

**KEY FACTORS INFLUENCING CONSUMER CHOICE OF
ELECTRIC VEHICLE (EV) CHARGING STATIONS**

The image features a large, faint watermark of the Mahidol University logo in the background. The logo is circular, with a blue center containing a golden emblem of a traditional Thai stupa. The outer ring of the logo contains Thai text. Overlaid on this watermark is the author's name.

PHURIPAT SUKKASEM

**A THEMATIC PAPER SUBMITTED IN PARTIAL
FULFILLMENT OF THE REQUIREMENTS FOR
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entitled
**KEY FACTORS INFLUENCING CONSUMER CHOICE OF
ELECTRIC VEHICLE (EV) CHARGING STATIONS**

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KEY FACTORS INFLUENCING CONSUMER CHOICE OF ELECTRIC VEHICLE (EV) CHARGING STATIONS

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ABSTRACT

The electric vehicle (EV) industry is poised for exponential expansion as worldwide worries about air pollution and climate change. The construction of a practical and accessible EV charging infrastructure is a critical component of the industry's growth. In this regard, this research paper explores the elements that influence consumers' decisions while selecting EV charging stations. Understanding consumer preferences and factors in choosing charging infrastructure is becoming increasingly important as EV adoption accelerates. This study attempts to identify the important elements influencing consumer preferences.

Key findings show that charging speed, location convenience, and pricing structures all have a substantial impact on consumer preferences when it comes to picking EV charging stations. Furthermore, this study underlines the crucial need for an expanded and standardized charging network to reduce range anxiety and allow EV incorporation into the existing power system. Through the extension of EV charging infrastructure, the report also highlights the possibilities for job creation, economic growth, and the integration of renewable energy sources. This research provides a platform for improving marketing tactics and encouraging the long-term success of Thailand's EV industry by completely analyzing customer decision-making processes.

KEY WORDS: Electric Vehicle/ Charging Station/ Location

43 pages

CONTENTS

	Page
ACKNOWLEDGEMENTS	ii
ABSTRACT	iii
LIST OF TABLES	vi
LIST OF FIGURES	vii
CHAPTER I INTRODUCTION	1
1.1 Overview of the Electric Vehicle Industry	1
1.2 Electric Vehicle Charging Stations Industry in Thailand	2
1.3 Challenge and Opportunities of EV Charging Stations	3
1.4 Research Question	4
1.5 Research Objective	4
CHAPTER II LITERATURE REVIEW	5
2.1 Electric Vehicle	5
2.2 EV Charger Type	5
2.3 Location	6
2.4 Convenience	7
2.5 Brand Trust	8
2.6 Consumer Preference	9
2.7 Conceptual Framework and Hypotheses	10
CHAPTER III RESEARCH METHODOLOGY	11
3.1 Sampling Plan	11
3.2 Questionnaire Structure	11
3.3 Data Analysis	12
CHAPTER IV FINDING	13
4.1 General Question	13
4.2 Respondent Profile	14
4.3 Mean Values from Specific Question	14
4.4 Respondent Profile	15

CONTENTS (cont.)

	Page
4.4.1 Gender	15
4.4.2 Age Range	16
4.4.3 Monthly Income	16
4.4.4 Location for Charging	17
4.4.5 Favorite Activity	17
4.4.6 Preferred Activity	18
4.5 Mean Values from Specific Question	18
4.6 Factor Analysis	20
4.6.1 Initial Factor Analysis	21
4.6.2 Initial Factor Analysis (Scree Plot)	22
4.6.3 Final Factor Analysis	23
4.6.4 Final Factor Analysis (KMO and Bartlett's Test)	24
4.6.5 Final Factor Analysis (Mean Values from the Remaining)	25
4.6.6 Final Factor Analysis (Scree Plot)	26
CHAPTER V CONCLUSIONS AND RECOMMENDATIONS	27
5.1 Conclusion	27
5.2 Recommendations	28
5.2.1 User Experience	28
5.2.2 Ambience	30
5.2.3 Perceived Benefits	31
5.3 Limitation	32
5.4 Future Research	33
REFERENCES	34
BIOGRAPHY	37
APPENDIX	38

LIST OF TABLES

Table		Page
2.1	Hypotheses	10
3.1	Questionnaire Structure	12
4.1	Means Score of Each Specific Question	20
4.2	Final Variables	24



LIST OF FIGURES

Figure	Page
1.1 Estimated number of Electric Vehicles in use worldwide	1
1.2 Number of EV charging stations in Thailand	3
2.1 Variable Model	10
4.1 Within the past month, how many times have you use public EV charging stations	13
4.2 Which brand of EV charging station do you currently use or prefer to use	14
4.3 What are the main considerations you take into account when choosing an EV charging station	14
4.4 Gender	15
4.5 Age Range	16
4.6 Monthly Income	16
4.7 Location for Charging	17
4.8 Favorite Activity	17
4.9 Preferred Activity	18
4.10 Initial Factor Analysis	21
4.11 Initial Factor Analysis (Eigenvalue Table)	22
4.12 Scree Plot (Initial Factor Analysis)	23
4.13 Final Factor Analysis	23
4.14 Final Factor Analysis (Eigenvalue Table)	23
4.15 Bartlett's Test of the Final Factor Analysis	24
4.16 Mean Values from the Remaining Attributes and Intention to Buy	25
4.17 Scree Plot (Final Factor Analysis)	26
5.1 Perceptual Map	28

CHAPTER I

INTRODUCTION

1.1 Overview of the Electric Vehicle industry

People are becoming more concerned about the environment and attempting to reduce pollution. Internal combustion engine vehicles that use fuel have been identified as a source of air pollution because each combustion releases an emission into the environment as a byproduct. Although regulations have been announced to tighten control on emission levels, which leads to an improvement in internal combustion engine emissions, they can only slow the release of emissions and cannot completely eliminate the problem. As a result, an electric vehicle. It produces no emissions because it uses electricity as a source of energy (Meesuwan, 2020).

Electric vehicles are a viable solution for reducing air pollution, reducing dependency on foreign energy, and combating climate change. Electric cars are becoming increasingly popular, and new applications such as electric taxis and buses are being explored. The total number of electric vehicles on the road will have topped 16.5 million by the end of 2021. A multitude of problems, including limited driving range and insufficient charging infrastructure, are impeding electric vehicle adoption. Electric vehicles can be charged at home or at public charging stations. As the number of electric vehicles increases, the number of public charging stations may be insufficient to support the scale of the electric vehicle market (Song et al, 2023).

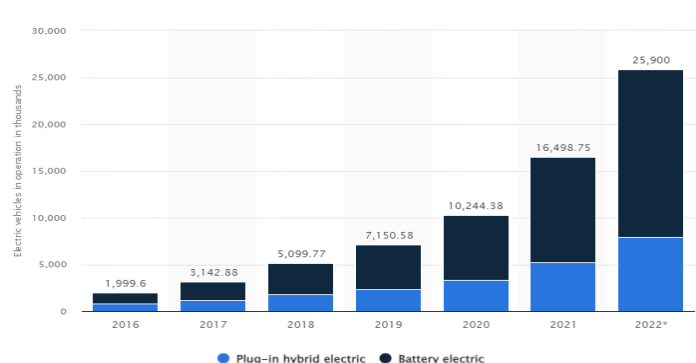


Figure 1.1: Estimated number of Electric Vehicles in use worldwide (Statista, 2023)

1.2 Electric Vehicle Charging Stations Industry in Thailand

Electric vehicle charging stations are critical infrastructure that must be built in order to develop proper knowledge and understanding of electric vehicles. Another issue is that all business stakeholders must consider the environment's common interests. The number of electric vehicles with such charging stations represents an unbalanced customer demand. There is still a lack of a business model that will aid or guide investors interested in owning charging stations (Insan et al, 2022).

According to EVAT (2023), the total number of EV charging stations across the country is approximately 1,482 as of 22 May 2023. In Thailand, the Metropolitan Electricity Authority (MEA) opened electric charging stations for EV cars within the MEA area by providing services to the general public; both normal chargers take about 4-8 hours and quick chargers take about 20-30 minutes. In addition, we are collaborating with 7-Eleven to open more EV charging stations. Other service providers include the Provincial Electricity Authority (PEA), which has opened EV charging stations under the brand name "PEA VOLTA" and is ready to support charging services for fast-charging electric vehicles or quick chargers with three standard chargers. Furthermore, it collaborated with the company Bangchak Corporation Public Company Limited to open PEA VOLTA electric charging stations for service at Bangchak gas stations along the main route to support inbound and outbound travel, as well as important tourist destinations. Another provider is PTT or PTT stations, which is opening charging stations in Bangkok and the surrounding area, as well as major cities, under the name "EV Stations Pluz" for BEV and PHEV electric vehicles, both in Normal Charger and Quick Charge formats. There are plans to continually expand the country's network of charging stations (Tawan, 2022).



Figure 1.2: Number of EV charging stations in Thailand (EVAT, 2023)

The purpose of this study is to look into the factors that influence consumer choice when it comes to electric vehicle (EV) charger stations. Understanding consumer preferences and considerations in selecting charging infrastructure becomes increasingly important as demand for EVs grows. This research also aims to identify the key factors influencing consumer choice, providing valuable insights for businesses, policymakers, and charging infrastructure providers.

1.3 Challenge and Opportunities of EV charging stations

The main issues connected with EV charging infrastructure include a shortage of public charging stations, which causes EV owners to worry about range anxiety, lengthy charging times, which may discourage potential EV drivers, and the necessity to integrate the infrastructure with the current power grid. Furthermore, the high expense of establishing charging stations and upgrading the electrical system, as well as the lack of standardization in chargers and connectors, are barriers to wider adoption. However, the expansion of EV charging infrastructure opens up new potential

for job creation, economic growth, and the incorporation of renewable energy sources. New business models such as charging-as-a-service and the use of smart technologies have the ability to generate revenue, increase efficiency, and save money (Lee, 2023). Thailand, according to Adair (2023), still has a limited amount of EV charging stations, including a lack of installations at private homes, in contrast to many other countries where homes have many convenient EV charging facilities. Furthermore, charging EVs at night can dramatically reduce energy expenditures, making them more cost-effective.

1.4 Research question

1. Which factors influence consumers when selecting EV charging stations.
2. Which factors are the most influential for consumer choice on EV charging stations.

1.5 Research objective

1. To identify key factors affecting consumer decision-making in selecting EV charging stations.
2. To examine the relative importance of each factor in shaping consumer preferences and decision-making processes.
3. To provide insight from consumer decision-making in selecting EV charging stations to improve marketing strategies, and based on a comprehensive understanding of consumer decision-making processes.

CHAPTER II

LITERATURE REVIEW

2.1 Electric Vehicle

According to Bandyopadhyay (2023), electric vehicles (EVs) use an electronic motor for propulsion and rechargeable batteries for electricity storage. Electric vehicles, unlike conventional gasoline or diesel-powered vehicles, do not use an internal combustion engine and have been praised as a solution to cut fossil fuel consumption if the electricity used is renewable. All-electric vehicles, also known as battery electric vehicles (BEVs), use a battery pack to store the electric energy that powers the motor. The batteries are charged by connecting the vehicle to an electric power source (AFDC, 2023). The widespread adoption of EVs is viewed as a solution to the scarcity of fossil fuels as well as the environmental problems produced by customers' insistence on driving carbon-fueled vehicles (J and Dsouza, 2023). On the market, there are numerous types of electric cars (EVs). Electric vehicles (EVs) that run solely on electricity are known as pure electric vehicles (EVs). With advancements in technology, electric-powered engines that can also run on gasoline or diesel are now available; these are known as Plug-in Hybrid Vehicles, or PHEVs. Self-charging hybrids or HEVs, like PHEVs, have a combustion engine and an electric motor, but HEV batteries can be charged by the engine. The last form of EV car, the Mild Hybrid or MHEV, is similar to the HEV but lacks the battery capacity to power the vehicle (Windsor, 2023).

2.2 EV Charger Type

There are two basic charging methods for electric vehicles: AC (alternate current) charging and DC (direct current) fast charging. The grid's power is always alternating current (AC), whereas an EV's battery can only store direct current (DC). AC charging relies on the vehicle's onboard charger to convert AC power to DC. DC

rapid charging, on the other hand, includes converting AC electricity to DC at the charging station before it flows into the vehicle. DC fast charging accelerates charging by bypassing the vehicle's onboard charger and sending additional power directly to the battery (power-sonic, 2023). According to Mastoi et al (2022), the pin-out, size, and shape of a universal AC connector varies based on the charger's electric car brand, country, and power level. The voltages and frequencies of the mains differ by region. There are three types of AC connectors: type 1, type 2, and US Tesla connection. Because of its output range of 50 kW to 500 kW, the DC fast charger can replace level 1 and level 2 AC chargers. To prevent interfering with power lines, DC fast chargers are often deployed offboard. Security worries are another factor. CCS combinations 1 and 2, CHAdeMO, Tesla DC connector, and GB/T China connector are the five major DC connector varieties.

2.3 Location

According to Phongphanich (2022), location is an important and long-term marketing decision, and making the wrong option might have long-term effects. Providers aim to be close to consumers in order to capture their attention, but doing so exposes them to competition from other providers pursuing the same goal. The biggest disadvantage of EVs is their limited range. The lack of public EV charging facilities exacerbates this. The restricted number of public EV charging stations also limits the travel distance of EV users. They are forced to charge their autos at home (Albana et al, 2022). According to Hardman et al. (2018), there are four major charging locations: at home or near home (usually overnight), at a workplace or commute location, at publicly accessible locations other than work, and on long-distance travel corridors where drivers stop between trip origin and destination.

According to Quattrini (2022), when it comes to charging locations, clear and visible signage, in addition to the existing LED lighting, is critical. While ChargePoint stations already have LED lighting to improve visibility and accessibility for drivers on-site, it is recommended that additional signage be included for effective wayfinding. Furthermore, ChargePoint provides a dedicated mobile app, seamless integration with numerous in-vehicle dashboards, and compatibility with popular

navigation platforms such as Apple Maps and Google Maps to aid in the discovery of your location. It is critical to prioritize accessibility and convenience for electric vehicle owners when selecting a location for an EV charging station. Several critical factors should be considered during the selection process. One such factor is proximity to highways, which ensures that the charging station is easily accessible for EV drivers on longer journeys. Furthermore, because of its proximity to commercial areas, residential neighborhoods, and popular destinations, the charging station can attract a larger pool of potential users, making it more accessible and appealing to a diverse range of electric vehicle owners (Ackodrive, 2023).

2.4 Convenience

Charging stations should be strategically positioned in places where people spend a lot of time, such as shopping malls, supermarkets, and office buildings. The utility operator should consider the EV's flexibility while making judgments. This flexibility is influenced by driving behavior and vehicle parking patterns, which are intrinsically stochastic. Because it alleviates range anxiety, the availability of public charging infrastructure can encourage EV users to drive larger distances. Because some users do not require a home charger, adding public charging stations in a neighborhood can lower the total cost of ownership of an EV and improve EV penetration (Bitencourt et al, 2021).

According to BTC Power (2023), when using a fast charge, EV drivers typically spend 15 to 30 minutes at a charging station. Charging time and in-store spending have a positive correlation. In fact, approximately 80% of EV owners shop while charging at public stations. Furthermore, roughly 40% of EV drivers report making purchases at local businesses while their vehicles are charging. These findings emphasize the economic benefits and opportunities associated with EV charging infrastructure.

Most people visit supermarkets frequently, often multiple times per week. They can accumulate a significant amount of time during their extended shopping trips, allowing for a substantial electric vehicle (EV) charge by the time they are finished.

Installing EV charging stations can encourage them to choose your shopping center over competitors in the area. Moreover, this could attract more commercial tenants who are keen to cater to the increasing number of employees who drive EVs. Hotels serve as temporary residences for EV drivers while they are on vacation, necessitating a reliable place to charge before embarking on their next journey. EV drivers also spend significant time at restaurants, cafés, coffee shops, and similar establishments. Incorporating EV charging capabilities into these businesses can serve as a savvy marketing strategy to attract a growing base of customers who drive EVs (EV Connect, 2023).

2.5 Brand trust

A brand, according to Anik and Putri (2015), is a name, term, sign, symbol, or design (or a combination) intended to identify and differentiate a seller's goods or services from competitors. The entity trusted in a brand is not a person, but a symbol. Brand trust is the perception of a specific brand by customers based on their knowledge and experiences. It is closely related to product performance because customers expect brands to keep their promises. Customers are more likely to return and repurchase if they believe a brand can meet their quality and security expectations (Phongphanich, 2022).

Building high-quality connections with clients requires trust. Building positive brand connections and long-term stable customer-brand partnerships necessitates trust. Brand trust is a sense of confidence that consumers feel as a result of interactions with companies, based on the belief that a brand is accountable for their interests and welfare. The three dimensions of brand trust are quality, capability, and compassion. Quality trust refers to customer faith in the quality of a brand or firm. Capability trust relates to a company's competence, which includes the desire to act on consumers' behalf. Finally, benevolence trust relates to a company's ability to show concern and responsibility for its consumers' well-being (Reinita Andriyani and Arie Yudhistira, 2023).

2.6 Consumer Preference

Individual consumers' subjective tastes and satisfaction with purchased items are referred to as consumer preference, which is also referred to as utility. Consumers make decisions by allocating their limited resources to achieve the greatest level of satisfaction. They want to maximize their utility while staying within their budget constraints. The utility is the satisfaction gained from consuming a good and is influenced by a variety of non-economic factors. The relative utility of different goods is used to calculate consumer value (Saiji, 2020). The preference of consumers for charging at home is the primary reason for their high interest in the installation of private charging piles. The lack of fixed parking spaces and community properties, on the other hand, has become the main barriers to the installation of private charging piles (Wang et al, 2021).

The user experience of charging an electric vehicle has some obvious flaws. The most obvious dissatisfaction is the time it takes to charge the vehicle. Every electric vehicle manufacturer is attempting to solve this problem. There is also an issue with the number of chargers and their proximity to urban and suburban hubs. However, there are issues with the user experience of charging at the point of sale (Thomas, 2021).

The majority of charging is still done at home (about 80%) or at work, according to Virta (2022), but not every EV driver has access to a home or work charger. Uninterrupted charging experiences at public charging stations are also crucial for electric vehicle adoption. A list of five important characteristics of a great EV charging experience that your customers will appreciate no matter where they charge has been developed. Provide a simple mobile app, Make the payment process as straightforward as possible. Ensure that EV chargers are easily accessible and operational. Customer service is available around the clock, seven days a week.

2.7 Conceptual Framework and Hypotheses

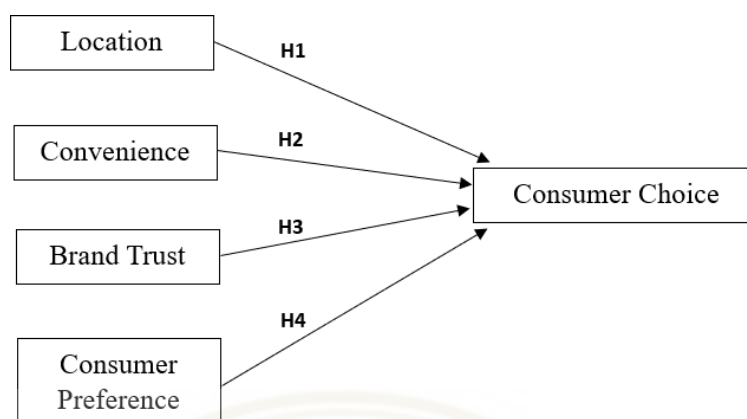


Figure 2.1: Variable Model

The goal of this study is to test the relationship between the independent variables and the dependent variable by collecting quantitative data to aid in the analysis and identification of significant relationships in order to identify the critical factors influencing consumer choice of EV charging station. According to the review of literature, four independent variables, including Location, Convenience, Brand Trust, and Consumer Preference, should influence consumer choice of EV charging stations (dependent variable). The hypotheses of the study are illustrated in the table below (Table 5.1).

Table 2.1: Hypotheses

Hypotheses Table	
Hypothesis 1	Location would have positive influence on Customer Choice
Hypothesis 2	Convenience would have positive influence on Customer Choice
Hypothesis 3	Brand Trust would have positive influence on Customer Choice
Hypothesis 4	Customer Preference would have positive influence on Customer Choice

CHAPTER III

RESEARCH METHODOLOGY

3.1 Sampling Plan

Our research aims to identify the factors that influence consumer choice on EV charging stations. People who own or plan to own an EV are the target audience for this study. Furthermore, the respondents must be over the age of 18 in order to be qualified, as this implies that the respondents have a valid driver's license. To collect the required data, the quantitative survey was distributed and collected entirely online using a convenience sampling method.

3.2 Questionnaire Structure

The purpose of this study is to identify key factors influencing consumer decision-making when choosing EV charger stations. An anonymous survey questionnaire was created to collect responses from the targeted respondents for this study. This survey questionnaire has five sections: an introduction, a screening question, a general question, a specific question, and a demographic question. Table 6.1 contains additional information for each section of this survey questionnaire.

Table 3.1: Questionnaire Structure

	No. of Questions	Usage
1. Introduction	0	<ul style="list-style-type: none"> • To inform the respondents regarding the background and objective of this survey questionnaire.
2. Screening Questions	3	<ul style="list-style-type: none"> • To filter out the respondents who currently own electric vehicles or have plans to own one in the future.
3. General Questions	4	<ul style="list-style-type: none"> • To measure the respondents' behavior frequency related to the chosen of EV charging stations.
4. Specific Questions	30	<ul style="list-style-type: none"> • 29 Questions were designed according to each construct (Location, Convenience, Brand Trust, and

Table 3.1: Questionnaire Structure (cont.)

		<p>Consumer Preference) to measure the construct attitude of the respondents with the 4-point scale from 1 (Strongly Disagree) to (Strongly Agree).</p> <ul style="list-style-type: none"> • 1 Question were designed to measure the influence factor of consumer choice toward EV charging stations with the 4-point scale from 1 (Strongly Disagree) to (Strongly Agree).
5. Demographic Questions	6	<ul style="list-style-type: none"> • To obtain the demographic information of the respondents which are age, gender, employment status, monthly income, location for charging, favorite activity, preferred activity.

3.3 Data Analysis

The data analysis was carried out using SPSS software to analyze the total of 126 respondents from the survey questionnaire. Using SPSS software, a total of 5 types of analysis were conducted which are Factor Analysis, Reliability Analysis, Regression Analysis, and Analysis of Variance (ANOVA).

CHAPTER IV

DATA ANALYSIS AND FINDING

4.1 Within the past month, how many times have you use public EV charging stations

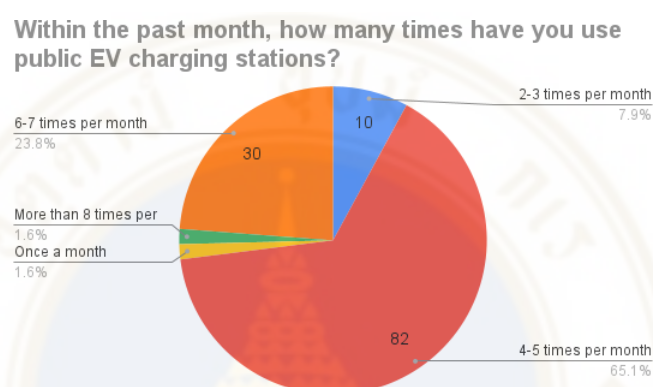


Figure 4.1: Within the past month, how many times have you use public EV charging stations

According to the pie chart, those who use public EV charging stations 4-5 times per month account for 82 respondents or 65.1%, followed by those who use EV charging stations 6-7 times per month (30 or 23.8%), and those who use EV charging stations 2-3 times per month (10 or 7.9%). The pie chart illustrates that users who use once a month and more than 8 times per month account for the smallest share (2 people or 1.6%).

4.2 Which brand of EV charging station do you currently use or prefer to use

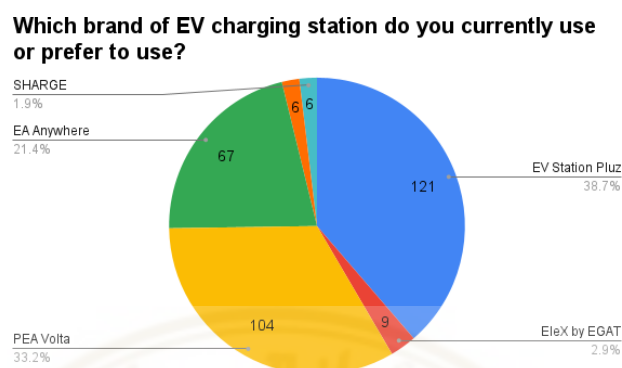


Figure 4.2: Which brand of EV charging station do you currently use or prefer to use

The pie chart shows that the most EV charging station brand that customers prefer to use is EV Station Pluz with 121 respondents or 38.7%, followed by PEA Volta with 104 respondents or 33.2%, and EA Anywhere with 67 respondents or 21.4%. The lowest brand that customers prefer to use is EleX by EGAT with 9 respondents or 2.9%. SHARGE and Evolt are the lowest brand preferred to use with 6 respondents or 1.9%.

4.3 What are the main considerations you take into account when choosing an EV charging station

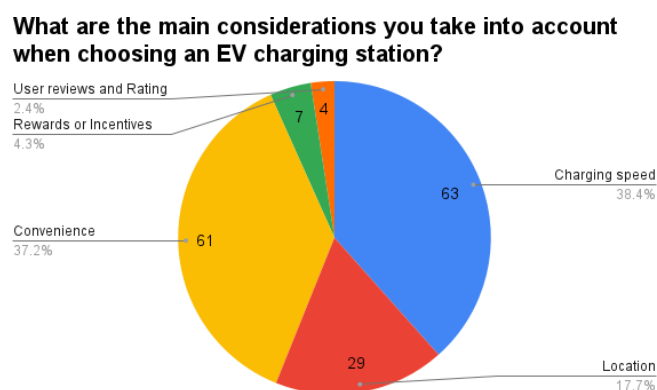


Figure 4.3: What are the main considerations you take into account when choosing an EV charging station

According to the pie charts, the major factors that customers evaluate when selecting an EV charging station are charging speed (63 respondents or 38.4%), followed by convenience (61 respondents or 37.2%). Location received 29 responses (17.7%). Customers' lowest considerations when selecting an EV charging station are Rewards and incentives (7 responses or 4.3%), followed by User reviews and Rating (4 respondents or 2.4%).

4.3 Respondent Profile

4.3.1 Gender

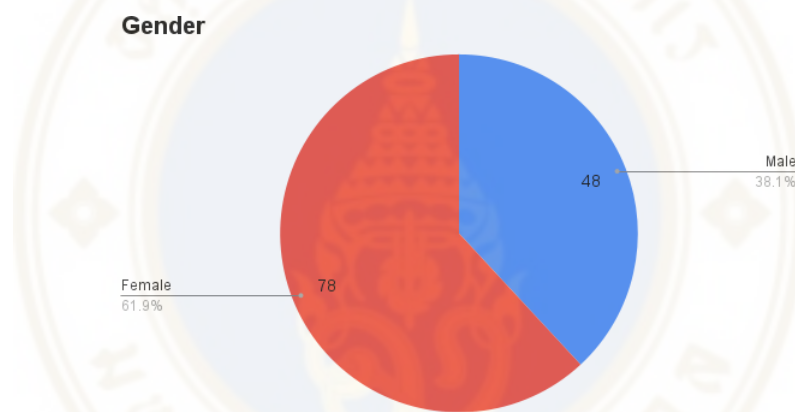


Figure 4.4: Gender

According to figure 7.4, the pie chart shows the gender frequency that most of our respondents are Female accounting for 61.9% or 78 respondents, and the rest is male accounting for 38.1% or 48 respondents.

4.3.2 Age Range

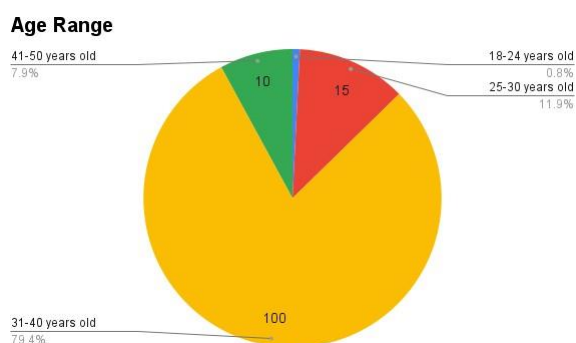


Figure 4.5: Age Range

The pie chart shows the age frequency among the respondents, it clearly seen that the majority of age between 31-40 years old account for 100 as the frequency or 79.4%, followed by the age between 25-30 years old, as the frequency 15 or 11.9%, and the age of people among 41-50 years old had 10 people or 7.9%, and the age of people among 18-24 years old as the last place with 1 people or 0.8%.

4.3.3 Monthly Income

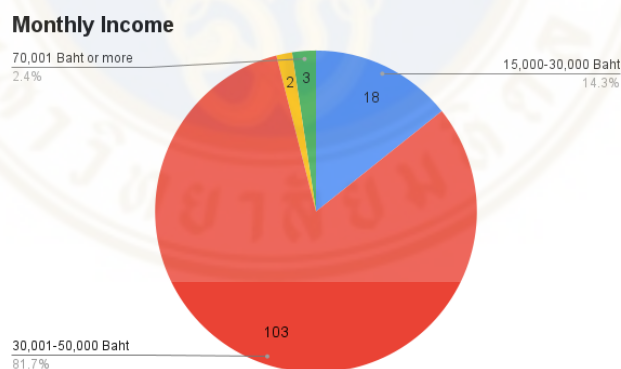


Figure 4.6 Monthly Income

For the monthly income frequency, the pie chart above shows that the respondents have a monthly income between 30,001-50,000 Baht with 100 respondents or 81.7%. followed by groups of monthly income between 15,000-30,000 Baht with 18 respondents or 14.3%. meanwhile, groups of 50,001-70,000 Baht, and 70,001 Baht or more are a small part of the pie chart.

4.3.4 Location for Charging

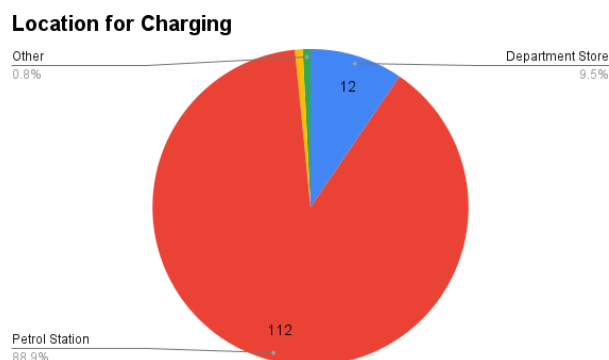


Figure 4.7 Location for Charging

The pie charts indicate that frequency of those who prefer to use EV charging stations in Petrol Station account for 112 respondents or 88.9%, followed by customer prefer to use EV charging station at Department Store with 12 respondents or 9.5%. The lowest proportion are people who use EV charging station at workplace and other accounting for 1 respondent or 0.8%.

4.3.5 Favorite Activity

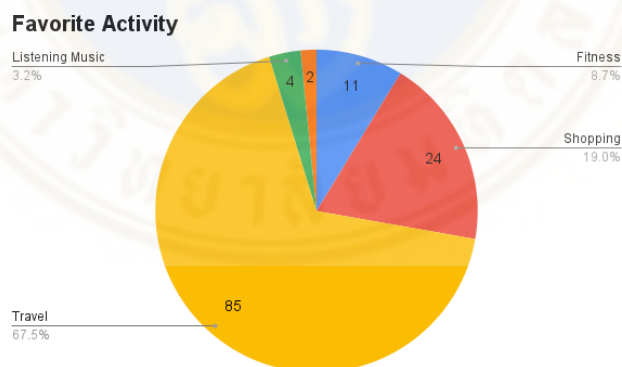


Figure 4.8: Favorite Activity

The pie chart shows that travel is the most popular activity for EV users, with 85 respondents or 67.5%, followed by shopping (24 respondents or 19%) and fitness (11 respondents or 8.7%). The least favored pastime for EV users was listening to music (4 respondents or 3.2%), followed by watching movies (2 respondents or 1.6%).

4.3.6 Preferred Activity

Preferred Activity

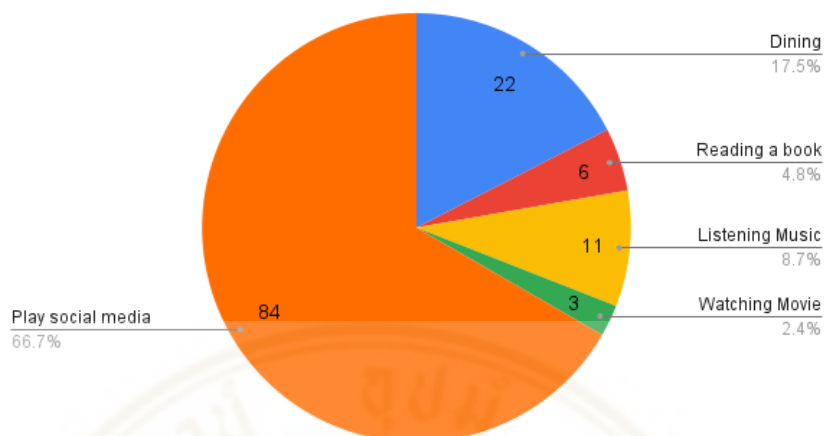


Figure 4.9: Preferred Activity

According to the pie chart, the pie charts show that the Preferred Activity of EV user when while waiting charging their car, the most activity is Play Social Media with 84 respondents or 66.7%, followed by Dining with 22 respondents or 17.5%. The small proportion in the pie chart is Listening Music with 11 respondents or 8.7%, followed by Reading a Book with 6 respondents or 4.8%. The lowest proportion in the pie chart is Watching Movie with 3 respondents or 2.4%.

4.4 Mean Values from Specific Question

The table indicates the average (mean) scores for every question. However, we will discuss the mean score after the factor analysis process since it will eliminate unclassified (or ambiguous) attributes away in order to describe the significant results.

Table 4.1: Means Score of Each Specific Questions

	Code	Details	Mean Value
Location	1. L1	I prefer to use EV charging station that available in these location (home/near home, workplace/department store, public locations other than workplace, a passageway for long travel distance).	3.56
	16.L2	The importance of clear and visible signage at EV charging stations for effective wayfinding.	3.62

Table 4.1: Means Score of Each Specific Questions (cont.)

	2. L3	The importance of have EV charging station locations shown on a mobile app for easy accessibility and convenience.	3.62
	17. L4	The availability of public charging infrastructure reduces range anxiety for drive longer distances.	3.60
	3. L5	I prefer to use an EV charging station with multiple charging ports.	3.60
	18. L6	It is important to have EV charging stations in areas with high population density or frequent EV traffic.	3.56
	4. L7	I prefer to use EV charging station that have presence of security measures (e.g., surveillance cameras or adequate lighting)	3.52
	19. L8	I prefer to use a location with a good ambience and clean.	3.52
	5. L9	I prefer to use a EV charging station that has fast charging.	3.51
Convenience	20. C1	It is convenience to you that placing charging stations in shopping malls or supermarkets.	3.56
	6. C2	It is convenience to you that placing charging stations in co-working space or office building.	3.51
	21. C3	I prefer to use charging stations in gas station.	3.50
	7. C4	As an EV driver, restaurants, cafes, coffee shops, and similar establishments that support EV charging are more appealing to you.	3.56
	22. C5	The convenience of EV charging stations reduces the overall inconvenience and challenges associated with owning an electric vehicle.	3.58
	8. C6	I would like to spend more time or make purchases at a retail location that provides charging stations for EVs.	3.55
Brand Trust	23. B1	The brand of EV charging station is trustworthy.	3.64
	9. B2	The information contained in the advertisement is credible.	3.48
	24. B3	The brand of EV charging station delivers what it promises.	3.53
	10. B4	Over time, my experiences with this brand have led me to expect it to keep its promises, no more and no less.	3.56
	25. B5	The brand of EV charging stations' product claims are believable.	3.48

Table 4.1: Means Score of Each Specific Questions (cont.)

	11. B6	The brand of EV charging stations provides a wide variety of deals.	3.44
	26. B7	The brand of EV charging stations offers sales or special deals frequently.	3.44
Consumer Preference	12. CP1	I was satisfied with the service provided.	3.47
	27. CP2	It was easy to contact the service provider.	3.51
	13. CP3	It did not take much time to reach the service provider.	3.54
	28. CP4	I was able to get the benefits of the service with minimal effort.	3.56
	14. CP5	I am able to complete a transaction with EV charging station without spending too much time.	3.57
	29. CP6	EV charging stations (mobile apps) allow you to quickly complete a transaction.	3.67
	15. CP7	I prefer to choose an EV charging station that provides 24/7 customer support or assistance in case of any issues or emergencies.	3.48
Intention to Buy	30. ITB	If there were more EV charging stations in your area, how likely would you be to increase your usage of electric vehicles?	3.56

4.5 Factor Analysis

The technique of determining the relationship between each data point by summarizing the component groupings and removing unclassified or unclear attributes is known as factor analysis. In this scenario, the researchers did the Initial Factor Analysis with all particular questions keep one from the intention to buy factor, and then cut those confusing features inside the criteria one at a time. Low factor loading with a factor loading score of less than 0.4, cross loading attributes (attributes that display scores from two or more components), and mismatch meaning characteristics compared to other attributes within its component group are the criteria for dropping the questions. The criteria to describe the numbers of the component is that each factor analysis, the researcher also uses the KMO (Kaiser-Meyer-Olkin) Measure of Sampling Adequacy

to test the suitability of the data in factor analysis, the Bartlett's Test of Sphericity is performed to test the correlation matrix significance indicating enough correlation among the variables to conduct factor analysis with the Sig. lower than 0.05.

4.5.1 Initial Factor Analysis

The initial factor analysis with all specific questions has 11 components in total that passes the Eigenvalue criteria with the cumulative percent of variance at 64.06% (Figure 7.11). However, it indicates various cross-loading factors that require the reduction process as mentioned (Figure 7.10).

	Component										
	1	2	3	4	5	6	7	8	9	10	11
q4	.741										
q5	.643										
q21	.545										
q16	.403										
q13		.665									
q27		.567									
q23		.516									
q28											
q18			.778								
q15			.569								
q10			.552								
q2				.774							
q25				.516		.467					
q1					-.790						
q3					.675						
q8					.407						
q20						.765					
q11						.488			.466		
q19							.829				
q17				.494			-.647				
q9								.775			
q6								.564			
q7								-.439			
q14									-.674		
q12									.608		
q26										.808	
q24										-.663	
q29											.854
q22											

Figure 4.10: Initial Factor Analysis

Total Variance Explained						
Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.510	12.104	12.104	2.141	7.384	7.384
2	2.019	6.961	19.065	1.867	6.439	13.823
3	1.861	6.417	25.482	1.787	6.163	19.986
4	1.745	6.017	31.499	1.746	6.021	26.006
5	1.607	5.542	37.040	1.718	5.924	31.930
6	1.515	5.223	42.263	1.701	5.866	37.796
7	1.412	4.869	47.132	1.658	5.716	43.512
8	1.319	4.547	51.679	1.548	5.337	48.849
9	1.295	4.465	56.144	1.534	5.288	54.137
10	1.163	4.011	60.155	1.483	5.114	59.250
11	1.134	3.910	64.065	1.396	4.814	64.065
12	.971	3.349	67.414			
13	.943	3.253	70.667			
14	.896	3.090	73.757			
15	.811	2.796	76.553			
16	.778	2.683	79.235			
17	.732	2.525	81.760			
18	.709	2.444	84.204			
19	.640	2.206	86.410			
20	.586	2.022	88.432			
21	.534	1.841	90.273			
22	.481	1.659	91.932			
23	.469	1.619	93.551			
24	.409	1.411	94.963			
25	.387	1.333	96.296			
26	.324	1.118	97.413			
27	.307	1.059	98.472			
28	.249	.859	99.332			
29	.184	.668	100.000			

Figure 4.11: Initial Factor Analysis (Eigenvalue Table)

4.5.2 Initial Factor Analysis (Scree Plot)

Another way for estimating the total number of significant elements is a scree plot. It is a graph with the eigenvalue on the Y-axis and the number of factors mentioned on the X-axis in decreasing order of eigenvalues. In order to calculate the total number of important elements, we must consider an eigenvalue of more than 1 on the Y-axis of a scree plot. Then, using the X-axis, we can calculate the total number of important components with an eigenvalue of more than 1. To ensure consistency, the total number of significant factors determined by a scree plot can be compared to the total number of significant factors established using factor analysis.

A scree plot in this study is shown in Figure 7.12. Examining this scree plot, we found that it is unable to make a clear separation at eigenvalue ≥ 1 for determining the total no. of significant factors. Therefore, factor analysis needs to be performed to cut off some attributes in order to make a scree plot become more horizontal.

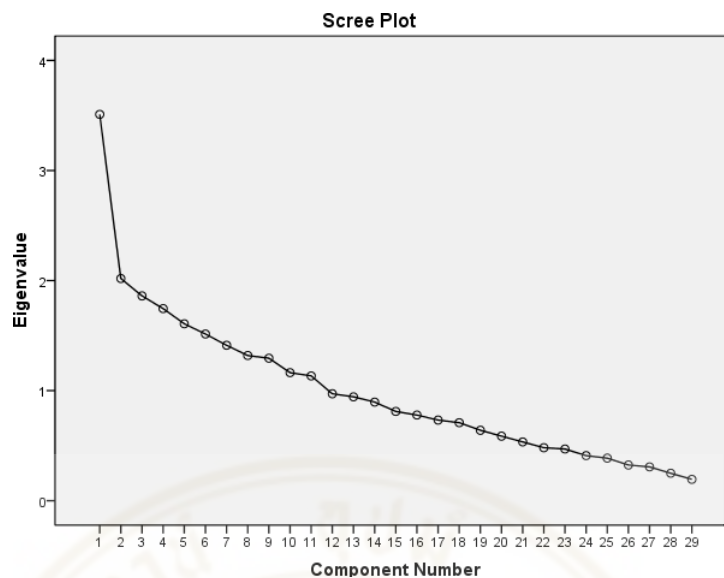


Figure 4.12: Scree Plot (Initial Factor Analysis)

4.5.3 Final Factor Analysis

After the process of dropping out unrelated factors, the final factor analysis has 3 components in total that passes the Eigenvalue criteria with the cumulative percent of variance at 51.9% (Figure 7.13). The three components left can be referred to as “User Experience”, “Ambience”, and “Perceived Benefits” based on its attributes as shown in the Table 7.2 below.

<i>Rotated Component Matrix^a</i>				Component	Initial Eigenvalues		
	1 User Experience	2 Ambience	3 Perceived Benefits		Total	% of Variance	Cumulative %
				1	1.695	21.181	21.181
				2	1.369	17.110	38.291
				3	1.087	13.588	51.879
				4	.979	12.241	64.120
				5	.892	11.152	75.272
				6	.740	9.255	84.527
				7	.665	8.317	92.844
				8	.572	7.156	100.000
Q15	.750						
Q21	.662						
Q8	.474						
Q7		.780					
Q19		.733					
Q12			.758				
Q9			.616				
Q27			.458				

Figure 4.13 (left): Final Factor Analysis

Figure 4.14 (right): Final Factor Analysis (Eigenvalue Table)

Table 4.2: Final Variables

Groups	Code	Detail
User Experience	Q15. CP7	I prefer to choose an EV charging station that provides 24/7 customer support or assistance in case of any issues or emergencies.
	Q21. C3	I prefer to use charging stations in gas station.
	Q8. C6	I would like to spend more time or make purchases at a retail location that provides charging stations for EVs.
Ambience	Q7. C4	As an EV driver, restaurants, cafes, coffee shops, and similar establishments that support EV charging are more appealing to you.
	Q19. L8	I prefer to use a location with a good ambience and clean.
Perceived Benefits	Q12. CP1	I was satisfied with the service provided.
	Q9. B2	The information contained in the advertisement is credible.
	Q24. B3	The brand of EV charging station delivers what it promises.

4.5.4 Final Factor Analysis (KMO and Bartlett's Test)

The final factor analysis passes both of the assumption test including the Sig. of Bartlett's Test of Sphericity is lower than 0.05.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.553
Bartlett's Test of Sphericity	Approx. Chi-Square	57.840
	df	28
	Sig.	.001

Figure 4.15: Bartlett's Test of the Final Factor Analysis

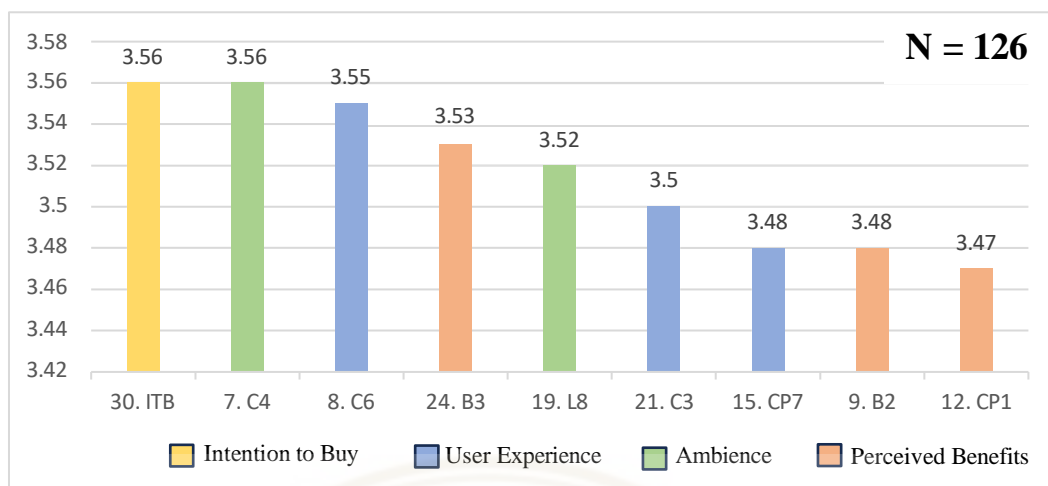


Figure 4.16: Mean Values from the Remaining Attributes and Intention to Buy

4.5.5 Final Factor Analysis (Mean Values from the Remaining)

After conducting the factor analysis, some attributes with low factor loading, cross loading, or mismatch meaning were cut down. The remaining attributes can be grouped and renamed into 3 groups which are “User Experience”, “Ambience”, and “Perceived Benefits”. The mean values of each remaining attribute are show on Figure 7.16 by showing that more EV charging stations will increase usage of EV cars, and location more appealing has the highest mean score followed by the spend more time in retail location, and the brand delivers what its promise.

4.5.6 Final Factor Analysis (Scree Plot)

The obtained scree plot after conducting the factor analysis is shown in Figure 7.17. After cutting off some attributes in factor analysis, this scree plot became more horizontal for making a clear separation at eigenvalue ≥ 1 . When considering eigenvalue ≥ 1 , this scree plot shows that the total no. of significant factors is 3 (which is also the same no. of significant factors obtained by factor analysis).

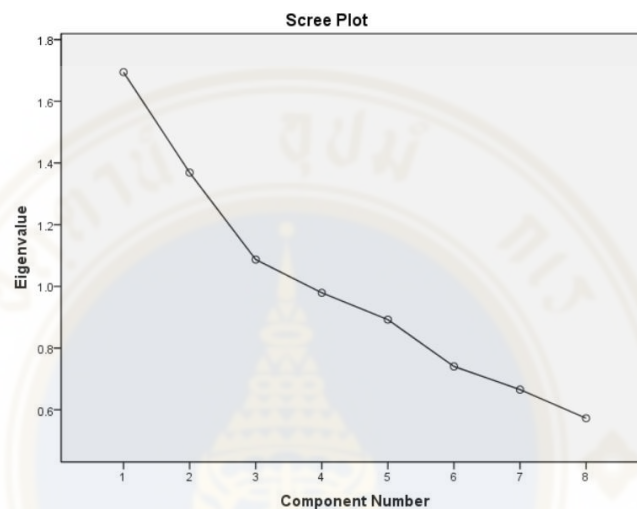


Figure 4.17: Scree Plot (Final Factor Analysis)

CHAPTER V

5.1 CONCLUSIONS AND RECOMMENDATIONS

The crucial elements of user experience, ambience, and perceived benefits heavily influence consumer choices in the industry of EV charging stations. A comprehensive examination of these aspects reveals the core of customers' preferences, allowing the production of a perceptive map that visually captures their points of view. The user experience, which includes flawless interfaces and quick operations, is a key driver of satisfaction and loyalty. Users' emotional relationships with stations are shaped by ambience, which is defined by aesthetics and comfort. Meanwhile, perceived benefits such as quick charging and sustainability connect with users' values and affect their decisions. The combination of these traits into a perceptual map provides brands with a strategic compass for optimizing design, interfaces, and value propositions, resulting in increased user adoption and long-term brand loyalty.

Perceptual maps are frequently utilized in marketing strategy to comprehend the characteristics of any product or service. These maps are visual representations that assist marketers in determining how customers perceive and assess various brands or items in a specific market. When creating a perceptual map, one of the most important things to consider is the User Experience and Ambience provided by a specific brand. We may acquire insights into how the brand is seen by consumers and how they might compete against competitors by examining these characteristics. To survive in the EV charging industry's competitive landscape, new entrants and current firms must employ a comprehensive strategy that incorporates customer-centric tactics, technological innovation, and an emphasis on long-term brand value. This perceptual map, in turn, can serve as a foundation for tailored recommendations and strategic decision-making, empowering the EV charging company to enhance its services and cater more effectively to its target audience.

User Experiences are the feelings and perceptions that users generate as a result of their interactions with a product, service, or brand. Ambience relates to a brand's atmosphere, setting, and overall sensory experience. These characteristics play

an important role in establishing consumer perceptions and can have a substantial impact on purchasing decisions.

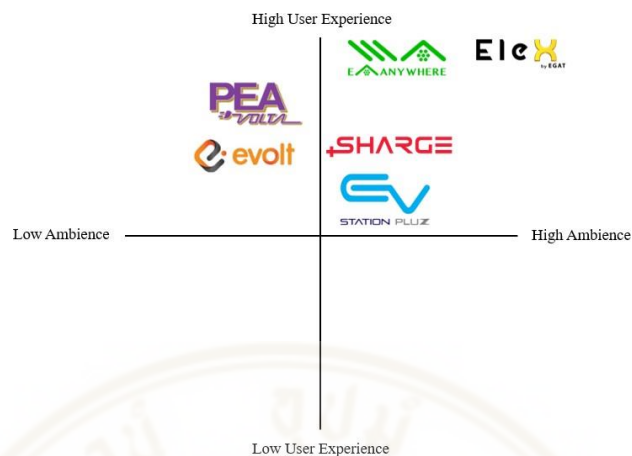


Figure 4.18: Perceptual Map

5.2 Recommendations

The major goal of these recommendations is to improve the overall user experience, create a friendly environment, and increase the perceived benefits connected with the Electric Vehicle (EV) charging brand, whether it is a new entrant or a market leader. These proposals aim to create an environment that not only speeds the charging procedure but also envelops consumers in a positive and convenient experience by meticulously addressing many aspects of the EV charging station. The goal is to make charging an EV as easy and fun as possible, with everything from clear user interfaces and efficient charging infrastructure to visually beautiful station designs. These recommendations, by emphasizing factors such as user-friendly interfaces, seamless payment systems, comfortable waiting areas, and even eco-friendly amenities, ultimately seek to establish a lasting impression of quality, sustainability, and customer-centricity, contributing to the brand's overall growth and reputation in the rapidly evolving landscape of electric mobility.

5.2.1 User Experience

The user experience of the brand's mobile application is provided to customers. The payment technique should be simple and convenient for the customer,

and some brands allow customers to finish a payment in a variety of methods, such as credit card, mobile banking, top up, or scanning a QR code to make a payment. And the tutorial film should show customers how to discover the location, reserve a charging slot, and make a payment. Overall, developing tutorial videos and onboarding lessons, as well as offering a variety of payment ways, are all crucial actions to do in order to improve the user experience and drive customer adoption.

The primary goal in the dynamic landscape of mobile applications is to enhance the user experience to unprecedented heights. This paradigm change involves all aspect of the user journey, including a frictionless and user-friendly payment process in the case of an EV charging brand's mobile app. Recognizing the diverse interests of its user base, the business should offer a diverse range of payment ways on the front end. Allowing credit card transactions, mobile banking systems, top-up methods, and the simplicity of QR codes serves to a wide range of users, guaranteeing that any individual can interact with the app using their preferred manner. This inclusivity not only simplifies the payment procedure, but it also sends a clear statement to customers that the brand appreciates their convenience. The video tutorial component within the software is critical to improving user involvement. A carefully created introductory video can act as a virtual tour guide, guiding users through every facet of the app's capabilities. The introductory video reduces uncertainty and allows users to utilize the software smoothly, from visually displaying how to locate local charging stations to booking charging slots and efficiently performing payments. This clarification not only increases user trust but also shortens the learning curve, transforming novices into competent users in minutes. Taking cues from breakthrough features like as PEA Volta's automatic automobile synchronization, the brand may push the user experience even further. This innovative innovation offers the potential to genuinely revolutionize convenience. For example, PEA Volta allows users to sync their vehicles with the app during their initial charging session if the customer wants to sync their car, for the next time they charge the car with PEA Volta, the app automatically initiates payments without requiring any manual intervention. This ground-breaking innovation fosters a trusting and dependable relationship between customers and the app, establishing a sense of true cooperation in the EV charging journey.

Allowing customers to register using their current social network accounts, such as Facebook, Line, or Google, provides a twofold benefit of increased security and user confidence within the EV charging brand's application. This smart approach not only speeds up the registration process but also instils trust in users, building an environment of dependability and authenticity. Beyond lowering entrance barriers, this technique increases user adoption rates and, more importantly, user retention by providing a favorable first experience with the app. This method deliberately addresses escalating user concerns about data privacy and security by reducing the personal data exchanged with the system, demonstrating the brand's commitment to safeguarding user interests.

In total, these multifaceted improvements add to an amazing user experience within the EV charging brand's mobile app. By catering to users' various payment preferences, providing extensive tutorial resources, and implementing forward-thinking automation, the brand not only improves usability but also cultivates a strong and devoted client base. This iterative approach to app refinement cements the brand's position as a leader in the EV charging market and drives higher adoption rates among the growing community of electric vehicle enthusiasts.

5.2.2 Ambience

It is critical to establish an engaging setting that matches with consumer tastes and expectations in order to improve the ambience and overall user experience of EV charging stations. As customers demand a pleasant and clean environment in which to charge their automobiles, incorporating features of comfort and convenience can considerably improve the charging experience. Consider carefully placing charging stations near or within establishments such as restaurants, cafes, coffee shops, and similar facilities. These additional services not only meet the physical demands of customers while charging, but also improve their overall pleasure. Investing in visually appealing station designs that mix in with the surroundings might help to generate a welcoming visual appeal. Landscape design, well-maintained green spaces, and interesting signage may all contribute to a pleasant first impression, helping users feel at ease. Furthermore, by incorporating comfortable seating arrangements, shaded spaces, and even interactive displays, the charging station may be transformed into a

dynamic social environment where users can relax, work, or communicate with their surroundings. Collaborating with local eateries or cafés to give special discounts or offers to charging customers could create a sense of exclusivity and improve the whole charging experience. By collaborating with surrounding companies, the charging station becomes more than just a basic necessity, but also a destination that provides value beyond charging. Incorporating sustainable techniques such as solar panels for shade or energy generation, recycling bins, and eco-friendly materials can resonate with environmentally aware users, aligning with electric vehicles' sustainable ethos. The atmosphere should reflect the brand's and the EV community's values.

In conclusion, optimizing the atmosphere of EV charging stations requires a holistic strategy that takes into account user preferences, aesthetics, convenience, and sustainability. Through strategic partnerships, visually appealing designs, and eco-friendly initiatives, charging stations can become appealing destinations that not only facilitate the charging process but also contribute to a positive, memorable, and enjoyable experience for users. This thorough upgrade perfectly coincides with the brand's mission of encouraging electric mobility and cultivating client loyalty in an ever-changing landscape.

5.2.3 Perceived Benefits

The perceived benefits of EV charging stations have a considerable impact on consumer preferences and loyalty. A holistic approach combining customer satisfaction, trustworthy information transmission, and constant brand promise fulfillment is required to amplify these perceived benefits and ensure a competitive edge.

Prioritizing client happiness as a basic principle is critical. This necessitates a thorough examination of the user path within the charging station ecosystem. Every interaction, from finding the station to starting the charging process and accessing extra services, should be streamlined for ease of use and seamlessness. Customers are not only satisfied with the service, but they also create an emotional connection with the brand, thanks to streamlined interfaces, informative signage, and fast support channels. A satisfied consumer becomes an advocate, spreading positive word of mouth and growing the customer base. The integrity of information conveyed through

advertisements is essential for generating trust. The company must make every effort to give accurate, up-to-date, and transparent information about its charging stations. Customers should be able to rely on advertisements for information ranging from charging prices to station facilities. This transparency not only reduces the likelihood of disappointment, but it also builds a sense of dependability, laying the groundwork for long-term confidence. The accuracy of information provided through advertisements is critical for building confidence. Every effort must be made by the company to provide accurate, up-to-date, and transparent information about its charging stations. Advertisements should provide customers with information ranging from charging rates to station amenities. This openness not only lessens the possibility of disappointment, but it also fosters a sense of dependability, setting the framework for long-term confidence.

Finally, the thorough adoption of these guidelines will synergistically increase the perceived benefits of EV charging stations. The charging station becomes a destination of choice by assuring consumer satisfaction, distributing accurate information, and rigorously delivering brand promises. This strategic alignment fosters a reputation for dependability, customer-centricity, and innovation, effectively establishing the brand as a dependable partner in the electrifying journey toward sustainable transportation.

5.4 Limitation

While the study's findings and recommendations provide useful insights into consumer preferences and perceptions in the EV charging industry, it is crucial to note some limitations that restrict the scope and generalizability of the results. While diversified in nature, the relatively small sample size of 126 respondents may not represent the whole range of electric car consumers and their multifaceted preferences. As a result, the results may not fully capture the complexities and differences found in the broader population of EV users. Furthermore, the study's geographical concentration on a specific location may limit the findings' application to other places with diverse demographic, cultural, and infrastructure characteristics.

5.5 Future Research

Future research efforts should investigate the following directions to alleviate the constraints described above and to further expand our understanding of consumer behavior in the EV charging market:

- **Increased Sample Size and Cross-Cultural Analysis:** Increasing the sample size and varying the geographic regions of data collecting can improve the study's representativeness. Comparative studies across different locations and cultures can shed light on the influence of contextual factors on consumer preferences and behavior.
- **Mixed-methodologies Approach:** Combining quantitative and qualitative methodologies can provide a more complete picture of customer behavior. In-depth interviews, focus groups, and observational studies can reveal underlying motivations, emotions, and decision-making processes that quantitative data may miss.
- **Behavioral Data Integration:** By including real usage data and behavioral observations from EV charging stations, self-reported preferences may be validated and a more objective assessment of customer behavior can be provided.
- **Technological Trends and Sustainability:** Given the EV industry's rapid technological advancements and growing concerns about environmental sustainability, future research could look into the impact of factors like wireless charging, renewable energy integration, and carbon footprint on consumer choices.

Future research can build on the foundation built by this study by addressing these recommendations, generating insights that are more robust, nuanced, and applicable to a broader range of settings within the evolving environment of electric vehicle charging.

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APPENDIX

Introduction

แบบสำรวจนี้เป็นส่วนหนึ่งของกระบวนการวิจัยภายในโครงการวิทยานิพนธ์ในระดับปริญญาโทด้านการจัดการธุรกิจ
 ดำเนินการ จัดการ ตลาด คณะบริหารธุรกิจ มหาวิทยาลัยมหิดล กำกับทำให้อังกฤษ

วัตถุประสงค์หลักของการสำรวจนี้คือเก็บรวบรวมข้อมูลสำหรับการวิเคราะห์ในชุดประเด็นวิจัยบนหัวข้อ
 "ปัจจัยที่ส่งผลต่อการเลือกใช้ สถานีชาร์จรถไฟฟ้าของคนกรุงเทพฯและปริมณฑล" โดยการสำรวจนี้จัดทำ
 ขึ้นเพื่อวัตถุประสงค์ทางวิชาการเท่านั้น โปรดอ่านแบบสอบถามอย่างละเอียดและกรุณาตอบคำถามอย่างเป็นความจริง

อีกทั้งจะขอยืนยันว่าทุกคำตอบที่ท่านให้มานั้นจะได้รับการจัดการเป็นความลับอย่างเข้มงวด และจะไม่มีการเปิดเผยข้อมูลส่วนบุคคลผู้
 สำรณะหรืออื่น ๆ ไปใช้เพื่อเป้าหมายทางพาณิชย์ใดๆ ขอความร่วมมือจากท่านในการทำแบบส
 ารวจะมีความสำคัญอย่างยิ่งและเป็นประโยชน์ต่องานวิจัย ทางวิชาการ ขอขอบคุณความร่วมมืออย่างสูง

This survey is being conducted as a component of a thematic paper within the Master of Management degree program at Mahidol University College of Management, specifically in the Marketing Management Program.

The primary objective of this survey is to gather data for analysis in the research topic titled "Key influencing Bangkok consumer choice of Electric Vehicle (EV) Charger Stations" It is important to emphasize that this research is being carried out solely for academic purposes. Therefore, I kindly request participants to carefully review the questionnaire and provide truthful responses.

Please be assured that every answer provided will be treated with strict confidentiality. The collected data will not be disclosed to the public or exploited for commercial purposes. Your cooperation in this survey is highly appreciated and will contribute significantly to the academic research.

Screening Question

1. Within the past month, how many times have you use public EV charging stations?
 - Once a month
 - 2-3 times per month
 - 4-5 times per month
 - 6-7 times per month
 - More than 8 times per month
 - Never use public EV charging stations

General Question

2. Which brand of EV charging station do you currently use or prefer to use?
 - EleX by EGAT
 - PEA Volta

- EV Station Pluz
 - EA Anywhere
 - Evolt
 - SHARGE
 - Other
3. What are the main considerations you take into account when choosing an EV charging station?
- Charging speed
 - Location
 - Convenience
 - Rewards or Incentives
 - User reviews and Rating
 - Other

Specific Question (Table)



No.	Questions	Strongly Disagree (1)	Disagree (2)	Agree (3)	Strongly Agree (4)
1.	I prefer to use EV charging station that available in these location (home/near home, workplace/department store, public locations other than workplace, a passageway for long travel distance).				
2.	The importance of clear and visible signage at EV charging stations for effective wayfinding.				
3.	The importance of have EV charging station locations shown on a mobile app for easy accessibility and convenience.				
4.	The availability of public charging infrastructure reduces range anxiety for drive longer distances.				
5.	I prefer to use an EV charging station with multiple charging ports.				
6.	It is important to have EV charging stations in areas with high population density or frequent EV traffic.				
7.	I prefer to use EV charging station that have presence of security measures (e.g., surveillance cameras or adequate lighting)				
8.	I prefer to use a location with a good ambience and clean.				
9.	I prefer to use a EV charging station that has fast charging.				
10.	It is convenience to you that placing charging stations in shopping malls or supermarkets.				
11.	It is convenience to you that placing charging stations in co-working space or office building.				

12.	I prefer to use charging stations in gas station.				
13.	As an EV driver, restaurants, cafes, coffee shops, and similar establishments that support EV charging are more appealing to you.				
14.	The convenience of EV charging stations reduces the overall inconvenience and challenges associated with owning an electric vehicle.				
15.	I would like to spend more time or make purchases at a retail location that provides charging stations for EVs.				
16.	The brand of EV charging station is trustworthy.				
17.	The information contained in the advertisement is credible.				
18.	The brand of EV charging station delivers what it promises.				
19.	Over time, my experiences with this brand have led me to expect it to keep its promises, no more and no less.				
20.	The brand of EV charging stations' product claims are believable.				
21.	The brand of EV charging stations provides a wide variety of deals.				
22.	The brand of EV charging stations offers sales or special deals frequently.				
23.	I was satisfied with the service provided.				

24.	It was easy to contact the service provider.				
25.	It did not take much time to reach the service provider.				
26.	I was able to get the benefits of the service with minimal effort.				
27.	I am able to complete a transaction with EV charging station without spending too much time.				
28.	EV charging stations (mobile apps) allow you to quickly complete a transaction.				
29.	I prefer to choose an EV charging station that provides 24/7 customer support or assistance in case of any issues or emergencies.				
30.	If there were more EV charging stations in your area, how likely would you be to increase your usage of electric vehicles?				

Demographic Question

1. Please inform your gender.
 - Male
 - Female
2. Please inform your age range.
 - Less than 18 years old (<18 years old)
 - 18 – 24 years old
 - 25 – 30 years old
 - 31 – 40 years old
 - 41 – 50 years old
 - 51 – 60 years old
 - More than 60 years old
3. Please inform your approximate monthly income.
 - Less than 15,000 Baht (<15,000 Baht)
 - 15,000 - 30,000 Baht
 - 30,001 - 50,000 Baht
 - 50,001 - 70,000 Baht

- 70,001 Baht or more
4. Please inform your location for charging your car.
 - Department Store
 - Petrol Station
 - Workplace
 - Restaurants, Café, Coffee Shop
 - Other
 5. Please inform your favorite activity.
 - Fitness
 - Shopping
 - Travel
 - Listening music
 - Watching movie
 - Other
 6. Please inform your preferred activity while charging your car.
 - Dining
 - Reading a book
 - Listening music
 - Watching movie
 - Play social media
 - Other
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