the importance of understanding household adoption behavior. The Provincial Electricity Authority (PEA) has continued to expand solar rooftop activities and reported that it had provided installation services to more than 5,000 customers by 2026. In addition, Thailand's electricity authorities have continued to develop mechanisms for residential rooftop solar participation, including programs allowing residential customers to sell surplus electricity. In 2026, the Metropolitan Electricity Authority (MEA) reported that the existing residential rooftop solar purchasing program had reached its previous target and that a new residential rooftop solar program was being developed, while the new program was designed with a target of 500 MW. These developments indicate that Thailand is continuing to create institutional mechanisms to support residential solar adoption, while also demonstrating that consumer participation remains an important component of the country's energy transition.

Despite favorable solar resources, technological development, and continuing policy support, residential solar PV adoption in Thailand remains constrained by several factors. Previous research has identified financial feasibility, policy design, regulatory conditions, technical requirements, and consumer-related barriers as important considerations in the Thai rooftop solar market. More recent research has also indicated that the financial attractiveness of residential rooftop solar can vary substantially according to household electricity consumption and self-consumption patterns. Under existing policy arrangements, therefore, households may evaluate not only environmental benefits but also installation costs, electricity savings, financial returns, and the conditions governing surplus electricity. This suggests that consumers' purchase decisions should be examined as a multidimensional behavioral decision rather than as a response to environmental awareness alone.

From a consumer-behavior perspective, psychological and social factors are particularly relevant to residential solar adoption because solar PV is a relatively high-involvement, long-term household investment. Consumers may consider whether family members, friends, neighbors, experts, or other socially important individuals support solar adoption. Recent empirical research has found that moral norms and subjective norms significantly influence household adoption of solar energy technologies, with personal moral motivation and obligations showing particularly strong explanatory importance. Other recent research has found that solar-energy knowledge and trust can promote household solar-energy consumption behavior, while social influence can alter the relationship between knowledge, trust, and behavioral outcomes. These findings support the relevance of examining Subjective Norm, Personal Norm, and Social Norm as dimensions of Psychological Factors in the present study.

Environmental knowledge is another potentially important determinant of consumers' evaluation of residential solar energy. Consumers who understand climate change, carbon emissions, energy limitations, and clean-energy technologies may be better able to evaluate the environmental and practical consequences of alternative energy choices. However, the relationship between environmental knowledge and purchase behavior is not necessarily direct. Previous research has shown that environmental knowledge may influence environmental attitudes without directly translating into purchase intention, suggesting that knowledge alone may be insufficient to produce behavioral change. For example, Simanjuntak et al. (2023), already included in this study's literature review, found that environmental knowledge positively influenced environmental attitudes but did not directly influence green purchase intention. Conversely, Asif et al. (2023) found a significant positive role for environmental knowledge in residential solar-energy purchase intention in rural China. These differences indicate that the effect of environmental knowledge may depend on the specific product, market, and behavioral context.

Marketing factors are also important because residential solar systems involve substantial financial expenditure, technical evaluation, installation services, and long-term performance expectations. Consumers may evaluate the quality and reliability of solar panels and related equipment, the affordability and value of the system, the accessibility of suppliers and installation services, and the information and promotional communication provided by solar-energy companies. Recent research on residential PV adoption has shown that perceived benefits, perceived sacrifice, price value, technology awareness, trust, and system performance can influence consumers' intention to adopt solar PV. Similarly, research examining solar PV adoption in the United States found that consumers who trusted installers and perceived personal benefits from solar energy were more likely to express interest in contacting installers. Such findings support the relevance of the Marketing Mix, particularly Product, Price, Place, and Promotion, in understanding consumers' purchase intention toward residential solar energy systems.

Previous studies have therefore demonstrated that consumers' decisions regarding renewable energy and environmentally friendly products are influenced by multiple interacting considerations rather than by a single determinant. Psychological factors may shape consumers' normative expectations and sense of responsibility; environmental knowledge may provide the cognitive basis for evaluating environmental consequences and clean-energy alternatives; and marketing factors may shape consumers' perceptions of product value, affordability, accessibility, and information. Existing research included in this study also provides evidence of these relationships. Jabbour Al Maalouf et al. (2024) identified subjective norms, environmental concern, social influence, and perceived solar-energy value as relevant factors in residential solar adoption; Pramana et al. (2024) found an important role for personal norms and subjective norms in Indonesian rooftop PV adoption; Simanjuntak et al. (2023) demonstrated the importance of environmental knowledge and environmental attitudes; and Photim et al. (2025) reported that product and price were particularly important in Thai residential solar rooftop decisions.

Although previous research has examined psychological factors, environmental knowledge, solar-energy adoption, and marketing-related variables in different countries and contexts, there remains a need for empirical research that examines these dimensions together in the context of residential solar energy systems in Bangkok, Thailand. Existing studies have often focused on individual determinants, specific behavioral theories, technical and economic feasibility, government policies, or particular marketing factors. Furthermore, evidence from other countries cannot necessarily be generalized to Thailand because residential solar adoption is affected by differences in electricity-market structures, regulatory arrangements, household characteristics, social norms, economic conditions, and consumer perceptions. Recent evidence from Thailand also indicates that residential rooftop solar continues to face policy and financial considerations that differ from those observed in other markets.

Therefore, this study aimed to examine the influence of Psychological Factors, Environmental Knowledge, and Marketing Mix on Customer Purchase Intention toward residential solar energy systems in Bangkok, Thailand. Psychological Factors were examined through Subjective Norm, Personal Norm, and Social Norm; Environmental Knowledge was examined through Climate Change Knowledge, Carbon Emission Knowledge, Energy Shortage Knowledge, and Clean Energy Knowledge; and Marketing Mix was examined through Product, Price, Place, and Promotion. Customer Purchase Intention represented consumers' willingness and likelihood to purchase and adopt residential solar energy systems. By integrating these dimensions within a single empirical framework, the study sought to provide evidence regarding the relative importance of psychological, environmental, and marketing factors in consumers' purchase intention and to provide practical implications for solar-energy businesses, marketers, policymakers, and other stakeholders seeking to support residential solar adoption in Thailand.

1.2 Problems of the study

The Thai government has continuously promoted renewable energy development to reduce dependence on fossil fuels, enhance energy security, and support long-term environmental sustainability. Residential solar energy systems represent an important component of this transition because they allow households to generate electricity from renewable sources and may reduce dependence on conventional grid electricity. Thailand has favorable conditions for solar energy development; however, the availability of solar resources and technological improvements alone do not guarantee household adoption. Previous research on Thailand has identified technical, economic, social, and regulatory barriers that can affect the implementation of residential rooftop solar systems (Chaianong & Pharino, 2015). More recent research has also demonstrated that consumers consider several marketing-related factors when making decisions regarding residential solar rooftop systems. For example, Photim et al. (2025) found that product and price were particularly important in consumers' evaluations, while product quality, accessibility, and promotional benefits also influenced residential solar rooftop decisions in Thailand. Therefore, the

continuing development of the residential solar market requires greater understanding of the factors that influence consumers' willingness to purchase these systems.

Previous empirical studies have identified several factors that influence consumers' purchase intention toward green products and renewable energy technologies, including psychological influences, environmental knowledge, and marketing-related variables. However, the findings reported in previous studies are not entirely consistent. Jabbour Al Maalouf et al. (2024) examined consumers' intention to adopt residential solar energy systems in Lebanon and found that environmental concern, subjective norms, perceived solar energy value, and social influence positively affected attitudes, while attitude was the strongest predictor of purchase intention. Similarly, Pramana et al. (2024) investigated consumers' intention to purchase residential rooftop photovoltaic systems in Indonesia and found that personal norm was the strongest predictor, while subjective norm and government regulation also positively influenced purchase intention. These findings indicate that psychological and social factors may play an important role in consumers' renewable energy decisions. However, the influence of environmental knowledge appears to be less consistent. Simanjuntak et al. (2023) found that environmental knowledge positively influenced environmental attitudes, whereas green marketing and environmental attitudes positively affected green purchase intention. These differences suggest that environmental knowledge may not necessarily translate directly into purchase intention and that its effect may depend on the behavioral and product context. In addition, marketing-related factors may influence how consumers evaluate solar energy systems in terms of product quality, price, accessibility, and promotional information. The differences among previous findings indicate that consumer purchasing behavior may be influenced by the specific social, economic, environmental, and marketing context in which the decision is made.

In Thailand, previous research has examined several aspects of solar energy adoption, including technical performance, government policies, financial feasibility, and specific marketing variables. Photim et al. (2025), for example, examined marketing-mix factors affecting residential solar rooftop decisions in Thailand and reported a high overall influence of the marketing mix, with product and price being particularly important considerations. However, the existing evidence provides limited understanding of how Psychological Factors, Environmental Knowledge, and Marketing Mix jointly relate to Customer Purchase Intention toward residential solar energy systems. In particular, Psychological Factors in this study consist of Subjective Norm, Personal Norm, and Social Norm, while Environmental Knowledge includes Climate Change Knowledge, Carbon Emission Knowledge, Energy Shortage Knowledge, and Clean Energy Knowledge. Marketing Mix is represented by Product, Price, Place, and Promotion. These dimensions correspond directly to the variables and measurement structure established in the present study. Consequently, there remains a need for empirical evidence concerning the relative contribution of these three major factors to consumers' purchase intention within the Thai residential solar-energy market, particularly in Bangkok.

Addressing this research gap is important because understanding the factors that influence customers' purchase intention can assist solar energy providers and marketers in developing more appropriate product offerings, pricing strategies, distribution channels, and promotional communication. It can also assist policymakers and relevant organizations in designing educational and awareness-building initiatives that address consumers' knowledge and psychological considerations related to residential solar energy. Therefore, this study investigated the influence of Psychological Factors, Environmental Knowledge, and Marketing Mix on Customer Purchase Intention toward residential solar energy systems in Bangkok, Thailand. The study was intended to provide empirical evidence regarding the determinants of consumer purchase intention and to contribute practical implications for solar energy businesses, marketers, policymakers, and other stakeholders seeking to promote residential solar energy adoption in Thailand. The study's hypotheses directly examine whether Psychological Factors, Environmental Knowledge, and Marketing Mix significantly influence Customer Purchase Intention.

1.3 Research Questions

1.3.1 What are the levels of Psychological Factors, Environmental Knowledge, Marketing Mix, and Customer Purchase Intention toward residential solar energy systems in Bangkok, Thailand?

1.3.2 What are the relationships between Psychological Factors, Environmental Knowledge, Marketing Mix, and Customer Purchase Intention toward residential solar energy systems in Bangkok, Thailand?

1.3.3 To what extent do Psychological Factors, Environmental Knowledge, and Marketing Mix significantly predict Customer Purchase Intention toward residential solar energy systems in Bangkok, Thailand?

1.4 Research Objectives

1.4.1 To examine the levels of Psychological Factors, Environmental Knowledge, Marketing Mix, and Customer Purchase Intention toward residential solar energy systems in Bangkok, Thailand.

1.4.2 To examine the relationships between Psychological Factors, Environmental Knowledge, Marketing Mix, and Customer Purchase Intention toward residential solar energy systems in Bangkok, Thailand.

1.4.3 To examine the effects of Psychological Factors, Environmental Knowledge, and Marketing Mix on Customer Purchase Intention toward residential solar energy systems in Bangkok, Thailand.

1.5 Scope of the research

1.5.1 Population Scope

The target population of this research comprised individuals of all genders residing in Bangkok, Thailand, who are 22 – 60 years of age, have attained at least a diploma-level education, and are currently employed across various occupational sectors. Bangkok was selected as the study area because it has the largest population in Thailand, with an estimated population of approximately 5.42 – 5.50 million residents, representing about 8% of the country's total population (National Statistical Office, 2025)

1.5.2 Content Scope

This study focused on investigating the factors influencing consumers' purchase intention toward residential solar energy systems in Bangkok, Thailand. To provide a comprehensive explanation of consumers' purchasing decisions, the research integrated concepts from consumer behavior, psychological theory, environmental knowledge, and marketing theory into a unified conceptual framework.

The research examined three independent latent constructs: Psychological Factors, Environmental Knowledge, and Marketing Mix. Psychological Factors consist of Subjective Norm, Personal Norm, and Social Norm, reflecting the influence of social expectations and individual moral responsibility on purchasing decisions. Environmental Knowledge comprises Climate Change Knowledge, Carbon Emission Knowledge, Energy Shortage Knowledge, and Clean Energy Knowledge, representing consumers' awareness of environmental issues associated with renewable energy adoption. Marketing Mix is examined through four dimensions: Product, Price, Place, and Promotion, which represent key marketing strategies influencing consumer decision-making.

1.5.3 Research Variables

The variables employed in this study were classified into independent and dependent variables. The conceptual framework comprises three independent variables: (1) Psychological Factors (PC), (2) Environmental Knowledge (EK), and (3) Marketing Mix (4P), and one dependent variable: Customers' Purchase Intention toward Residential Solar Energy Systems (CPI).

The Psychological Factors (PC), an independent variable, is measured by three observed variables: Subjective Norm (SN), Personal Norm (PN), and Social Norm (SCN).

The Environmental Knowledge (EK), an independent variable, is measured by four observed variables: Climate Change Knowledge (CCK), Carbon Emission Knowledge (CEK), Energy Shortage Knowledge (ESK), and Clean Energy Knowledge (CEKn).

The Marketing Mix (4Ps), an independent variable, is measured by four observed variables: Product (P1), Price (P2), Place (P3), and Promotion (P4).

The Customers' Purchase Intention toward Residential Solar Energy Systems (CPI), the dependent variable, is measured by five observed variables: Energy-Saving Motivation (ESM), Perceived Product Quality (PQ), Perceived Long-Term Investment Benefits (LTI), Positive Attitude toward Using Solar Energy (PA), and Perceived Household Benefits (PHB).

1.5.4 Analytic Scope

The analytical scope of this study covered the statistical examination of factors influencing customers' purchase intention toward residential solar energy systems in Bangkok, Thailand. The analysis was conducted using data from 396 valid respondents and focused on four principal study variables: Psychological Factors (PC), Environmental Knowledge (EK), Marketing Mix (4P), and Customer Purchase Intention (CPI). These variables were examined to assess their relationships, predictive effects, and differences across respondents' demographic characteristics.

1.5.5 Timing Scope

The research period spanned from Jan 1, 2026 to July 8, 2026.

1.6 Definition of Key Terms

1.6.1 Solar energy systems

refers to residential photovoltaic (PV) systems that convert sunlight into electricity for household use. In this study, the term refers specifically to rooftop solar systems used to reduce reliance on conventional electricity and support renewable energy adoption.

1.6.2 Psychology

refers to the social and personal influences that shape consumers' decisions regarding the purchase and adoption of residential solar energy systems. In this study, psychological factors comprise subjective norm, personal norm, and social norm, reflecting perceived expectations from significant others, individual moral responsibility toward environmental behavior, and shared social expectations regarding solar energy adoption.

1.6.3 Environmental Knowledge

refers to consumers' understanding of environmental issues related to energy consumption and renewable energy. In this study, it includes knowledge of climate change, carbon emissions, energy shortages, and clean energy.

1.6.4 Marketing Mix

refers to the combination of marketing strategies used to influence consumer purchasing decisions. In this study, it comprises Product, Price, Place, and Promotion, which represent the quality and features, affordability and value, accessibility and availability, and promotional communication of residential solar energy systems, respectively.

1.6.5 Customers' Purchase Intention

refers to consumers' willingness and likelihood to purchase and adopt residential solar energy systems. In this study, it reflects consumers' intention based on energy-saving motivation, perceived product quality, long-term investment benefits, positive attitudes, and perceived household benefits.



Chapter 2 Literature Review

For this research, the researcher reviewed concepts, theories, and related research. The review covers the following:

- 2.1 Customer Behavior Concept
- 2.2 Psychological Concept
- 2.3 Environmental Knowledge Concept
- 2.4 Marketing Mix Concept
- 2.5 Customer Purchase Intention Concept
- 2.6 Residential Solar Energy Systems
- 2.7 Related Research
- 2.8 Research Framework

2.1 Customer Behavior Concept

Consumer behavior refers to the processes through which individuals or groups recognize needs, evaluate alternatives, purchase, use, and dispose of products or services. It is influenced by psychological, social, cultural, personal, and situational factors throughout the decision-making process.

Engel et al. (1995) conceptualized consumer behavior as a decision-making process involving problem recognition, information search, alternative evaluation, purchase, consumption, post-purchase evaluation, and disposal. Schiffman and Wisenblit (2019) emphasized the allocation of consumers' time, money, and effort, together with psychological and external factors such as motivation, perception, culture, family, and marketing activities. Kotler and Keller (2016) identified cultural, social, personal, and psychological factors as major determinants of purchasing decisions. Solomon (2020) further defined consumer behavior as the processes through which individuals or groups select, purchase, use, and dispose of products, services, ideas, or experiences to satisfy their needs and desires.

Overall, consumer behavior is a multidimensional decision-making process shaped by individual characteristics and external influences. Understanding these factors provides a basis for explaining purchasing decisions and developing marketing strategies that respond to consumer needs and preferences.

2.2 Psychological Concept

Psychology explains how cognitive, emotional, and behavioral processes influence individual decision-making. Individuals actively interpret information, integrate previous experiences, and evaluate potential outcomes before engaging in behavior (Neisser, 1967). Lewin's (1936) Field Theory proposes that behavior results from the interaction between personal characteristics and environmental conditions, expressed as $B = f(P, E)$. Similarly, Bandura's (1986) Social Cognitive Theory emphasizes the reciprocal interaction among personal cognition, behavior, and environmental influences, including observational learning and social interaction.

In consumer behavior, psychological factors influence how individuals interpret information, evaluate alternatives, and form purchase intentions. These factors include beliefs, values, perceptions, experiences, and social expectations (Bandura, 1986; Lewin, 1936). In the present study, psychological factors are represented by Subjective Norm, Personal Norm, and Social Norm. Subjective Norm reflects perceived expectations from significant others and is derived from TRA and TPB (Fishbein & Ajzen, 1975; Ajzen, 1991). Personal Norm represents an individual's internal moral obligation to perform a behavior based on Norm Activation Theory (Schwartz, 1977). Social Norm reflects perceived societal expectations and accepted behavioral patterns, consistent with the Focus Theory of Normative Conduct (Cialdini et al., 1990, 1991). Together, these dimensions explain the normative influences underlying consumers' intention to purchase residential solar energy systems.

2.3 Environmental Knowledge Concept

Environmental knowledge refers to individuals' understanding of environmental issues, ecological systems, and the consequences of human activities on the environment. Fryxell and Lo (2003) defined it as knowledge of facts, concepts, and relationships concerning the natural environment and its major ecosystems. Kaiser and Fuhrer (2003) further conceptualized environmental knowledge as multidimensional, comprising system knowledge, action-related knowledge, and effectiveness knowledge, which explain environmental processes, possible actions, and their expected outcomes.

Maloney and Ward (1973) identified environmental knowledge as an important basis for understanding environmental problems and developing environmentally responsible behavior. In consumer research, environmental knowledge supports the evaluation of environmentally friendly products and technologies and can influence environmental attitudes and purchase intentions. However, knowledge alone may not determine behavior and can interact with personal values, psychological factors, social norms, and perceived behavioral control.

In the context of residential solar energy systems, environmental knowledge refers to consumers' understanding of climate change, carbon emissions, energy resource limitations, and

clean energy technologies. Such knowledge provides a cognitive basis for evaluating the environmental and practical benefits of solar energy and may influence consumers' purchase intentions.

2.4 Marketing Mix Concept

The marketing mix refers to the controllable marketing variables that organizations integrate to satisfy customer needs and achieve marketing objectives. The concept originated from Culliton (1948), who described marketers as “mixers of ingredients,” and was formalized by Borden (1964). McCarthy (1960) subsequently simplified the framework into four elements: Product, Price, Place, and Promotion (4Ps).

Kotler and Keller (2016) further defined the marketing mix as a set of controllable marketing tools used to generate the desired response in a target market. The 4Ps emphasize the integration of product characteristics, pricing, distribution, and promotional activities rather than treating each element independently. Effective marketing therefore requires consistency among the four elements to create customer value and influence purchasing decisions.

Although expanded models such as the 7Ps have been developed, the 4Ps remain appropriate for tangible products. For residential solar energy systems, Product concerns system quality, features, and reliability; Price reflects affordability and economic value; Place concerns distribution and accessibility; and Promotion involves communication of product benefits and incentives. Accordingly, the 4Ps provide an appropriate framework for examining factors influencing consumers' purchase intentions toward residential solar energy systems in Thailand.

2.5 Customer Purchase Intention Concept

Customer purchase intention refers to an individual's willingness or likelihood to purchase a product or service in the future. It represents a key predictor of subsequent purchasing behavior, although intention does not necessarily result in actual purchase (Fishbein & Ajzen, 1975).

According to the Theory of Reasoned Action (TRA), behavioral intention is determined by attitudes and subjective norms and serves as the immediate antecedent of behavior (Fishbein & Ajzen, 1975). The Theory of Planned Behavior (TPB) further incorporates perceived behavioral control, recognizing that purchase decisions may be affected by factors such as financial resources and product availability (Ajzen, 1991). Thus, purchase intention reflects consumers' willingness to act after evaluating product information, expected benefits, and relevant constraints.

In the context of residential solar energy systems, customer purchase intention represents the degree to which consumers are willing to adopt solar technology based on their psychological

factors, environmental knowledge, and perceptions of the marketing mix. It is therefore an appropriate dependent variable for examining consumers' decisions regarding residential solar energy adoption.

2.6 Residential Solar Energy Systems

2.6.1 Definition of Residential Solar Energy Systems (RSES)

RSES is renewable energy systems that use photovoltaic (PV) technology to convert sunlight into electricity for household consumption. As distributed energy resources, RSES generate electricity at the point of use, reducing dependence on conventional grid electricity and supporting energy independence, carbon reduction, and sustainable energy consumption.

2.6.2 Operating Principle of Residential Solar Energy Systems

RSES operate through the photovoltaic effect, in which solar cells convert sunlight into direct current (DC) electricity. An inverter then converts DC electricity into alternating current (AC) for household use. Excess electricity may be stored in batteries or exported to the grid, while electricity can be supplied from batteries or the grid when solar generation is insufficient.

2.6.3 Components of Residential Solar Energy Systems

The main components include PV panels, solar inverters, mounting structures, electrical wiring and protection equipment, and battery energy storage systems. PV panels generate electricity, inverters convert and regulate electricity, mounting structures support the panels, and protection equipment ensures safe operation. Battery storage and smart monitoring systems may also be incorporated to improve energy management, reliability, and system monitoring.

2.6.4 Factors Affecting System Performance

System performance is primarily affected by solar irradiance, geographic location, panel orientation and tilt, shading, temperature, equipment quality, installation standards, and maintenance. Appropriate installation and high-quality components contribute to greater energy efficiency, reliability, and system lifespan.

2.6.5 Benefits of Residential Solar Energy Systems

RSES provide economic, environmental, and energy-security benefits. They can reduce household electricity costs, decrease greenhouse gas emissions and fossil-fuel dependence, and contribute to energy diversification and system resilience. These benefits support sustainable household energy consumption and broader renewable energy objectives.

2.6.6 Limitations of Residential Solar Energy Systems

Key limitations include high initial investment, intermittent electricity generation, installation constraints, battery costs, and maintenance requirements. System feasibility and performance may also be affected by roof characteristics, shading, weather conditions, and local regulations.

2.6.7 Residential Solar Energy Systems from the Consumer Perspective

From a consumer perspective, RSES represent a high-involvement, long-term investment requiring evaluation of installation costs, electricity savings, payback period, financing, government incentives, system efficiency, equipment quality, warranties, maintenance, environmental benefits, and installer reliability. Because of the substantial investment and long-term benefits, consumers typically engage in information search and comparison before purchase. Consequently, purchase decisions are influenced by perceived economic value, technological performance, environmental considerations, and long-term household benefits.

2.7 Related Research

Jabbour Al Maalouf et al. (2024) examined consumers' intention to adopt residential solar energy systems in Lebanon using TRA and TPB. Based on 450 valid questionnaires, the study found that environmental concern, subjective norms, perceived solar energy value, and social influence positively affected attitudes, while behavioral constraints had a negative effect. Attitude was the strongest predictor of purchase intention ($\beta = 0.944$, $p < 0.001$). The study recommended financial incentives, supportive regulations, public awareness, and marketing strategies emphasizing the economic and environmental value of solar energy.

Pramana et al. (2024) investigated consumers' intention to purchase residential rooftop PV systems in Indonesia. Using 602 valid responses, the study found that personal norm was the strongest predictor, while subjective norm and government regulation also positively influenced purchase intention. Attitude was significant among lower-income consumers, whereas perceived behavioral control was insignificant. The study recommended strengthening environmental responsibility, social influence, government support, and financial incentives to promote rooftop PV adoption.

Simanjuntak et al. (2023) examined environmental knowledge, WOM, green marketing, environmental attitudes, and green purchase intention based on ABC Theory and NAM. Using SEM with 159 valid responses, the findings showed that environmental knowledge positively influenced environmental attitudes, while green marketing and environmental attitudes positively affected purchase intention. Environmental knowledge had no direct effect on purchase intention, indicating the mediating importance of environmental attitudes.

Asif et al. (2023) examined residential solar energy purchase intention in rural China by extending TPB with environmental knowledge, environmental concern, and perceived solar benefits. Based on 847 valid responses, attitude, environmental knowledge, subjective norm, perceived behavioral control, and perceived solar benefits positively influenced purchase intention, while environmental concern was insignificant. The study emphasized education, financial incentives, infrastructure development, and improved accessibility of solar technologies.

Koojaroenprasit and Pumpinyo (2024) examined the effects of the 4Ps on consumers' purchasing decisions regarding environmentally friendly technologies in Bangkok. Based on 415 respondents, price was the most influential marketing-mix element, followed by considerations of product quality, accessibility, and promotional benefits. The study recommended competitive pricing, quality products, accessible services, and government financial incentives to encourage sustainable technology adoption.

Photim et al. (2025) investigated marketing-mix factors affecting residential solar rooftop decisions in Thailand. Using 513 valid responses, the study found a high overall influence of the 7Ps, with product and price being particularly important. Certified equipment, qualified installers, safety, service quality, warranties, and after-sales support strongly influenced consumer decisions. The study recommended certified products, professional installation, transparent information, maintenance services, warranties, and flexible financing to reduce perceived risk and support solar adoption.

2.8 Research Framework

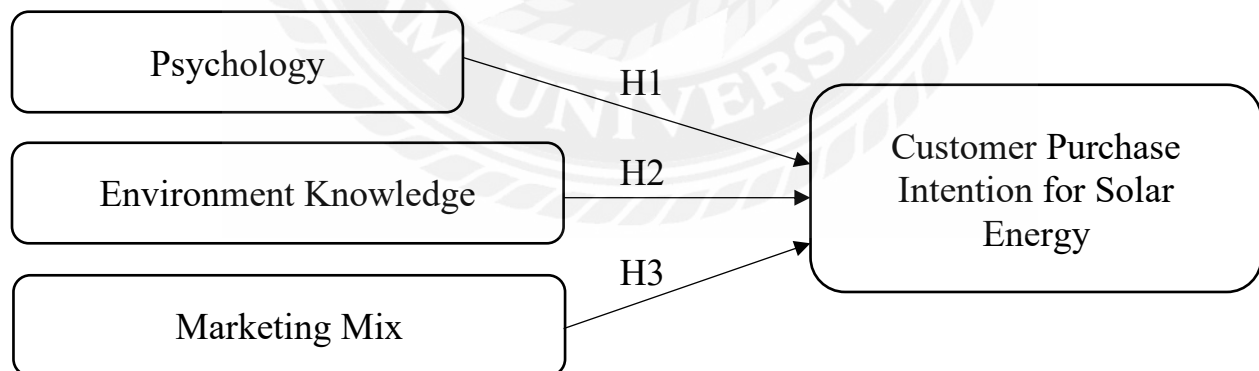


Figure 2.1 Research Framework

The research framework presents the relationship between the study variables. Psychological Factors, Environmental Knowledge, and Marketing Mix are the independent variables, while Customer Purchase Intention for Solar Energy is the dependent variable. The framework provides the basis for examining how the three independent variables relate to and predict customers' purchase intention toward residential solar energy systems.

Chapter 3 Methodology

This study, entitled *An Integrated Model of Consumers' Purchase Intention toward Residential Solar Energy Systems in Bangkok, Thailand: The Roles of Psychological, Environmental, and Marketing Factors*, employed a quantitative research approach to examine the factors associated with consumers' purchase intention toward residential solar energy systems. The methodology was designed to provide a systematic procedure for defining the study population, selecting an appropriate sample, collecting and assessing the quality of the data, and conducting statistical analysis.

This chapter presents the population, sampling method, research instrument, data collection procedures, data quality assessment, and data analysis methods. The data analysis was conducted using SPSS, including descriptive statistics, Cronbach's alpha reliability analysis, Pearson correlation analysis, Pearson chi-square analysis, multiple linear regression analysis, and One-Way ANOVA with Scheffé post hoc comparisons. These procedures were used to describe the sample and study variables, assess the reliability of the measurement scales, examine relationships among the study variables, determine their predictive effects on customer purchase intention, and identify differences across demographic groups.

3.1 Population

The target population of this research comprised individuals of all genders residing in Bangkok, Thailand, who are 22 – 60 years of age, have attained at least a diploma-level education, and are currently employed across various occupational sectors. Bangkok was selected as the study area because it has the largest population in Thailand, with an estimated population of approximately 5.42 – 5.50 million residents, representing about 8% of the country's total population (Thailand National Statistical Office, 2025)

3.2 Sample

The sample size was determined using Cochran's (1963) formula for an unknown population at a 95% confidence level and a 5% margin of error, resulting in a minimum required sample size of 384 respondents. To obtain a sufficient number of valid responses, 450 questionnaires were collected using a purposive sampling technique targeting potential purchasers, prospective customers, and individuals involved in purchasing decisions regarding residential solar energy systems in Thailand.

3.3 Hypothesis

H1: Psychological Factors significantly influence Customer Purchase Intention toward residential solar energy systems in Bangkok, Thailand.

H2: Environmental Knowledge significantly influences Customer Purchase Intention toward residential solar energy systems in Bangkok, Thailand.

H3: Marketing Mix significantly influences Customer Purchase Intention toward residential solar energy systems in Bangkok, Thailand.

3.4 Research Instrument

The research instrument employed in this study was a structured questionnaire developed based on a review of relevant literature, theoretical frameworks, and previously established measurement scales. The questionnaire was designed to measure the four principal constructs of the study: Psychological Factors, Environmental Knowledge, Marketing Mix, and Customer Purchase Intention toward Residential Solar Energy Systems. Existing measurement items were adapted from previous empirical studies to maintain consistency with established constructs. Minor modifications were made where necessary to reflect the context of residential solar energy systems in Bangkok, Thailand, while maintaining the original meaning of the measurement items.

The questionnaire consisted of five parts. Part 1 collected demographic information using categorical questions. Parts 2 to 5 measured the study variables using a five-point Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The scale was used to measure respondents' levels of agreement with each statement and to provide quantitative data for subsequent statistical analysis using SPSS, as shown in Tables 3.1 – 3.5.

Part 1: Demographic Information

The first part collected respondents' demographic characteristics, including gender, age, educational attainment, occupation, monthly income, marital status, and family size. These variables were used to describe the characteristics of the respondents and to examine differences and associations between demographic characteristics and the study variables. The demographic questions were adapted from Jabbour Al Maalouf et al. (2024).

Part 2: Psychological Factors

Psychological Factors were measured through three dimensions: Subjective Norm, Personal Norm, and Social Norm. Subjective Norm reflects perceived expectations from important others, Personal Norm represents an individual's sense of moral responsibility toward environmental protection, and Social Norm reflects the influence of social expectations and

information from others. The measurement items were adapted from Asif et al. (2023), Pramana et al. (2024), Abbas et al. (2024), and Jabbour Al Maalouf et al. (2024).

Part 3: Environmental Knowledge

Environmental Knowledge was measured using four dimensions: Climate Change Knowledge, Carbon Emission Knowledge, Energy Shortage Knowledge, and Clean Energy Knowledge. These dimensions represent respondents' knowledge of the environmental and energy-related benefits of solar energy. The measurement items were adapted from Lin and Dong (2023) and modified to reflect the context of residential solar energy systems.

Part 4: Marketing Mix

The Marketing Mix was measured using the four dimensions of Product, Price, Place, and Promotion. Product represents perceptions of product quality, reliability, and performance; Price reflects perceptions of price and value; Place concerns accessibility and service convenience; and Promotion reflects marketing communication and promotional activities. The measurement items were adapted from Photim et al. (2025) and adjusted to suit the context of residential solar energy systems in Thailand.

Part 5: Customer Purchase Intention toward Residential Solar Energy Systems

Customer Purchase Intention was measured through five dimensions: Energy-Saving Motivation, Perceived Product Quality, Perceived Long-Term Investment Benefits, Positive Attitude toward Using Solar Energy, and Perceived Household Benefits. These dimensions represent respondents' intentions and perceptions of the expected benefits associated with residential solar energy systems. The measurement items were adapted from Asif et al. (2023), Pramana et al. (2024), Jabbour Al Maalouf et al. (2024), and Nguyen et al. (2022)

Table 3.1 Measurement Items of Demographic Characteristics

Variable	Dimension	Measurement Item	Measurement Scale	Source
Demographic	Gender	Male	Categorical	Jabbour Al Maalouf et al. (2024)
		Female		
		LGBTQ		
	Age	22 – 30 years		
		31 – 40 years		
		41 – 50 years		
		51 – 60 years		

Table 3.1(Cont.) Measurement Items of Demographic Characteristics

Variable	Dimension	Measurement Item	Measurement Scale	Source
	Educational Attainment	Diploma-level		Jabbour Al Maalouf et al. (2024)
		Bachelor's degree		
		Master's degree		
		Doctor's degree		
	Occupation	Government Employee		
		State Enterprise Employee		
		Company Employee		
		Business Owner		
		Freelancer		
	Monthly Income	15,001 – 25,000		
		25,001 – 35,000		
		35,001 – 45,000		
		45,001 – 55,000		
		55,001 and above		
	Marital Status	Single		
		Married		
		Divorced		
		Separated		
		Widowed		
	Family Size	Small family (1-2 members)		
		Medium family (3-4 members)		
		Large family (5 or more members)		

Table 3.2 Measurement Items of Psychological Factors

Variable	Dimension	Item Code	Measurement Item	Measurement Scale	Source
Psychological Factors	Subjective Norm	SN1	1 My family members think that I should purchase solar energy.	5-point Likert scale	Asif et al. (2023) Pramana et al. (2024)
		SN2	2 My friends and relatives encourage me to purchase solar energy.		
		SN3	3 My neighbors would approve of my decision to purchase solar energy.		
		SN4	4 The opinions of people who are important to me influence my decision to purchase solar energy.		
		SN5	5 I consider the expectations of people who are close to me when deciding whether to purchase solar energy.		

Table 3.2(Cont.) Measurement Items of Psychological Factors

Variable	Dimension	Item Code	Measurement Item	Measurement Scale	Source
Psychological Factors	Personal Norm	PN1	1 I believe that purchasing a Residential Solar Energy System is my moral responsibility.	5-point Likert scale	Pramana et al. (2024) Abbas et al. (2024)
		PN2	2 I feel personally responsible for reducing environmental impacts by purchasing a Residential Solar Energy System.		
		PN3	3 I would feel guilty if I ignored purchasing a Residential Solar Energy System for the environmental benefits.		
		PN4	4 I feel a sense of personal satisfaction when considering the purchase of a Residential Solar Energy System because it contributes to environmental sustainability.		
		PN5	5 Purchasing a Residential Solar Energy System reflects my personal values regarding environmental protection.		

Table 3.2(Cont.) Measurement Items of Psychological Factors

Variable	Dimension	Item Code	Measurement Item	Measurement Scale	Source
Psychological Factors	Social Norm	SCN1	1 If purchasing a Residential Solar Energy System becomes a popular social trend, I am more likely to purchase one.	5-point Likert scale	Abbas et al. (2024) Jabbour Al Maalouf et al. (2024)
		SCN2	2 Recommendations from influencers encourage me to purchase a Residential Solar Energy System.		
		SCN3	3 Recommendations from environmental experts increase my willingness to purchase a Residential Solar Energy System.		
		SCN4	4 I use social media to search for information about Residential Solar Energy Systems.		
		SCN5	5 I trust information about Residential Solar Energy Systems shared on social media.		
		SCN6	6 Positive opinions shared by others influence my decision to purchase a Residential Solar Energy System.		

Table 3.3 Measurement Items of Environmental Knowledge Factors

Variable	Dimension	Item Code	Measurement Item	Measurement Scale	Source
Environmental Knowledge Factors	Climate Change Knowledge	CCK	1 I understand that Residential Solar Energy Systems can help reduce the effects of climate change.	5-point Likert scale	Lin and Dong (2023)
	Carbon Emission Knowledge	CEK	2 I have sufficient knowledge about how Residential Solar Energy Systems help reduce carbon emissions.		
	Energy Shortage Knowledge	ESK	3 I understand that Residential Solar Energy Systems can help address energy shortages by generating renewable electricity.		
	Clean Energy Knowledge	CEKn	4 I understand that Residential Solar Energy Systems are a form of clean and renewable energy.		

Table 3.4 Measurement Items of Marketing Mix Factors

Variable	Dimension	Item Code	Measurement Item	Measurement Scale	Source
Marketing Mix Factors	Product	P11	1 The materials and components of a Residential Solar Energy System should comply with recognized quality and safety standards.	5-point Likert scale	Photim et al. (2025)
		P12	2 A Residential Solar Energy System should be covered by a comprehensive warranty and insurance.		
		P13	3 A Residential Solar Energy System should have a long-lasting and reliable battery storage system.		
		P14	4 A Residential Solar Energy System should have an attractive and modern design.		
		P15	5 A Residential Solar Energy System should provide efficient battery charging and energy storage performance.		
		P16	6 A Residential Solar Energy System should include advanced safety features to ensure safe operation.		
		P17	7 A Residential Solar Energy System should support multiple charging and energy management options.		

Table 3.4(Cont.) Measurement Items of Marketing Mix Factors

Variable	Dimension	Item Code	Measurement Item	Measurement Scale	Source
Marketing Mix Factors	Price	P21	1 The price of a Residential Solar Energy System is reasonable considering its quality and performance.	5-point Likert scale	Photim et al. (2025)
		P22	2 The insurance cost associated with a Residential Solar Energy System is reasonable.		
		P23	3 The prices of accessories and installation equipment for a Residential Solar Energy System are reasonable.		
		P24	4 The price of a Residential Solar Energy System is competitive compared with similar products available in the market.		
		P25	5 The price of a Residential Solar Energy System meets customer expectations.		
		P26	6 The maintenance cost of a Residential Solar Energy System is reasonable.		

Table 3.4(Cont.) Measurement Items of Marketing Mix Factors

Variable	Dimension	Item Code	Measurement Item	Measurement Scale	Source
Marketing Mix Factors	Place	P31	1 Residential Solar Energy Systems are available through conveniently located sales and service centers. (such as parking space, near transportation publi, etc.)	5-point Likert scale	Photim et al. (2025)
		P32	2 Sales and service centers for Residential Solar Energy Systems are easily accessible. (such as traffic flow, online channel support etc.)		
		P33	3 Residential Solar Energy Systems are available through one-stop service centers that provide consultation, sales, installation, and after-sales services.		
		P34	4 Residential Solar Energy System providers have sufficient branches or service centers to support customers.		
		P35	5 Residential Solar Energy System providers offer convenient home delivery and installation services.		
		P36	6 Sales and service centers for Residential Solar Energy Systems are clean and well decorated		

Table 3.4(Cont.) Measurement Items of Marketing Mix Factors

Variable	Dimension	Item Code	Measurement Item	Measurement Scale	Source
Marketing Mix Factors	Promotion	P41	1 Residential Solar Energy Systems are promoted through a variety of online and offline advertising channels.	5-point Likert scale	Photim et al. (2025)
		P42	2 Public relations activities effectively increase public awareness of Residential Solar Energy Systems.		
		P43	3 Sales promotions (e.g., discounts, coupons, free maintenance, or free cleaning services) make Residential Solar Energy Systems more attractive to purchase.		
		P44	4 Sales representatives provide knowledgeable and professional recommendations about Residential Solar Energy Systems.		
		P45	5 Promotional campaigns provide sufficient information to help consumers make purchasing decisions.		
		P46	6 Promotional activities encourage consumers to consider purchasing a Residential Solar Energy System.		

Table 3.5 Measurement Items of Customers' Purchase Intention Factors

Variable	Dimension	Item Code	Measurement Item	Measurement Scale	Source
Customers' Purchase Intention	Energy Saving Motivation	ESM	1 My motivation to save energy increases my intention to purchase a Residential Solar Energy System.	5-point Likert scale	Asif et al. (2023)
	Perceived Product Quality	PQ	2 My perception of the high quality of a Residential Solar Energy System increases my intention to purchase one.		Nguyen et al. (2022)
	Perceived Long-Term Investment Benefits	LTB	3 The long-term investment benefits of a Residential Solar Energy System increase my intention to purchase one.		Jabbour Al Maalouf et al. (2024)
	Positive Attitude toward Using Solar Energy	PA	4 My positive attitude toward using solar energy increases my intention to purchase a Residential Solar Energy System.		Pramana et al. (2024)
	Perceived Household Benefits	PHB	5 My understanding of the household benefits of a Residential Solar Energy System increases my intention to purchase one.		

3.5 Data Collection

This study employed a quantitative research approach using a structured questionnaire as the primary instrument for data collection. Data were collected through both online and offline survey methods from respondents who met the predetermined sampling criteria. The respondents were individuals of all genders residing in Bangkok, Thailand, aged 22–60 years, with at least a diploma-level education, and currently employed.

Before completing the questionnaire, respondents were informed of the purpose and objectives of the study. Participation was voluntary, and respondents were informed that their responses would be treated confidentially and used solely for academic research purposes.

A total of 450 questionnaires were collected. Following data collection, the questionnaires were coded, checked for completeness and response quality, and screened for suitability for statistical analysis. After the screening process, 54 responses were excluded, resulting in 396 valid questionnaires for the final analysis.

3.6 Data Analysis Methods

The collected data were analyzed using IBM SPSS Statistics. The statistical procedures were selected to correspond with the research objectives and the nature of the collected data. The data analysis was conducted in six parts as follows.

Part 1: Descriptive Statistical Analysis

Descriptive statistics were used to summarize the demographic characteristics of the respondents, including gender, age, educational attainment, occupation, monthly income, marital status, and family size. Frequency and percentage were used to describe the demographic profile, while mean and standard deviation were used to summarize the study variables.

Part 2: Reliability Analysis

The reliability of the measurement instrument was assessed using Cronbach's alpha coefficient to examine the internal consistency of the items within each study construct. Corrected item-total correlations were also examined to assess the contribution of individual items to their respective constructs. The analysis was conducted for Psychological Factors, Environmental Knowledge, Marketing Mix, and Customer Purchase Intention.

Part 3: Pearson Correlation Analysis

Pearson correlation analysis was conducted to examine the direction and strength of the linear relationships among the dimensions of the study variables and the four principal study variables. The Pearson correlation coefficient (r) was used to determine the strength and direction of the relationships, with statistical significance assessed at the specified significance level.

Part 4: Pearson Chi-Square Analysis

The Pearson chi-square test of independence was conducted to examine whether statistically significant associations existed between respondents' demographic characteristics and the four study variables: Psychological Factors, Environmental Knowledge, Marketing Mix, and Customer Purchase Intention. The study variables were categorized prior to the analysis, and statistical significance was evaluated at the 0.05 level.

Part 5: Multiple Linear Regression Analysis

Multiple linear regression analysis was conducted to examine the predictive effects of Psychological Factors, Environmental Knowledge, and Marketing Mix on Customer Purchase Intention toward residential solar energy systems. The three independent variables were entered simultaneously using the Enter method. The analysis examined the regression coefficients, standardized beta coefficients, t-values, significance levels, R^2 , adjusted R^2 , and the overall significance of the regression model.

Part 6: One-Way Analysis of Variance

One-Way Analysis of Variance (ANOVA) was conducted to determine whether significant differences existed in Psychological Factors, Environmental Knowledge, Marketing Mix, and Customer Purchase Intention across the respondents' demographic groups, including gender, age, education level, occupation, monthly income, marital status, and family size. Statistical significance was assessed at the 0.05 level. Where the overall ANOVA result was statistically significant, the Scheffé post hoc test was conducted to identify the specific groups that differed significantly.

Chapter 4 Findings and Discussion

Following data collection, the questionnaires were screened for completeness, eligibility, consistency, and response quality. Of the 450 questionnaires collected, 54 responses were excluded, resulting in 396 valid responses for the final analysis.

The data were analyzed using IBM SPSS Statistics through descriptive statistics, Cronbach's alpha reliability analysis, Pearson correlation, Pearson chi-square, multiple linear regression, and One-Way ANOVA with Scheffé post hoc comparisons. These analyses were conducted to examine the study variables, their relationships, predictive effects, and differences across demographic groups.

4.1 Descriptive Statistics of Respondents

Descriptive statistics were used to summarize the demographic characteristics of the 396 respondents, including gender, age, educational attainment, occupation, monthly income, marital status, and family size. The frequency and percentage distributions of these demographic characteristics are presented in Table 4.1.

Table 4.1 Descriptive Statistics of Sample's Demographic Characteristics

Demographic Characteristic	Frequency (n)	Percentage (%)
Gender		
Male	167	42.2
Female	185	46.7
LGBTQ	44	11.1
Age		
22 – 30 years	159	40.2
31 – 40 years	114	28.8
41 – 50 years	70	17.7
51 – 60 years	53	13.4
Educational Attainment		
Diploma-level	35	8.8
Bachelor's degree	225	56.8
Master's degree	112	28.3
Doctor's degree	24	6.1
Occupation		
Government Employee	57	14.4
State Enterprise Employee	34	8.6
Company Employee	141	35.6

Table 4.1(Cont.) Descriptive Statistics of Sample's Demographic Characteristics

Demographic Characteristic	Frequency (n)	Percentage (%)
Occupation		
Business Owner	95	24.0
Freelancer	69	17.4
Monthly Income		
15,001 – 25,000	127	32.1
25,001 – 35,000	120	30.3
35,001 – 45,000	83	21.0
45,001 – 55,000	39	9.8
55,001 and above	27	6.8
Marital Status		
Single	175	44.2
Married	144	36.4
Divorced	25	6.3
Separated	26	6.6
Widowed	26	6.6
Family Size		
Small family (1-2 members)	109	27.5
Medium family (3-4 members)	167	42.2
Large family (5 or more members)	120	30.3
Total	396	100

Table 4.1 presents the demographic characteristics of the 396 respondents who participated in this study. The respondents were classified according to gender, age, educational attainment, occupation, monthly income, marital status, and family size.

Regarding gender, the largest proportion of respondents were female, accounting for 46.7% (n = 185), followed by male respondents at 42.2% (n = 167). Respondents identifying as LGBTQ represented 11.1% (n = 44) of the total sample.

In terms of age, the majority of respondents were between 22 and 30 years old, representing 40.2% (n = 159) of the sample. Respondents aged 31–40 years accounted for 28.8% (n = 114), followed by those aged 41–50 years at 17.7% (n = 70). The smallest age group comprised respondents aged 51–60 years, representing 13.4% (n = 53).

Regarding educational attainment, most respondents held a bachelor's degree, accounting for 56.8% (n = 225). This was followed by respondents with a master's degree (28.3%, n = 112), diploma-level education (8.8%, n = 35), and doctoral degrees (6.1%, n = 24).

With respect to occupation, company employees constituted the largest group, representing 35.6% (n = 141). Business owners accounted for 24.0% (n = 95), followed by freelancers at 17.4% (n = 69), government employees at 14.4% (n = 57), and state enterprise employees at 8.6% (n = 34).

For monthly income, the largest proportion of respondents reported earning 15,001–25,000 Thai Baht per month, accounting for 32.1% (n = 127). Respondents with monthly incomes of 25,001–35,000 Thai Baht represented 30.3% (n = 120), while those earning 35,001–45,000 Thai Baht accounted for 21.0% (n = 83). Respondents with monthly incomes of 45,001–55,000 Thai Baht represented 9.8% (n = 39), whereas those earning 55,001 Thai Baht or above comprised the smallest group at 6.8% (n = 27).

Regarding marital status, single respondents formed the largest group, accounting for 44.2% (n = 175). Married respondents represented 36.4% (n = 144), while widowed and separated respondents each accounted for 6.6% (n = 26). Divorced respondents represented the smallest proportion of the sample at 6.3% (n = 25).

Finally, regarding family size, respondents living in medium-sized households (3–4 members) constituted the largest group, accounting for 42.2% (n = 167). Respondents from large households (five or more members) represented 30.3% (n = 120), while those from small households (1–2 members) accounted for 27.5% (n = 109).

Overall, the sample primarily consisted of female respondents, individuals aged 22–30 years, bachelor's degree holders, company employees, respondents earning between 15,001 and 25,000 Thai Baht per month, single individuals, and respondents living in medium-sized households. These demographic characteristics provide an overview of the respondent profile used for the subsequent analyses of the factors influencing consumers' purchase intention toward residential solar energy systems in Bangkok, Thailand.

4.2 Descriptive Statistics of Variables

Descriptive was conducted to summarize the study variables, including psychological factors, environmental knowledge, marketing mix, and customers' purchase intention toward residential solar energy systems. The results are presented in Table 4.2.

Table 4.2 Descriptive Statistics of Psychological Factors

Dimension	$\bar{x}$	S.D.	Result
Psychological Factors			
Subjective Norm			
My family members think that I should purchase solar energy	3.6136	1.13616	Medium
My friends and relatives encourage me to purchase solar energy.	3.3232	1.15466	Medium
My neighbors would approve of my decision to purchase solar energy.	3.2626	1.19777	Medium
The opinions of people who are important to me influence my decision to purchase solar energy.	3.5379	1.13676	Medium
I consider the expectations of people who are close to me when deciding whether to purchase solar energy.	3.5177	1.14834	Medium
Personal Norm			
I believe that purchasing solar energy is my moral responsibility.	3.6338	1.14063	Medium
I feel personally responsible for reducing environmental impacts by purchasing solar energy.	3.6944	.99623	Medium
I would feel guilty if I ignored purchasing solar energy for the environmental benefits.	3.5480	1.18224	Medium
I feel a sense of personal satisfaction when considering the purchase of solar energy because it contributes to environmental sustainability.	3.7980	1.01612	Medium
Purchasing solar energy reflects my personal values regarding environmental protection.	3.6793	1.11181	Medium
Social Norm			
If purchasing solar energy becomes a popular social trend, I am more likely to purchase.	3.5758	1.03939	Medium
Recommendations from influencers encourage me to purchase solar energy.	3.5328	1.02941	Medium
Recommendations from environmental experts increase my willingness to purchase solar energy.	3.7121	1.02028	Medium
I use social media to search for information about solar energy.	3.5909	1.01598	Medium
I trust information about solar energy shared on social media.	3.6414	1.02263	Medium
Positive opinions shared by others influence my decision to purchase solar energy.	3.6540	1.05014	Medium

Table 4.2 presents the descriptive statistics of the psychological factors influencing consumers' purchase intention toward residential solar energy systems in Bangkok, Thailand. The psychological factors comprise three dimensions: Subjective Norm, Personal Norm, and Social Norm. Overall, all measurement items were rated at a moderate level, indicating that respondents perceived psychological influences as having a moderate impact on their intention to purchase residential solar energy systems.

Regarding Subjective Norm, the statement "My family members think that I should purchase solar energy" received the highest mean score ($M = 3.61$, $SD = 1.14$), followed by "The opinions of people who are important to me influence my decision to purchase solar energy" ($M = 3.54$, $SD = 1.14$) and "I consider the expectations of people who are close to me when deciding whether to purchase solar energy" ($M = 3.52$, $SD = 1.15$). In contrast, "My neighbors would approve of my decision to purchase solar energy" recorded the lowest mean score ($M = 3.26$, $SD = 1.20$). These findings suggest that respondents were more influenced by the opinions of close family members and significant others than by those of their neighbors when considering the purchase of residential solar energy systems.

For Personal Norm, the highest-rated statement was "I feel a sense of personal satisfaction when considering the purchase of solar energy because it contributes to environmental sustainability" ($M = 3.80$, $SD = 1.02$). This was followed by "Purchasing solar energy reflects my personal values regarding environmental protection" ($M = 3.68$, $SD = 1.11$) and "I feel personally responsible for reducing environmental impacts by purchasing solar energy" ($M = 3.69$, $SD = 1.00$). The lowest mean score was observed for "I would feel guilty if I ignored purchasing solar energy for the environmental benefits" ($M = 3.55$, $SD = 1.18$). Overall, the results indicate that respondents moderately associated purchasing residential solar energy systems with their personal values and environmental responsibility.

Regarding Social Norm, "Recommendations from environmental experts increase my willingness to purchase solar energy" obtained the highest mean score ($M = 3.71$, $SD = 1.02$). Other relatively high-rated statements included "Positive opinions shared by others influence my decision to purchase solar energy" ($M = 3.65$, $SD = 1.05$) and "I trust information about solar energy shared on social media" ($M = 3.64$, $SD = 1.02$). The lowest mean score was reported for "Recommendations from influencers encourage me to purchase solar energy" ($M = 3.53$, $SD = 1.03$). These findings suggest that respondents placed greater trust in information provided by environmental experts and other consumers than in recommendations from social media influencers.

Overall, the descriptive statistics indicate that all three psychological dimensions were perceived at a moderate level. Among the three dimensions, Personal Norm exhibited the strongest tendency, particularly regarding respondents' sense of personal satisfaction from contributing to

environmental sustainability. In comparison, Subjective Norm reflected the influence of family members and significant others on purchasing decisions, whereas Social Norm highlighted the importance of expert recommendations and positive social opinions in shaping consumers' purchase intentions toward residential solar energy systems.

Table 4.3 Descriptive Statistics of Environmental Knowledge Factors

Dimension	$\bar{x}$	S.D.	Result
Environmental Knowledge Factors			
Solar energy can help reduce the effects of climate change.	3.9596	.83492	Medium
Solar Energy help reduce carbon emissions.	3.8838	.91493	Medium
Solar Energy can help address energy shortages by generating renewable electricity.	3.9975	.92640	Medium
Solar Energy are a form of clean and renewable energy.	3.9949	.96258	Medium

Table 4.3 presents the descriptive statistics of the environmental knowledge factors related to consumers' purchase intention toward residential solar energy systems in Bangkok, Thailand. The findings indicate that all environmental knowledge indicators were rated at a moderate level, suggesting that respondents possessed a moderate level of knowledge regarding the environmental benefits and contributions of residential solar energy systems.

Among the four indicators, the statement "Solar energy can help address energy shortages by generating renewable electricity" received the highest mean score ($M = 4.00$, $SD = 0.93$), indicating that respondents were relatively more aware of the role of solar energy in enhancing energy security through renewable electricity generation. This was closely followed by the statement "Solar energy is a form of clean and renewable energy" ($M = 3.99$, $SD = 0.96$) and "Solar energy can help reduce the effects of climate change" ($M = 3.96$, $SD = 0.83$).

The statement "Solar energy helps reduce carbon emissions" recorded the lowest mean score ($M = 3.88$, $SD = 0.91$), although it remained within the moderate level of agreement. This result suggests that respondents were comparatively less aware of the contribution of residential solar energy systems to carbon emission reduction than of their roles in renewable electricity generation and environmental sustainability.

Overall, the findings indicate that respondents demonstrated a moderate level of environmental knowledge regarding residential solar energy systems. The highest level of agreement was associated with the contribution of solar energy to renewable electricity generation and energy security, whereas knowledge related to carbon emission reduction received relatively lower agreement. Nevertheless, all indicators recorded mean scores approaching 4.00, reflecting a generally positive level of environmental awareness among the respondents.

Table 4.4 Descriptive Statistics of Marketing Mix Factors

Dimension	$\bar{x}$	S.D.	Result
Marketing Mix Factors			
Product			
The materials and components of solar energy should comply with recognized quality and safety standards.	4.3510	.82709	Good
Solar Energy should be covered by a comprehensive warranty and insurance.	4.2551	.86161	Good
Solar Energy should have a long-lasting and reliable battery storage system.	4.3611	.85590	Good
Solar Energy should have an attractive and modern design.	4.2348	.88183	Good
Solar Energy should provide efficient battery charging and energy storage performance.	4.3636	.83535	Good
Solar Energy should include advanced safety features to ensure safe operation.	4.3687	.85710	Good
Solar Energy should support multiple charging and energy management options.	4.2551	.83778	Good
Price			
The price of solar energy is reasonable considering its quality and performance.	4.4470	.77277	Good
The insurance cost associated with solar energy is reasonable.	4.3535	.81831	Good
The prices of accessories and installation equipment for solar energy are reasonable.	4.4167	.80858	Good
The price of solar energy is competitive compared with similar products available in the market.	4.2702	.83906	Good
The price of solar energy meets customer expectations.	4.3636	.82927	Good
The maintenance cost of solar energy is reasonable.	4.4066	.79801	Good
Place			
Solar Energy is available through conveniently located sales and service centers. (such as parking space, near transportation publi, etc.)	4.0732	.84326	Good
Sales and service centers for solar energy are easily accessible. (such as traffic flow, online channel support etc.)	4.0152	.82969	Good
Solar Energy are available through one-stop service centers that provide consultation, sales, installation, and after-sales services.	4.0657	.88631	Good
Solar Energy providers have sufficient branches or service centers to support customers.	4.0051	.85090	Good

Table 4.4 (Cont.) Descriptive Statistics of Marketing Mix Factors

Dimension	$\bar{x}$	S.D.	Result
Place			
Solar Energy providers offer convenient home delivery and installation services.	4.1465	.89937	Good
Sales and service centers for solar energy are clean and well decorated	4.0707	.87152	Good
Promotion			
Solar Energy are promoted through a variety of online and offline advertising channels.	3.9217	.85176	Medium
Public relations activities effectively increase public awareness of solar energy.	3.7980	.82345	Medium
Sales promotions (e.g., discounts, coupons, free maintenance, or free cleaning services) make solar energy more attractive to purchase.	4.0732	.90130	Good
Sales representatives provide knowledgeable and professional recommendations about solar energy.	3.9823	.92897	Medium
Promotional campaigns provide sufficient information to help consumers make purchasing decisions.	3.9318	.89889	Medium
Promotional activities encourage consumers to consider purchasing solar energy.	3.9268	.90411	Medium

Table 4.4 presents the descriptive statistics of the marketing mix factors influencing consumers' purchase intention toward residential solar energy systems in Bangkok, Thailand. The marketing mix comprises four dimensions: Product, Price, Place, and Promotion. Overall, respondents expressed positive perceptions of the marketing mix. The Product, Price, and Place dimensions were evaluated at a good level, whereas Promotion was evaluated at a moderate level.

Regarding the Product dimension, all measurement items were rated at a good level. The statement "Solar energy should include advanced safety features to ensure safe operation" received the highest mean score ($M = 4.37$, $SD = 0.86$), followed closely by "Solar energy should provide efficient battery charging and energy storage performance" ($M = 4.36$, $SD = 0.84$) and "Solar energy should have a long-lasting and reliable battery storage system" ($M = 4.36$, $SD = 0.86$). The lowest mean score was recorded for "Solar energy should have an attractive and modern design" ($M = 4.23$, $SD = 0.88$). These findings indicate that respondents placed greater importance on product quality, safety, and system performance than on product appearance.

For the Price dimension, all indicators were also evaluated at a good level. The highest mean score was observed for "The price of solar energy is reasonable considering its quality and performance" ($M = 4.45$, $SD = 0.77$). This was followed by "The prices of accessories and

installation equipment for solar energy are reasonable" ($M = 4.42$, $SD = 0.81$) and "The maintenance cost of solar energy is reasonable" ($M = 4.41$, $SD = 0.80$). The lowest mean score within this dimension was "The price of solar energy is competitive compared with similar products available in the market" ($M = 4.27$, $SD = 0.84$). Overall, the results suggest that respondents emphasized value for money and reasonable ownership costs when evaluating residential solar energy systems.

Regarding the Place dimension, all measurement items achieved a good level of agreement. The highest mean score was obtained by "Solar energy providers offer convenient home delivery and installation services" ($M = 4.15$, $SD = 0.90$), followed by "Solar energy is available through conveniently located sales and service centers" ($M = 4.07$, $SD = 0.84$) and "Sales and service centers for solar energy are clean and well decorated" ($M = 4.07$, $SD = 0.87$). The lowest mean score was reported for "Solar energy providers have sufficient branches or service centers to support customers" ($M = 4.01$, $SD = 0.85$). These findings indicate that respondents valued convenient access to installation and after-sales services when considering residential solar energy systems.

With respect to the Promotion dimension, most indicators were evaluated at a moderate level, while only one indicator reached a good level. The highest mean score was recorded for "Sales promotions (e.g., discounts, coupons, free maintenance, or free cleaning services) make solar energy more attractive to purchase" ($M = 4.07$, $SD = 0.90$), indicating that promotional incentives were perceived as the most effective marketing activity. Conversely, "Public relations activities effectively increase public awareness of solar energy" received the lowest mean score ($M = 3.80$, $SD = 0.82$). The remaining indicators—including advertising through online and offline channels, knowledgeable sales representatives, promotional campaigns providing purchasing information, and promotional activities encouraging consumers to consider purchasing solar energy—were all evaluated at a moderate level, with mean scores ranging from 3.92 to 3.98.

Overall, the descriptive statistics indicate that respondents assigned greater importance to Product and Price attributes than to Promotion when evaluating residential solar energy systems. Product quality, safety, performance, and reasonable pricing received the highest levels of agreement, whereas promotional activities were perceived less favorably. These findings suggest that consumers place greater emphasis on the tangible attributes and economic value of residential solar energy systems than on marketing communications when forming their purchase intentions.

Table 4.5 Descriptive Statistics of Customers' Purchase Intention Factors

Dimension	$\bar{x}$	S.D.	Result
Customers' Purchase Intention toward Residential Solar Energy Systems			
My motivation to save energy increases my intention to purchase.	4.0530	.83573	Good
My perception of the high quality of solar energy increases my intention to purchase.	3.9823	.81268	Medium
The long-term investment benefits of solar energy increase my intention to purchase.	4.0859	.84056	Good
My positive attitude toward using solar energy increases my intention to purchase.	3.9899	.84787	Medium
My understanding of the household benefits solar increases my intention to purchase.	4.0303	.85334	Good

Table 4.5 presents the descriptive statistics of customers' purchase intention toward residential solar energy systems in Bangkok, Thailand. The findings indicate that respondents exhibited a moderately high level of purchase intention, with all measurement items evaluated at either the good or moderate level.

Among the five indicators, the statement "The long-term investment benefits of solar energy increase my intention to purchase" received the highest mean score ($M = 4.09$, $SD = 0.84$), indicating that respondents regarded long-term economic benefits as the most influential factor in their intention to purchase residential solar energy systems. This was followed by "My motivation to save energy increases my intention to purchase" ($M = 4.05$, $SD = 0.84$) and "My understanding of the household benefits of solar energy increases my intention to purchase" ($M = 4.03$, $SD = 0.85$). These three indicators were evaluated at the good level.

The remaining two indicators were rated at the moderate level. "My positive attitude toward using solar energy increases my intention to purchase" recorded a mean score of 3.99 ($SD = 0.85$), while "My perception of the high quality of solar energy increases my intention to purchase" received the lowest mean score ($M = 3.98$, $SD = 0.81$). Although these indicators received relatively lower ratings, their mean scores remained close to 4.00, reflecting generally favorable perceptions among the respondents.

Overall, the results suggest that respondents demonstrated a relatively positive intention to purchase residential solar energy systems. Long-term investment benefits, energy-saving motivation, and perceived household benefits were the strongest contributors to purchase intention, whereas perceptions of product quality and positive attitudes toward solar energy were comparatively less influential, although they were still evaluated favorably.

4.3 Reliability Analysis

Before conducting the main statistical analyses, the reliability of the measurement items was assessed using Cronbach's alpha coefficient. This analysis was conducted to determine the internal consistency of the items measuring each study construct. A Cronbach's alpha value of 0.70 or above is generally considered acceptable for research purposes. The analysis also examined the corrected item–total correlations to confirm that each item contributed adequately to the overall construct.

Table 4.6 Cronbach's Alpha Reliability of Psychological Factors

Construct	Dimension	Mean	SD	Corrected Item–Total Correlation	Cronbach's Alpha
Psychological Factors (PC)	Subjective Norm (SN)	3.4510	1.00436	.798	.897
	Personal Norm (PN)	3.6707	.97194	.802	-
	Social Norm (SCN)	3.6178	.91909	.795	-
Overall PC	3 items	10.7396	2.63892	-	.897

Table 4.6 shows that the Psychological Factors achieved a Cronbach's alpha of 0.897, indicating a high level of internal consistency among the three items. The corrected item–total correlations ranged from .795 to .802, exceeding the recommended minimum level. Therefore, all three items—Subjective Norm, Personal Norm, and Social Norm—were retained for subsequent analysis.

Table 4.7 Cronbach's Alpha Reliability of Environmental Knowledge Factors

Construct	Dimension	Mean	SD	Corrected Item–Total Correlation	Cronbach's Alpha
Environmental Knowledge (EK)	Climate Change Knowledge (CCK)	3.9596	.83492	.741	.907
	Clean Energy Knowledge (CEK)	3.8838	.91493	.796	-
	Energy Shortage Knowledge (ESK)	3.9975	.92640	.825	-
	Carbon Emission Knowledge (CEKn)	3.9949	.96258	.800	-
Overall EK	4 items	15.8359	3.22032	-	.907

Table 4.7 shows that the Environmental Knowledge (EK) achieved a Cronbach's alpha of .907, indicating high internal consistency among the four items. The corrected item–total correlations ranged from .741 to .825, confirming satisfactory relationships between each item and

the overall construct. Since all items contributed adequately to the reliability of the scale, all four items were retained for subsequent analysis.

Table 4.8 Cronbach's Alpha Reliability of Marketing Mix Factors

Construct	Dimension	Mean	SD	Corrected Item–Total Correlation	Cronbach's Alpha
Marketing Mix Factors	Product (P1)	4.3128	.75129	.740	.861
	Price (P2)	4.3763	.71146	.688	-
	Place (P3)	4.0627	.74776	.675	-
	Promotion (P4)	3.9390	.74299	.730	-
Overall 4Ps	4 items	16.6907	2.48281	-	.861

Table 4.8 shows that the Marketing Mix factors (4Ps) achieved a Cronbach's alpha coefficient of .861, indicating good internal consistency among the four items. The corrected item–total correlations ranged from .675 to .740, demonstrating satisfactory relationships between each item and the overall construct. Although the values for P2 (.688) and P3 (.675) were below .70, they remained sufficiently high for item retention. In addition, the Cronbach's alpha values if individual items were deleted ranged from .810 to .837, all lower than the overall alpha of .861. Therefore, removing any item would not improve the reliability of the scale. All four items were consequently retained for subsequent analysis.

Table 4.9 Cronbach's Alpha Reliability of Customer Purchase Intention Factors

Construct	Dimension	Mean	SD	Corrected Item–Total Correlation	Cronbach's Alpha
Customer Purchase Intention (CPI)	Energy-Saving Motivation (ESM)	4.0530	.83573	.774	.916
	Perceived Product Quality (PQ)	3.9823	.81268	.771	-
	Long-Term Investment (LTI)	4.0859	.84056	.784	-
	Positive Attitude (PA)	3.9899	.84787	.824	-
	Perceived Household Benefits (PHB)	4.0303	.85334	.774	-
Overall CPI	5 items	20.1414	3.62833	-	.916

Table 4.9 shows that the Customer Purchase Intention (CPI) construct obtained a Cronbach's alpha coefficient of .916, indicating a high level of internal consistency among the five measurement items. The corrected item–total correlations ranged from .771 to .824, exceeding the acceptable threshold of .30. Furthermore, the Cronbach's alpha values if an item were deleted ranged from .890 to .901, all lower than the overall alpha of .916. Therefore, all five items were retained for subsequent statistical analysis, confirming that the CPIF scale demonstrated satisfactory reliability for the study.

Table 4.10 Cronbach's Alpha Reliability of All Variables

Variable	Mean	S.D.	Corrected Item–Total Correlation	Cronbach's Alpha if Item Deleted
Psychological Factors (PC)	3.5799	.87964	.716	.865
Environmental Knowledge (EK)	3.9590	.80508	.768	.837
Marketing Mix (4Ps)	4.1727	.62070	.797	.838
Customer Purchase Intention (CPI)	4.0283	.72567	.733	.851
Overall All Factors	15.7398	2.62241	-	.881

Table 4.10 presents the reliability assessment of the four study factors using Cronbach's alpha. The overall Cronbach's alpha coefficient was .881, indicating a high level of internal consistency among the factors included in the reliability assessment. The corrected item–total correlations ranged from .716 to .797, demonstrating that each factor had a strong positive relationship with the overall scale and contributed appropriately to the measurement structure.

The Cronbach's Alpha if Item Deleted statistic was also examined to assess whether removing any individual factor would improve the reliability coefficient. The resulting values ranged from .837 to .865, which were all lower than the overall Cronbach's alpha of .881. This indicates that the removal of any one factor would reduce, rather than improve, the internal consistency of the scale. In particular, removing Psychological Factors would result in $\alpha = .865$, Environmental Knowledge in $\alpha = .837$, Marketing Mix in $\alpha = .838$, and Customer Purchase Intention in $\alpha = .851$.

Accordingly, there was no statistical basis for excluding any of the four study factors from the subsequent analysis. The reliability results therefore support the retention of Psychological Factors (PC), Environmental Knowledge (EK), Marketing Mix (4Ps), and Customer Purchase Intention (CPI) as the principal factors examined in this study. These results, together with the individual construct reliability coefficients reported in Tables 3.1–3.4, provide evidence that the measurement scales demonstrate adequate internal consistency for subsequent statistical analysis.

4.4 Validity and Factorability Analysis

Validity and factorability analysis was conducted to determine whether the measurement items were suitable for further statistical analysis. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's Test of Sphericity were used to assess the adequacy of the correlation structure among the measurement items. Factor loadings, communalities, and the percentage of variance explained were also examined to evaluate the relationships between the measurement items and their respective dimensions. The analysis was conducted separately for each dimension of the study variables.

Table 4.11 Validity and Factorability Analysis of Subjective Norm Measurement Items

Measurement Item	Factor Loading	Communality
SN1	.892	.796
SN2	.858	.737
SN3	.851	.724
SN4	.873	.762
SN5	.875	.766
KMO	.793	
Bartlett's Approx. Chi-Square	1,741.673	
df	10	
Sig.	< .001	
Total Variance Explained	75.700%	

Table 4.11 shows the validity and factorability results for the Subjective Norm measurement items. The KMO value was .793, while Bartlett's Test of Sphericity was statistically significant ($\chi^2 = 1,741.673$, $df = 10$, $p < .001$), indicating adequate correlations among the items. Factor loadings ranged from .851 to .892, and communalities ranged from .724 to .796. The extracted factor explained 75.700% of the total variance, and all five items were retained for further analysis.

Table 4.12 Validity and Factorability Analysis of Personal Norm Measurement Items

Measurement Item	Factor Loading	Communality
PN1	.897	.804
PN2	.884	.781
PN3	.897	.804
PN4	.879	.773
PN5	.901	.813
KMO	.854	
Bartlett's Approx. Chi-Square	1,741.952	
df	10	
Sig.	< .001	
Total Variance Explained	79.493%	

Table 4.12 shows the validity and factorability results for the Personal Norm measurement items. The KMO value was .854, and Bartlett's Test of Sphericity was statistically significant ($\chi^2 = 1,741.952$, $df = 10$, $p < .001$), indicating adequate correlations among the items. Factor loadings ranged from .879 to .901, while communalities ranged from .773 to .813. The extracted factor explained 79.493% of the total variance, and all five items were retained for further analysis.

Table 4.13 Validity and Factorability Analysis of Social Norm Measurement Items

Measurement Item	Factor Loading	Communality
SCN1	.853	.727
SCN2	.900	.809
SCN3	.885	.784
SCN4	.881	.776
SCN5	.922	.850
SCN6	.916	.838
KMO	.911	
Bartlett's Approx. Chi-Square	2,297.485	
df	15	
Sig.	< .001	
Total Variance Explained	79.727%	

Table 4.13 shows the validity and factorability results for the Social Norm measurement items. The KMO value was .911, and Bartlett's Test of Sphericity was statistically significant ($\chi^2 = 2,297.485$, $df = 15$, $p < .001$), indicating adequate correlations among the items. Factor loadings ranged from .853 to .922, while communalities ranged from .727 to .850. The extracted factor explained 79.727% of the total variance, and all six items were retained for further analysis.

Table 4.14 Validity and Factorability Analysis of Psychological Factors

Measurement Item	Factor Loading	Communality
SN	.911	.830
PN	.913	.834
SCN	.910	.828
KMO	.753	
Bartlett's Approx. Chi-Square	718.201	
df	3	
Sig.	< .001	
Total Variance Explained	83.054%	

Table 4.14 shows the validity and factorability results for Psychological Factors. The KMO value was .753, and Bartlett's Test of Sphericity was statistically significant ($\chi^2 = 718.201$, $df = 3$, $p < .001$), indicating adequate correlations among the dimensions. Factor loadings ranged

from .910 to .913, while communalities ranged from .828 to .834. The extracted factor explained 83.054% of the total variance, indicating that the three dimensions adequately represented Psychological Factors.

Table 4.15 Validity and Factorability Analysis of Environmental Knowledge Factors

Measurement Item	Factor Loading	Communality
CCK	.852	.726
CEK	.888	.789
ESK	.905	.820
CEKn	.890	.793
KMO	.818	
Bartlett's Approx. Chi-Square	1,062.958	
df	6	
Sig.	< .001	
Total Variance Explained	78.197%	

Table 4.15 presents the validity and factorability results for the items in the Environmental Knowledge dimension. The KMO value was .818, and Bartlett's Test of Sphericity was statistically significant ($\chi^2 = 1,062.958$, $df = 6$, $p < .001$), indicating adequate correlations among the items. Factor loadings ranged from .852 to .905, while communalities ranged from .726 to .820. The extracted factor explained 78.197% of the total variance, and all four items were retained for further analysis.

Table 4.16 Validity and Factorability Analysis of Product Measurement Items

Measurement Item	Factor Loading	Communality
P11	.834	.695
P12	.870	.757
P13	.913	.834
P14	.840	.705
P15	.918	.844
P16	.916	.839
P17	.889	.791
KMO	.926	
Bartlett's Approx. Chi-Square	2,767.943	
df	21	
Sig.	< .001	
Total Variance Explained	78.068%	

Table 4.16 shows the validity and factorability results for the Product measurement items. The KMO value was .926, and Bartlett's Test of Sphericity was statistically significant ($\chi^2 = 2,767.943$, $df = 21$, $p < .001$), indicating adequate correlations among the items. Factor loadings

ranged from .834 to .918, while communalities ranged from .695 to .844. The extracted factor explained 78.068% of the total variance, and all seven items were retained for further analysis.

Table 4.17 Validity and Factorability Analysis of Price Measurement Items

Measurement Item	Factor Loading	Communality
P21	.829	.687
P22	.859	.739
P23	.908	.824
P24	.874	.764
P25	.885	.783
P26	.906	.821
KMO	.909	
Bartlett's Test: Approx. χ^2	2,056.565	
df	15	
Sig.	< .001	
Total Variance Explained (%)	76.981	

The validity of the Price measurement items in Table 4.17 was assessed using the KMO measure and Bartlett's Test of Sphericity. The KMO value was .909, while Bartlett's Test was significant ($\chi^2 = 2,056.565$, $df = 15$, $p < .001$). Factor loadings ranged from .829 to .908, and communalities ranged from .687 to .824. The extracted factor explained 76.981% of the total variance. All six Price items were therefore retained for subsequent analysis.

Table 4.18 Validity and Factorability Analysis of Place Measurement Items

Measurement Item	Factor Loading	Communality
P31	.840	.706
P32	.858	.736
P33	.884	.781
P34	.843	.711
P35	.893	.798
P36	.874	.764
KMO	.897	
Bartlett's Test: Approx. χ^2	1,891.969	
df	15	
Sig.	< .001	
Total Variance Explained (%)	74.941	

The validity of the Place measurement items in Table 4.18 was assessed using the KMO measure and Bartlett's Test of Sphericity. The KMO value was .897, and Bartlett's Test was significant ($\chi^2 = 1,891.969$, $df = 15$, $p < .001$). Factor loadings ranged from .840 to .893, while

communalities ranged from .706 to .798. The extracted factor explained 74.941% of the total variance. All six Place items were retained for subsequent analysis.

Table 4.19 Validity and Factorability Analysis of Promotion Measurement Items

Measurement Item	Factor Loading	Communality
P41	.791	.626
P42	.796	.634
P43	.835	.698
P44	.855	.731
P45	.890	.792
P46	.864	.747
KMO	.881	
Bartlett's Test: Approx. χ^2	1,639.586	
df	15	
Sig.	< .001	
Total Variance Explained (%)	70.454	

The validity of the Promotion measurement items in Table 4.19 was assessed using the KMO measure and Bartlett's Test of Sphericity. The KMO value was .881, and Bartlett's Test was significant ($\chi^2 = 1,639.586$, $df = 15$, $p < .001$). Factor loadings ranged from .791 to .890, while communalities ranged from .626 to .792. The extracted factor explained 70.454% of the total variance. All six Promotion items were retained for subsequent analysis.

Table 4.20 Validity and Factorability Analysis of Marketing Mix Factors

Measurement Item	Factor Loading	Communality
P1	.864	.746
P2	.828	.685
P3	.816	.666
P4	.854	.729
KMO	.753	
Bartlett's Test of Sphericity	$\chi^2 = 798.675$	
df	6	
Sig.	< .001	
Total Variance Explained	70.669%	

Table 4.20 presents the validity/factorability analysis of the Marketing Mix. The KMO value was .753, and Bartlett's Test was significant ($\chi^2 = 798.675$, $df = 6$, $p < .001$). Factor loadings ranged from .816 to .864, with communalities from .666 to .746. The extracted factor explained 70.669% of the total variance, supporting the retention of all four dimensions.

Table 4.21 Validity and Factorability Analysis of Customers' Purchase Intention Factors

Measurement Item	Factor Loading	Communality
ESM	.858	.736
PQ	.856	.732
LTI	.865	.748
PA	.892	.796
PHB	.858	.736
KMO	.887	
Bartlett's Test of Sphericity	$\chi^2 = 1,343.434$	
df	10	
Sig.	< .001	
Total Variance Explained	74.981%	

Table 4.21 presents the validity/factorability analysis of Customer Purchase Intention. The KMO value was .887, and Bartlett's Test was significant ($\chi^2 = 1,343.434$, $df = 10$, $p < .001$). Factor loadings ranged from .856 to .892, with communalities from .732 to .796. The extracted factor explained 74.981% of the total variance, supporting the retention of all five dimensions.

4.5 Pearson Correlation Analysis

Pearson correlation analysis was conducted to examine the direction and strength of the linear relationships among the variables in the study. The Pearson correlation coefficient (r) ranges from -1 to $+1$, with a positive coefficient indicating a positive relationship between variables and a negative coefficient indicating an inverse relationship. A coefficient closer to ± 1 represents a stronger relationship, whereas a coefficient closer to 0 indicates a weaker relationship. The statistical significance of the correlations was assessed using a two-tailed test at the 0.01 significance level.

Table 4.22 Pearson Correlation Analysis of Psychological Factors

Dimension	Subjective Norm (SN)	Personal Norm (PN)	Social Norm (SCN)
Subjective Norm (SN)	1.000	.750**	.741**
Personal Norm (PN)	.750**	1.000	.746**
Social Norm (SCN)	.741**	.746**	1.000
N	396	396	396

For the Psychological Factors (PC) in Table 4.22, the results show that Subjective Norm (SN), Personal Norm (PN), and Social Norm (SCN) were positively and significantly correlated with one another. The correlation between SN and PN was $r = .750$, while the correlations between SN and SCN and between PN and SCN were $r = .741$ and $r = .746$, respectively. All correlations were statistically significant at $p < .001$, based on 396 respondents. These findings indicate that the three dimensions of Psychological Factors have strong positive relationships with one another.

Table 4.23 Pearson Correlation Analysis of Environmental Knowledge Factors

Dimension	Climate Change Knowledge (CCK)	Carbon Emission Knowledge (CEK)	Energy Shortage Knowledge (ESK)	Clean Energy Knowledge (CEKn)
Climate Change Knowledge (CCK)	1.000	.716**	.681**	.630**
Carbon Emission Knowledge (CEK)	.716**	1.000	.714**	.712**
Energy Shortage Knowledge (ESK)	.681**	.714**	1.000	.801**
Clean Energy Knowledge (CEKn)	.630**	.712**	.801**	1.000
N	396	396	396	396

Table 4.23 shows the Pearson correlation coefficients among the four dimensions of Environmental Knowledge (EK): Climate Change Knowledge (CCK), Carbon Emission Knowledge (CEK), Energy Shortage Knowledge (ESK), and Clean Energy Knowledge (CEKn). The results indicate that all four dimensions were positively and significantly correlated with one another, with correlation coefficients ranging from $r = .630$ to $.801$. The strongest correlation was found between ESK and CEKn ($r = .801$), while the weakest correlation was between CCK and CEKn ($r = .630$). All correlations were statistically significant at $p < .001$, based on 396 respondents. Overall, the findings indicate that the dimensions of Environmental Knowledge were strongly and positively associated with one another.

Table 4.24 Pearson Correlation Analysis of Marketing Mix Factors

Dimension	Product (P1)	Price (P2)	Place (P3)	Promotion (P4)
Product (P1)	1.000	.738**	.553**	.605**
Price (P2)	.738**	1.000	.492**	.554**
Place (P3)	.553**	.492**	1.000	.709**
Promotion (P4)	.605**	.554**	.709**	1.000
N	396	396	396	396

Table 4.24 shows the Pearson correlation coefficients among the four dimensions of Marketing Mix (4Ps): Product (P1), Price (P2), Place (P3), and Promotion (P4). The results indicate that all four dimensions were positively and significantly correlated with one another, with correlation coefficients ranging from $r = .492$ to $.738$. The strongest correlation was found between Product (P1) and Price (P2) ($r = .738$), while the weakest correlation was between Price (P2) and Place (P3) ($r = .492$). All correlations were statistically significant at $p < .001$, based on 396

respondents. Overall, the findings indicate that the four dimensions of the Marketing Mix were positively associated with one another.

Table 4.25 Pearson Correlation Analysis of Customers' Purchase Intention Factors

Dimension	Energy-Saving Motivation (ESM)	Perceived Product Quality (PQ)	Perceived Long-Term Investment Benefits (LTI)	Positive Attitude toward Using Solar Energy (PA)	Perceived Household Benefits (PHB)
Energy-Saving Motivation (ESM)	1.000	.698**	.682**	.701**	.637**
Perceived Product Quality (PQ)	.698**	1.000	.688**	.679**	.643**
Perceived Long-Term Investment Benefits (LTI)	.682**	.688**	1.000	.708**	.667**
Positive Attitude toward Using Solar Energy (PA)	.701**	.679**	.708**	1.000	.767**
Perceived Household Benefits (PHB)	.637**	.643**	.667**	.767**	1.000
N	396	396	396	396	396

Table 4.25 shows the Pearson correlation coefficients among the five dimensions of Customer Purchase Intention toward Residential Solar Energy Systems (CPI): Energy-Saving Motivation (ESM), Perceived Product Quality (PQ), Perceived Long-Term Investment Benefits (LTI), Positive Attitude toward Using Solar Energy (PA), and Perceived Household Benefits (PHB). The results indicate that all five dimensions were positively and significantly correlated with one another, with correlation coefficients ranging from $r = .637$ to $.767$. The strongest correlation was found between Positive Attitude toward Using Solar Energy (PA) and Perceived Household Benefits (PHB) ($r = .767$), while the weakest correlation was between Energy-Saving Motivation (ESM) and Perceived Household Benefits (PHB) ($r = .637$). All correlations were statistically significant at $p < .001$, based on 396 respondents. Overall, the findings indicate that the five dimensions of Customer Purchase Intention were positively associated with one another.

Table 4.26 Pearson Correlation Analysis of All Variables

Variable	Psychological Factors (PC)	Environmental Knowledge (EK)	Marketing Mix (4P)	Customer Purchase Intention (CPI)
Psychological Factors (PC)	1.000	.688**	.618**	.603**
Environmental Knowledge (EK)	.688**	1.000	.720**	.618**
Marketing Mix (4Ps)	.618**	.720**	1.000	.759**
Customer Purchase Intention (CPI)	.603**	.618**	.759**	1.000
N	396	396	396	396

Table 4.26 shows the Pearson correlation coefficients among the four main variables: Psychological Factors (PC), Environmental Knowledge (EK), Marketing Mix (4P), and Customer Purchase Intention toward Residential Solar Energy Systems (CPI). The results indicate that all variables were positively and significantly correlated with one another, with correlation coefficients ranging from $r = .603$ to $.759$. The strongest correlation was found between Marketing Mix (4P) and Customer Purchase Intention (CPI) ($r = .759$), while the weakest correlation was between Psychological Factors (PC) and Customer Purchase Intention (CPI) ($r = .603$). All correlations were statistically significant at $p < .001$, based on 396 respondents. Overall, the findings indicate that the four main variables were positively associated with one another.

4.6 Pearson Chi-square Analysis

The Pearson Chi-square test of independence was conducted to examine whether statistically significant associations existed between respondents' demographic characteristics and the four study variables: Psychological Factors (PC), Environmental Knowledge (EK), Marketing Mix (4P), and Customer Purchase Intention (CPI). The study variables were categorized prior to the analysis, and the analysis was based on 396 respondents. Statistical significance was assessed at the 0.05 level.

Table 4.27 Chi-square Analysis

Demo Variables	Gender	Age	Education	Occupation	Income	Status	Family's size
PC	0.523	0.209	0.181	0.362	0.122	0.892	0.142
EK	0.107	0.006	0.000	0.024	0.000	0.074	0.054
4Ps	0.829	0.647	0.105	0.503	0.720	0.695	0.350
CPI	0.637	0.253	0.492	0.120	0.339	0.165	0.031
N	396	396	396	396	396	396	396

Table 4.27 shows that Psychological Factors (PC) had no statistically significant association with any demographic characteristic, as all p-values were greater than .05.

Environmental Knowledge (EK) was significantly associated with Age ($p = .006$), Education ($p < .001$), Occupation ($p = .024$), and Income ($p < .001$), while no significant associations were found with Gender, Marital Status, or Family Size. Marketing Mix (4Ps) showed no statistically significant association with any demographic characteristic. Customer Purchase Intention (CPI) was significantly associated with Family Size ($p = .031$), whereas no significant associations were found with Gender, Age, Education, Occupation, Income, or Marital Status.

4.7 Multiple Linear Regression Analysis

Multiple linear regression analysis was conducted to examine the relationships between the three independent variables: Psychological Factors (PC), Environmental Knowledge (EK), and Marketing Mix (4Ps), and the dependent variable, Customer Purchase Intention toward Residential Solar Energy Systems (CPI). The three independent variables were entered simultaneously using the Enter method, with 396 valid observations.

Table 4.28 Model Summary and Analysis of Variance for Multiple Linear Regression

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson	F	Sig.
1	.779	.606	.603	.45719	1.586	201.039	< .001

Table 4.28 presents the results of the multiple linear regression model. The model produced a multiple correlation coefficient of $R = .779$ and an R^2 of .606, indicating that Psychological Factors, Environmental Knowledge, and Marketing Mix collectively explain 60.6% of the variance in Customer Purchase Intention. The adjusted R^2 was .603, indicating that the model explains approximately 60.3% of the variance after adjustment for the number of predictors. The overall regression model was statistically significant, $F(3, 392) = 201.039$, $p < .001$, indicating that the three independent variables, considered together, significantly predict Customer Purchase Intention.

Table 4.29 Multiple Linear Regression Coefficients for Customer Purchase Intention

Independent Variable	B	Std. Error	Standardized Beta (β)	t	Sig.
Constant	.334	.156	—	2.136	.033
Psychological Factors (PC)	.162	.037	.197	4.367	< .001
Environmental Knowledge (EK)	.044	.046	.049	.962	.336
Marketing Mix (4Ps)	.704	.055	.602	12.793	< .001

Table 4.29 shows that Psychological Factors (PC) and Marketing Mix (4Ps) were significant positive predictors of Customer Purchase Intention. PC had a significant positive coefficient ($\beta = .197$, $p < .001$), indicating that higher psychological factors were associated with

higher purchase intention. 4Ps had a stronger positive coefficient ($\beta = .602$, $p < .001$), indicating that Marketing Mix was the strongest predictor among the three independent variables. In contrast, Environmental Knowledge (EK) was not statistically significant ($\beta = .049$, $p = .336$). Therefore, when PC, EK, and 4Ps were considered simultaneously, PC and 4Ps significantly predicted CPI, whereas EK did not.

4.8 One-Way Analysis of Variance across Demographic Groups

One-Way Analysis of Variance was employed to examine whether significant differences existed in the study variables across different demographic groups. The analysis was conducted based on respondents' demographic characteristics, including gender, age, education level, occupation, monthly income, marital status, and family size. Specifically, the analysis assessed differences in Psychological Factors (PC), Environmental Knowledge (EK), Marketing Mix (4P), and Customer Purchase Intention toward Residential Solar Energy Systems (CPI). Statistical significance was evaluated at the 0.05 level. Where a statistically significant overall ANOVA result was obtained, a post hoc analysis was conducted to identify the specific groups that differed significantly. The Scheffé procedure was used for post hoc comparisons. The results of the analyses are presented in the following tables.

Table 4.30 One-Way Analysis of Variance of Variables across Gender Groups

Variable	Male	Female	LGBTQ	F	Sig.	Conclusion
Psychological Factors (PC)	3.6846	3.5098	3.4765	2.086	.126	Not significant
Environmental Knowledge(EK)	3.9957	3.9546	3.9167	.862	.423	Not significant
Marketing Mix (4Ps)	4.1770	4.1454	4.1667	.255	.775	Not significant
Customer Purchase Intention (CPI)	4.1011	4.0200	3.9222	2.290	.103	Not significant

Table 4.30 shows that there were no statistically significant differences in the mean scores of the four study variables across the three gender groups. Psychological Factors showed $F(2, 393) = 2.086$, $p = .126$; Environmental Knowledge showed $F(2, 393) = .862$, $p = .423$; Marketing Mix showed $F(2, 393) = .255$, $p = .775$; and Customer Purchase Intention showed $F(2, 393) = 2.290$, $p = .103$. Since all p-values were greater than .05, the results indicate that the mean scores of Psychological Factors, Environmental Knowledge, Marketing Mix, and Customer Purchase Intention did not differ significantly among Male, Female, and LGBTQ respondents.

Table 4.31 One-Way Analysis of Variance of Variables across Age Groups

Variable	22–30 (n=159)	31–40 (n=114)	41–50 (n=70)	51–60 (n=53)	F	Sig.	Conclusion
Psychological Factors (PC)	3.4632	3.6554	3.7040	3.6034	1.698	.167	Not significant
Environmental Knowledge (EK)	3.8726	4.0702	3.9750	3.9575	1.347	.259	Not significant
Marketing Mix (4Ps)	4.0922	4.2505	4.2354	4.1640	1.741	.158	Not significant
Customer Purchase Intention (CPI)	3.9623	4.1123	4.0829	3.9736	1.182	.316	Not significant

Table 4.31 presents the results of the One-Way ANOVA examining differences in Psychological Factors (PC), Environmental Knowledge (EK), Marketing Mix (4Ps), and Customer Purchase Intention (CPI) across four age groups: 22–30, 31–40, 41–50, and 51–60 years.

The results indicate that there were no statistically significant differences among the age groups for PC ($F(3,392) = 1.698$, $p = .167$), EK ($F(3,392) = 1.347$, $p = .259$), 4Ps ($F(3,392) = 1.741$, $p = .158$), or CPI ($F(3,392) = 1.182$, $p = .316$). Since all p-values exceeded the 0.05 significance level, the findings indicate that the mean scores of the four study variables did not differ significantly across the four age groups. Although some differences were observed in the group means, these differences were not statistically significant.

Table 4.32 One-Way Analysis of Variance of Variables across Education Groups

Variable	Diploma (n=35)	Bachelor's (n=225)	Master's (n=112)	Doctoral (n=24)	F	Sig.	Conclusion
Psychological Factors (PC)	2.9829	3.5214	3.7347	4.2759	12.949	< .001	Significant
Environmental Knowledge (EK)	3.5000	3.8867	4.1161	4.5729	11.289	< .001	Significant
Marketing Mix (4Ps)	4.0080	4.1148	4.2633	4.5330	5.121	.002	Significant
Customer Purchase Intention (CPI)	3.7771	4.0116	4.0946	4.2417	2.468	.062	Not significant

Table 4.32 indicates that education level was significantly associated with differences in Psychological Factors (PC), Environmental Knowledge (EK), and Marketing Mix (4Ps), with p-values of < .001, < .001, and .002, respectively. Scheffé post hoc comparisons showed that PC

differed significantly between Diploma and Bachelor's, Diploma and Master's, Diploma and Doctoral, Bachelor's and Doctoral, and Master's and Doctoral groups, while no significant difference was found between Bachelor's and Master's groups. For EK, significant differences were found between Diploma and Master's, Diploma and Doctoral, and Bachelor's and Doctoral groups. For 4Ps, significant differences were found between Doctoral and Diploma groups and between Doctoral and Bachelor's groups. In contrast, Customer Purchase Intention (CPI) did not differ significantly across education groups ($p = .062$).

Table 4.33 One-Way Analysis of Variance of Variables across Occupation Groups

Variable	Govern ment (n=57)	State Enterpris e (n=34)	Com pany (n=141)	Business Owner (n=95)	Free lance (n=69)	F	Sig.	Conclusion
Psychologic al Factors (PC)	3.6142	3.4562	3.5497	3.7992	3.3720	2.717	.030	Significant
Environmen tal Knowledge (EK)	3.8947	3.8971	4.0018	4.1158	3.7391	2.464	.045	Significant
Marketing Mix (4Ps)	4.1775	4.1744	4.1811	4.2533	4.0396	1.203	.309	Not significant
Customer Purchase Intention (CPI)	3.9930	3.9118	4.0780	4.0484	3.9855	.494	.740	Not significant

Table 4.33 shows that Psychological Factors (PC) differed significantly across occupation groups, $F(4,391) = 2.717$, $p = .030$. The Scheffé post hoc analysis identified a significant difference between Business Owners ($M = 3.7992$) and Freelancers ($M = 3.3720$), $p = .050$, with Business Owners reporting a higher mean score.

Environmental Knowledge (EK) also differed significantly across occupation groups, $F(4,391) = 2.464$, $p = .045$. However, the Scheffé post hoc comparisons did not identify any pairwise differences at the 0.05 level. Therefore, the overall ANOVA indicates a significant difference among occupation groups, but the specific group differences were not sufficiently established by the more conservative Scheffé procedure.

In contrast, Marketing Mix (4Ps), $F(4,391) = 1.203$, $p = .309$, and Customer Purchase Intention (CPI), $F(4,391) = .494$, $p = .740$, did not differ significantly across occupation groups.

Overall, occupation was significantly associated with differences in PC and EK, but not 4Ps or CPI. The post hoc results indicate that the significant PC difference was specifically observed between Business Owners and Freelancers, while no specific pairwise difference was established for EK using Scheffé.

Table 4.34 One-Way Analysis of Variance of Variables across Income Groups

Variable	15,001– 25,000 (n=127)	25,001 – 35,000 (n=120)	35,001 – 45,000 (n=83)	45,001 – 55,000 (n=39)	55,001 + (n=27)	F	Sig.	Concl usion
Psychological Factors (PC)	3.2744	3.4945	3.8210	3.9319	4.1461	11.051	< .001	Signif icant
Environmenta l Knowledge (EK)	3.6693	3.9167	4.1205	4.2244	4.6296	11.969	< .001	Signif icant
Marketing Mix (4Ps)	3.9510	4.1762	4.3191	4.3291	4.5238	8.597	< .001	Signif icant
Customer Purchase Intention (CPI)	3.8630	4.0067	4.1277	4.1795	4.3778	4.183	.002	Signif icant

Table 4.34 shows statistically significant differences across income groups for PC, $F(4,391) = 11.051$, $p < .001$; EK, $F(4,391) = 11.969$, $p < .001$; 4Ps, $F(4,391) = 8.597$, $p < .001$; and CPI, $F(4,391) = 4.183$, $p = .002$. Therefore, Scheffé post hoc comparisons were conducted to identify the specific income groups contributing to these differences.

For PC, significant differences were found between 15,001–25,000 baht and 35,001–45,000 baht, 45,001–55,000 baht, and 55,001+ baht groups, as well as between 25,001–35,000 baht and 55,001+ baht groups. For EK, significant differences were found between 15,001–25,000 baht and 35,001–45,000 baht, 45,001–55,000 baht, and 55,001+ baht groups, and between 25,001–35,000 baht and 55,001+ baht groups. For 4Ps, significant differences were found between 15,001–25,000 baht and 35,001–45,000 baht, 45,001–55,000 baht, and 55,001+ baht groups. For CPI, a significant difference was found only between the 15,001–25,000 baht and 55,001+ baht groups.

Overall, the mean scores increased across income groups, indicating that respondents with higher income tended to report higher levels of psychological factors, environmental knowledge, marketing mix perceptions, and purchase intention.

Table 4.35 One-Way Analysis of Variance of Variables across Marital Status Groups

Variable	Single (n=175)	Married (n=144)	Divorced (n=25)	Separated (n=26)	Widowed (n=26)	F	Sig.	Conclusion
Psychological Factors (PC)	3.4114	3.8615	3.3040	3.3799	3.6188	6.613	< .001	Significant
Environmental Knowledge (EK)	3.8514	4.1667	3.7000	3.7019	4.0385	4.721	.001	Significant
Marketing Mix (4Ps)	4.0805	4.3004	4.0302	4.1074	4.2880	3.183	.014	Significant
Customer Purchase Intention (CPI)	3.9920	4.1597	3.8880	3.7615	3.9462	2.524	.041	Significant

Table 4.35 indicates that Psychological Factors (PF) differed significantly across marital-status groups, $F(4,391) = 6.613$, $p < .001$. Scheffé post hoc comparisons showed a significant difference between single and married respondents, with married respondents reporting a higher mean PC score. Environmental Knowledge (EK) also differed significantly, $F(4,391) = 4.721$, $p = .001$, with a significant difference between single and married respondents. Similarly, Marketing Mix (4Ps) showed a significant difference, $F(4,391) = 3.183$, $p = .014$, with married respondents reporting a higher mean score than single respondents. For Customer Purchase Intention (CPI), the overall ANOVA was significant, $F(4,391) = 2.524$, $p = .041$; however, the Scheffé post hoc test did not identify any statistically significant pairwise differences. Overall, marital status was associated with significant differences in all four study variables at the overall ANOVA level, with the clearest pairwise differences observed between single and married respondents.

Table 4.36 One-Way Analysis of Variance of Variables across Family Size Groups

Study Variable	Small (n=109)	Medium (n=167)	Large (n=120)	F	Sig.	Conclusion
Psychological Factors (PC)	3.3518	3.5242	3.8644	10.787	< .001	Significant
Environmental Knowledge (EK)	3.7454	3.9476	4.1688	8.215	< .001	Significant
Marketing Mix (4Ps)	3.9885	4.2032	4.2975	7.680	.001	Significant
Customer Purchase Intention (CPI)	3.9138	4.0359	4.1217	2.377	.094	Not significant

Table 4.36 shows significant differences across family-size groups for Psychological Factors (PC), $F(2,393) = 10.787$, $p < .001$; Environmental Knowledge (EK), $F(2,393) = 8.215$, $p < .001$; and Marketing Mix (4Ps), $F(2,393) = 7.680$, $p = .001$. However, Customer Purchase Intention (CPI) did not differ significantly across family-size groups, $F(2,393) = 2.377$, $p = .094$.

Scheffé post hoc analysis found that large-family respondents scored significantly higher than both small- and medium-family respondents in PC. For EK, the large-family group scored significantly higher than the small-family group. For 4Ps, the small-family group scored significantly lower than both medium- and large-family groups. No significant pairwise differences were found for CPI. Overall, family size was associated with differences in PC, EK, and 4Ps, but not CPI.

4.9 Discussion of Findings

H1: Psychological Factors significantly influence Customer Purchase Intention toward residential solar energy systems in Bangkok, Thailand.

The findings support H1. Multiple linear regression analysis showed that Psychological Factors had a statistically significant positive effect on Customer Purchase Intention, with a standardized coefficient of $\beta = .197$, $p < .001$. This indicates that stronger psychological influences were associated with higher intention to purchase residential solar energy systems. Although the effect was smaller than that of the Marketing Mix, Psychological Factors remained a significant predictor when Environmental Knowledge and Marketing Mix were considered simultaneously.

This finding is consistent with Jabbour Al Maalouf et al. (2024) and Pramana et al. (2024), who emphasized the role of psychological and normative factors in shaping consumers' decisions regarding renewable energy and sustainable consumption. The result suggests that consumers' purchase intentions are influenced not only by practical considerations but also by psychological considerations, including perceived social expectations, personal responsibility, and social influence. Therefore, strengthening consumers' psychological engagement with residential solar energy may contribute to greater purchase intention.

H2: Environmental Knowledge significantly influences Customer Purchase Intention toward residential solar energy systems in Bangkok, Thailand.

The findings do not support H2. Environmental Knowledge did not have a statistically significant effect on Customer Purchase Intention when the three independent variables were examined simultaneously, with $\beta = .049$, $p = .336$. Although the descriptive results indicated that respondents demonstrated a moderate level of environmental knowledge, this knowledge did not significantly predict their purchase intention.

This finding differs from the expected relationship proposed based on Simanjuntak et al. (2023) and Asif et al. (2023). The result suggests that awareness of climate change, carbon emissions, energy shortages, and clean energy alone may not be sufficient to translate environmental knowledge into an intention to purchase residential solar energy systems. In the context of this study, consumers may require additional considerations, particularly psychological and marketing-related factors, before environmental knowledge contributes to a purchase decision. Thus, environmental knowledge appears to function more as background awareness than as a direct predictor of purchase intention in the present sample.

H3: Marketing Mix significantly influences Customer Purchase Intention toward residential solar energy systems in Bangkok, Thailand.

The findings support H3. Marketing Mix demonstrated a statistically significant and positive effect on Customer Purchase Intention, with $\beta = .602$, $p < .001$. Among the three independent variables, Marketing Mix was the strongest predictor of purchase intention. The overall regression model was also statistically significant, $F(3,392) = 201.039$, $p < .001$, with the three predictors collectively explaining 60.6% of the variance in Customer Purchase Intention.

The finding is consistent with Koojaroenprasit and Pumpinyo (2024) and Photim et al. (2025), supporting the importance of marketing-related considerations in consumers' adoption of residential solar energy. The descriptive results further show that respondents evaluated the Product, Price, and Place dimensions at a good level, while Promotion received a comparatively moderate evaluation. This suggests that product quality and performance, reasonable pricing, convenient access to installation and service, and appropriate promotional activities may play an important role in converting consumers' interest into purchase intention.

4.10 Summary of Findings

The regression results provide empirical support for H1 and H3, but not H2. Psychological Factors and Marketing Mix significantly and positively predicted Customer Purchase Intention, whereas Environmental Knowledge did not show a significant direct effect. Marketing Mix demonstrated the strongest predictive effect ($\beta = .602$), followed by Psychological Factors ($\beta = .197$). These findings indicate that consumers' intention to purchase residential solar energy systems is more strongly associated with marketing considerations and psychological influences than with environmental knowledge alone.



Chapter 5 Conclusion

5.1 Summary of the Study

This study examined the factors influencing consumers' purchase intention toward residential solar energy systems in Bangkok, Thailand. The study focused on three independent variables: Psychological Factors (PC), Environmental Knowledge (EK), and Marketing Mix (4P), and one dependent variable, Customer Purchase Intention (CPI). A quantitative research design was employed, and 450 questionnaires were collected. Following data screening, 396 valid responses were retained for the final analysis. The data were analyzed using descriptive statistics, Cronbach's alpha reliability analysis, Pearson correlation, Pearson chi-square, multiple linear regression, and One-Way ANOVA with Scheffé post hoc comparisons.

The reliability analysis demonstrated satisfactory internal consistency for all four principal constructs, with Cronbach's alpha coefficients of .897 for Psychological Factors, .907 for Environmental Knowledge, .861 for Marketing Mix, and .916 for Customer Purchase Intention. Pearson correlation analysis also showed statistically significant positive relationships among the four principal variables.

Multiple linear regression was used to test the proposed hypotheses. The regression model was statistically significant, $F(3,392) = 201.039$, $p < .001$, with an R^2 of .606, indicating that the three independent variables jointly explained 60.6% of the variance in Customer Purchase Intention. Psychological Factors and Marketing Mix were significant positive predictors, whereas Environmental Knowledge was not statistically significant.

5.2 Conclusion

5.2.1 Overall Conclusion

The findings demonstrate that Psychological Factors and Marketing Mix significantly influence Customer Purchase Intention toward residential solar energy systems, whereas Environmental Knowledge does not have a significant direct effect when the three independent variables are examined simultaneously.

Marketing Mix was the strongest predictor of Customer Purchase Intention ($\beta = .602$, $p < .001$), followed by Psychological Factors ($\beta = .197$, $p < .001$). Environmental Knowledge did not significantly predict Customer Purchase Intention ($\beta = .049$, $p = .336$). The regression model explained 60.6% of the variance in Customer Purchase Intention.

The findings therefore suggest that consumers' intention to purchase residential solar energy systems is influenced more strongly by marketing-related conditions and psychological considerations than by environmental knowledge alone.

5.2.2 Conclusion Regarding Psychological Factors

H1 was supported. Psychological Factors had a statistically significant positive influence on Customer Purchase Intention ($\beta = .197$, $p < .001$). This finding indicates that psychological considerations contribute to consumers' willingness to purchase residential solar energy systems.

The descriptive findings showed that all three psychological dimensions—Subjective Norm, Personal Norm, and Social Norm—were evaluated at a moderate level. Personal Norm showed the strongest tendency, particularly respondents' sense of personal satisfaction associated with contributing to environmental sustainability. Subjective Norm reflected the influence of family members and important others, while Social Norm emphasized the influence of environmental experts and social opinions.

These findings indicate that consumers' purchase intention is not determined solely by functional considerations. Their personal values and perceived social influences also contribute to the formation of purchase intention.

5.2.3 Conclusion Regarding Environmental Knowledge

H2 was not supported. Environmental Knowledge did not have a statistically significant influence on Customer Purchase Intention ($\beta = .049$, $p = .336$).

Although respondents demonstrated moderate environmental knowledge, the findings indicate that such knowledge did not independently translate into stronger purchase intention when Psychological Factors and Marketing Mix were included in the regression model. Respondents showed relatively stronger knowledge regarding the role of solar energy in addressing energy shortages and its classification as clean and renewable energy, while knowledge concerning carbon-emission reduction received the comparatively lowest mean score.

Accordingly, environmental knowledge appears to provide an awareness of solar energy benefits but, within this study, does not constitute a significant direct predictor of purchase intention.

5.2.4 Conclusion Regarding Marketing Mix

H3 was supported. Marketing Mix had a statistically significant positive influence on Customer Purchase Intention ($\beta = .602$, $p < .001$) and was the strongest predictor among the three independent variables.

The descriptive findings showed that Product, Price, and Place were evaluated at a good level, whereas Promotion was evaluated at a moderate level. Respondents placed particular importance on product safety, performance, reasonable pricing, and convenient installation and service.

The findings indicate that consumers place considerable emphasis on the practical and economic aspects of residential solar energy systems. Therefore, the effectiveness of the Marketing Mix is particularly important in converting consumer interest into purchase intention.

5.2.5 Theoretical and Practical Contributions

The study provides empirical evidence concerning the relative importance of psychological, environmental, and marketing factors in explaining residential solar energy purchase intention. The results demonstrate that Psychological Factors and Marketing Mix have significant direct predictive effects, whereas Environmental Knowledge does not. This finding indicates that knowledge of environmental benefits alone may not adequately explain consumers' purchase intention.

From a practical perspective, the findings indicate that residential solar energy adoption should be addressed through a combination of consumer psychological engagement and effective marketing strategies, rather than relying exclusively on environmental education. The comparatively stronger coefficient of Marketing Mix indicates that market-related factors represent an important consideration in consumers' purchase decisions.

5.3 Practical Recommendations

5.3.1 Recommendations for Government Agencies

Government agencies should develop policies that reduce practical and financial barriers to residential solar energy adoption. Particular attention should be given to financial incentives, transparent information, installation standards, and consumer protection. Since Environmental Knowledge did not significantly predict purchase intention, public policy should combine environmental education with information concerning the economic, household, and long-term benefits of solar energy.

5.3.2 Recommendations for Solar Energy Companies

Solar energy companies should prioritize the Product, Price, and Place elements that received favorable evaluations. Product offerings should emphasize safety, reliability, system performance, and appropriate energy-storage capabilities. Pricing strategies should communicate the relationship between system quality, installation costs, maintenance costs, and long-term value.

Companies should also strengthen installation and after-sales services. Respondents placed relatively high importance on convenient home delivery and installation services, indicating that service accessibility is an important consideration in the purchasing process.

5.3.3 Recommendations for Marketing Practitioners

Marketing practitioners should develop communication strategies that connect functional benefits with psychological motivations. Messages may emphasize energy savings, long-term investment benefits, household advantages, environmental responsibility, and social acceptance.

Promotion requires particular attention because it received a comparatively lower evaluation than Product, Price, and Place. Sales promotions such as discounts, free maintenance, or free cleaning services received relatively favorable responses and may therefore be incorporated into promotional strategies.

5.3.4 Recommendations for Consumers

Consumers should evaluate residential solar energy systems using a comprehensive assessment of product quality, safety, price, installation and maintenance requirements, expected long-term benefits, and household energy needs. Environmental benefits should also be considered, but the findings indicate that environmental knowledge alone does not significantly predict purchase intention.

5.4 Recommendations for Future Research

5.4.1 Expansion of the Conceptual Framework

Future research should examine additional factors that may explain Customer Purchase Intention, such as perceived financial benefits, perceived risk, government incentives, trust in solar energy providers, perceived behavioral control, and perceived return on investment. The current model explains 60.6% of the variance in Customer Purchase Intention, indicating that other explanatory variables remain to be investigated.

5.4.2 Expansion of the Study Area

The study was conducted among respondents in Bangkok. Future research should include other provinces and regions of Thailand to determine whether the observed relationships remain consistent across different geographical, economic, and social contexts.

5.4.3 Methodological Improvements

Future studies should consider larger samples and longitudinal or mixed-method approaches. Longitudinal research could examine changes in purchase intention over time, while qualitative research could provide deeper explanations of consumers' motivations, concerns, and barriers regarding residential solar energy adoption.

5.4.4 Expansion of the Target Population

Future research could include different consumer groups, such as homeowners and renters, different income groups, individuals with previous experience using renewable energy, and consumers from different age groups. Such comparisons could provide a broader understanding of residential solar energy adoption.

5.4.5 Investigation of Emerging Marketing Strategies

Future studies should investigate emerging marketing strategies, particularly digital marketing, social media communication, expert recommendations, online consultation, promotional incentives, and personalized solar energy solutions. This recommendation is supported by the relatively lower evaluation of the Promotion dimension compared with Product, Price, and Place.

5.4.6 Future Development of Renewable Energy Consumer Behaviour Research

Future research should distinguish more clearly among environmental knowledge, purchase intention, actual purchase behavior, and continued use of renewable energy systems. The present study demonstrates that environmental knowledge did not significantly predict purchase intention, while psychological and marketing factors did. Further research could therefore examine how knowledge is transformed into behavioral intention and, ultimately, actual adoption under different market and social conditions.

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Appendix

The questionnaire

Part 1: Demographic Information

1. Gender
 - ☐ Male
 - ☐ Female
 - ☐ LGBTQ
2. Age
 - ☐ 22 – 30 years
 - ☐ 31 – 40 years
 - ☐ 41 – 50 years
 - ☐ 51 – 60 years
3. Educational Attainment
 - ☐ Diploma-level
 - ☐ Bachelor's degree
 - ☐ Master's degree
 - ☐ Doctor's degree
4. Occupation
 - ☐ Government Employee
 - ☐ State Enterprise Employee
 - ☐ Company Employee
 - ☐ Business Owner
 - ☐ Freelancer
5. Monthly Income
 - ☐ 15,001 – 25,000
 - ☐ 25,001 – 35,000
 - ☐ 35,001 – 45,000
 - ☐ 45,001 – 55,000
 - ☐ 55,001 and above
6. Marital Status
 - ☐ Single
 - ☐ Married
 - ☐ Divorced
 - ☐ Separated
 - ☐ Widowed
7. Family Size
 - ☐ Small family (1-2 members)
 - ☐ Medium family (3-4 members)
 - ☐ Large family (5 or more members)

Part 2: The factors influencing customers' purchase intention toward residential solar energy systems.

Items	five-point Likert scale				
	Strongly Disagree	2	3	4	Strongly Agree
Psychological Factors					
Subjective Norm					
1 My family members think that I should purchase solar energy.					
2 My friends and relatives encourage me to purchase solar energy.					
3 My neighbors would approve of my decision to purchase solar energy.					
4 The opinions of people who are important to me influence my decision to purchase solar energy.					
5 I consider the expectations of people who are close to me when deciding whether to purchase solar energy.					
Personal Norm					
1 I believe that purchasing a Residential Solar Energy System is my moral responsibility.					
2 I feel personally responsible for reducing environmental impacts by purchasing a Residential Solar Energy System.					
3 I would feel guilty if I ignored purchasing a Residential Solar Energy System for the environmental benefits.					
4 I feel a sense of personal satisfaction when considering the purchase of a Residential Solar Energy System because it contributes to environmental sustainability.					
5 Purchasing a Residential Solar Energy System reflects my personal values regarding environmental protection.					
Social Norm					
1 If purchasing a Residential Solar Energy System becomes a popular social trend, I am more likely to purchase one.					
2 Recommendations from influencers encourage me to purchase a Residential Solar Energy System.					
3 Recommendations from environmental experts increase my willingness to purchase a Residential Solar Energy System.					
4 I use social media to search for information about Residential Solar Energy Systems.					
5 I trust information about Residential Solar Energy Systems shared on social media.					

Items	five-point Likert scale				
	Strongly Disagree	2	3	4	Strongly Agree
Social Norm					
6 Positive opinions shared by others influence my decision to purchase a Residential Solar Energy System.					
Environmental Knowledge Factors					
1 I understand that Residential Solar Energy Systems can help reduce the effects of climate change.					
2 I have sufficient knowledge about how Residential Solar Energy Systems help reduce carbon emissions.					
3 I understand that Residential Solar Energy Systems can help address energy shortages by generating renewable electricity.					
4 I understand that Residential Solar Energy Systems are a form of clean and renewable energy.					
Marketing Mix Factors					
Product					
1 The materials and components of a Residential Solar Energy System should comply with recognized quality and safety standards.					
2 A Residential Solar Energy System should be covered by a comprehensive warranty and insurance.					
3 A Residential Solar Energy System should have a long-lasting and reliable battery storage system.					
4 A Residential Solar Energy System should have an attractive and modern design.					
5 A Residential Solar Energy System should provide efficient battery charging and energy storage performance.					
6 A Residential Solar Energy System should include advanced safety features to ensure safe operation.					
7 A Residential Solar Energy System should support multiple charging and energy management options.					

Items	five-point Likert scale				
	Strongly Disagree	2	3	4	Strongly Agree
Price					
1 The price of a Residential Solar Energy System is reasonable considering its quality and performance.					
2 The insurance cost associated with a Residential Solar Energy System is reasonable.					
3 The prices of accessories and installation equipment for a Residential Solar Energy System are reasonable.					
4 The price of a Residential Solar Energy System is competitive compared with similar products available in the market.					
5 The price of a Residential Solar Energy System meets customer expectations.					
6 The maintenance cost of a Residential Solar Energy System is reasonable.					
Place					
1 Residential Solar Energy Systems are available through conveniently located sales and service centers. (such as parking space, near transportation publi, etc.)					
2 Sales and service centers for Residential Solar Energy Systems are easily accessible. (such as traffic flow, online channel support etc.)					
3 Residential Solar Energy Systems are available through one-stop service centers that provide consultation, sales, installation, and after-sales services.					
4 Residential Solar Energy System providers have sufficient branches or service centers to support customers.					
5 Residential Solar Energy System providers offer convenient home delivery and installation services.					
6 Sales and service centers for Residential Solar Energy Systems are clean and well decorated					

Items	five-point Likert scale				
	Strongly Disagree	2	3	4	Strongly Agree
Promotion					
1 Residential Solar Energy Systems are promoted through a variety of online and offline advertising channels.					
2 Public relations activities effectively increase public awareness of Residential Solar Energy Systems.					
3 Sales promotions (e.g., discounts, coupons, free maintenance, or free cleaning services) make Residential Solar Energy Systems more attractive to purchase.					
4 Sales representatives provide knowledgeable and professional recommendations about Residential Solar Energy Systems.					
5 Promotional campaigns provide sufficient information to help consumers make purchasing decisions.					
6 Promotional activities encourage consumers to consider purchasing a Residential Solar Energy System.					
Customers' Purchase Intention toward Residential Solar Energy Systems					
1 My motivation to save energy increases my intention to purchase a Residential Solar Energy System.					
2 My perception of the high quality of a Residential Solar Energy System increases my intention to purchase one.					
3 The long-term investment benefits of a Residential Solar Energy System increase my intention to purchase one.					
4 My positive attitude toward using solar energy increases my intention to purchase a Residential Solar Energy System.					
5 My understanding of the household benefits of a Residential Solar Energy System increases my intention to purchase one.					