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# Condominium Residents' Attitudes toward Car-Adoption Intention: A Case Study of Car Parking Space Reduction in Condominiums near Urban Rail Transit Stations in Bangkok, Thailand

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**Abstract:**

This research examines the factors influencing car-sharing adoption intentions among condominium residents near Bangkok's public transit stations. Car-sharing, a cost-effective and sustainable alternative to private car ownership, is gaining global traction, particularly in rapidly motorizing cities. With rising car ownership posing significant challenges, promoting shared mobility has become a critical strategy for urban management. High-rise condominiums near transit stations are encouraged to reduce parking spaces and promote car-sharing, which can lower construction costs and make residential units more affordable. Understanding residents' attitudes is essential before advocating car-sharing to real estate developers. To gather insights, data were collected via a questionnaire survey of 237 condominium residents, and Structural Equation Modeling (SEM) was employed to analyze adoption intentions. The analysis focused on key factors such as attitudes

**Keywords:**
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toward car-sharing, subjective norms (SN), and perceived behavioral control (PBC). The findings reveal valuable opportunities for developers and urban planners to effectively integrate car-sharing initiatives. Attitudes toward car-sharing, particularly perceptions of service quality, emerged as the most significant factor influencing adoption. Conversely, perceived behavioral control such as challenges in finding parking or traveling long distances was identified as the primary barrier discouraging car-sharing use. Environmental concerns (EC) also played a role, with environmentally conscious travelers typically opting for other forms of public transportation. However, interest in car-sharing increased among this group when electric vehicles were offered, highlighting the potential of eco-friendly options. Interestingly, subjective norms, or social influence, had little impact on car-sharing adoption intentions. These findings suggest that addressing practical barriers—such as improving accessibility and service quality—and promoting environmentally friendly electric car-sharing options are key strategies to encourage adoption. Such an approach can help reduce dependency on private cars, alleviate congestion, and support sustainable urban mobility by offering affordable, efficient, and eco-conscious transportation alternatives.

# 公寓居民对汽车购买意向的态度：以泰国曼谷城市轨道交通站附近公寓停车位减少为例

**摘要：**
本研究考察了影响曼谷公共交通站附近公寓居民采用汽车共享意愿的因素。汽车共享是一种经济高效且可持续的私家车替代方案，正在全球范围内受到欢迎，尤其是在机动化迅速发展的城市。随着汽车保有量的增加带来重大挑战，推广共享出行已成为城市管理的关键战略。鼓励交通站附近的高层公寓减少停车位并推广汽车共享，这可以降低建筑成本并使住宅单元更实惠。在向房地产开发商提倡汽车共享之前，了解居民的态度至关重要。为了收集见解，通过对 237 名公寓居民的问卷调查收集数据，并使用结构方程模型 (SEM) 分析采用意愿。分析侧重于对汽车共享的态度、主观规范 (SN) 和感知行为控制 (PBC) 等关键因素。研究结果为开发商和城市规划者揭示了有效整合汽车共享计划的宝贵机会。对汽车共享的态度，尤其是对服务质量的看法，成为影响采用的最重要因素。相反，感知到的行为控制，例如难以找到停车位或长途旅行，被认为是阻碍使用汽车共享的主要障碍。环境问题 (EC) 也发挥了作用，有环保意识的旅行者通常会选择其他形式的公共交通。然而，当提供电动汽车时，这一群体对汽车共享的兴趣增加了，凸显了环保选择的潜力。有趣的是，主观规范或社会影响对汽车共享采用意愿影响不大。这些研究结果表明，解决实际障碍（例如改善可达性和服务质量）和推广环保的电动汽车共享选择是鼓励采用的关键策略。这种方法可以通过提供经济实惠、高效和环保的交通替代方案，帮助减少对私家车的依赖、缓解交通拥堵并支持可持续的城市交通。

**关键词：**共享汽车采纳意向, 汽车使用减少, 汽车停车位, 公寓, 曼谷

## 1. Introduction

As land prices in the Bangkok area have risen rapidly, real estate developers are increasingly focusing on condominium projects rather than horizontal properties. According to Knight Frank (2023), the asking price per square meter in Bangkok's Central Business District (CBD) and Non-Core CBD areas has reached an estimated 246,000 Baht per sq.m. and 120,200 Baht per sq.m., respectively. This trend has led to the relocation of residents from the Bangkok area to its perimeter, contributing to an increase in car ownership within the Bangkok Metropolitan region. Despite the residential shift, office buildings remain concentrated in the CBD area, and public transportation systems are not adequately connected. Consequently, commuters rely heavily on private vehicles to travel to their workplaces. This reliance has significantly increased the number of cars in Bangkok, leading to severe traffic congestion. Bangkok is now ranked 13th globally and 3rd in Asia for traffic congestion (INRIX, 2023). On average, Bangkok drivers spent 63 hours stuck in traffic last year, according to the same study. Car-sharing programs offer substantial benefits for both the public and real estate developers, in addition to helping alleviate traffic problems. Integrating car-sharing into real estate projects, particularly

condominiums, can reduce the costs incurred by developers for constructing parking spaces and lower housing costs for residents. If developers construct 100% parking capacity in condominiums, it significantly increases the price per square meter of the units. It's not just new condominiums; the prices of second-hand condominiums also increase if the building includes several parking spaces (Pongprasert and Chantapattanarangkul, 2024). This impacts homebuyers, who face higher costs for smaller living spaces as saleable areas are allocated to parking. By adopting car-sharing initiatives, both housing and transportation costs can be reduced. Lower condominium prices in Bangkok would make urban housing more affordable, enabling more residents to own homes in the city and reduce their commuting expenses. Furthermore, Pongprasert and Kubota (2018) found that condominium residents living within a 1-kilometer radius of urban rail stations, who regularly use private cars, are more likely to switch to rail transit if parking spaces around stations are limited.

However, integrating car-sharing into condominiums in Bangkok and surrounding areas requires a study of the behaviors and reasons why residents rely on private cars. This is crucial to assess the feasibility of car-sharing and ensure it meets the needs of this group effectively. Residents' attitudes and opinions will play a key role in determining the success of implementing car-sharing in condominiums.

This research is a pilot study examining the attitudes of condominium residents in Bangkok who primarily use personal cars for commuting from their condos to work regularly. It also explores the factors influencing their intention to switch from using private cars to using car-sharing services. The findings from this research offer insights for real estate developers to enhance their condominium projects' efficiency by reducing parking space costs, thereby providing a more cost-effective offering to buyers and establishing competitive pricing in the market. Additionally, the data can guide decisions on integrating car-sharing services into condominiums to meet the diverse needs of different resident segments, ranging from super-luxury to lower-end levels, thus effectively boosting market competitiveness.

## 2. Literature Review

### *2.1 What is Car-Sharing?*

The Car-Sharing business emerged from the need to address traffic problems in urban areas, as automobiles are a major cause of air pollution, including the emission of carbon monoxide. The concept of car sharing originated in Europe, specifically in Switzerland and Germany, in 1980. Katzev (2003) defined car-sharing as a for-profit business model involving a group of commuters who share a fleet of cars with other members. This service is typically available to subscribers who have access to station cars at central hubs such as rail stations and transit terminals.

In general, the concept of car sharing is a model of car rental where individuals rent cars for short periods, often by the hour. Unlike traditional car rental, where the company owns the vehicle, car sharing often involves private vehicle owners, with the car sharing service provider being distinct from the car owner. This concept is part of a broader trend toward shared mobility. Car sharing has gained traction in densely populated urban markets globally, including Argentina, Brazil, China, India, Mexico, Russia, and Turkey, as population density is a key factor in its success (Dhinra and Stanich, 2013). Successful car sharing initiatives are typically found in city centers and, more recently, in high-rise residential buildings, malls and office buildings. While some programs exist in lower-density and rural areas (primarily in Europe), these locations are generally more challenging to serve due to limited transportation alternatives and the greater distances users must travel to access vehicles.

Presently, especially in Europe and the United States, many real estate developers are incorporating car-sharing services into their projects to add value for tenants and users. Municipal governments worldwide are increasingly requiring car-sharing services in new buildings as part of their sustainability initiatives. This trend has led to the emergence of a new model of car sharing—residential, private-access vehicles typically supported by homeowners' associations. This shift from private cars to shared vehicles can directly reduce the demand for parking spaces. Additionally, because a limited number of cars can be in use at any given time, this may alleviate traffic congestion during peak hours. Furthermore, the cost structure of car sharing encourages driving less, as the fees incurred are based on usage, contrasting with owned vehicles where many expenses are fixed costs (e.g., purchase price, insurance, registration, and some maintenance).

Cohen and Kietzmann (2014) stated that there are two service charge models of Business to customer Car-sharing are 1) Free-floating car-sharing (One-way trip): will be charged from two parts; the first part is derived from the hours of usage, which will be calculated from baht per hour. The second is from the distance, charged as baht per kilometer and will be offered as a package, for example, 105 baht (around 3.07 USD.) for 30 km. and there's no annual or monthly membership fee. 2) Stationary car-sharing: will be charged from two parts; the first part is the monthly membership fee. The second is the hourly fee, which is similar to free-floating car-sharing. If the distance is exceeded, the excess service fee will be charged based on the excess distance multiplied by the specified service fee per mile.

### *2.2 The Theory of Planned Behaviors (TPB)*

Ajzen (1991) defined the Theory of Planned Behavior (TPB) that the individual's intention affects

the behavior, and the factors influencing individuals' intentions consist of three factors; 1) Attitude toward behavior which means that if individuals expect the result of their behavior to be positive, they will have good attitudes toward those behaviors. Conversely, if their expectations are negative, they will have bad attitudes toward those behaviors 2) Subjective norm toward behavior is an individual perception toward the behavior that is seriously affected by the intimate friends or family. 3) Perceived behavioral control of the behavior is defined as the perception of the difficulty of enacting a behavior. It may deter or advocate individuals to perform their behaviors.

### *2.3 Previous Research Related to Attitude toward Car-Sharing*

Katzev (2003) studied the factors influencing car-sharing adoption intentions in the United States. His research identified two significant factors: the periodic need for a vehicle and financial savings from the costs associated with owning a private vehicle. His findings contrasted with the research of Meijkamp (1999) in Europe, which concluded that environmental concerns were the most significant factor influencing adoption intentions. Katzev's study also revealed that after participating in a car-sharing program for one year, 26% of the participants decided to sell their private vehicles, while 53% chose not to proceed with planned vehicle purchases. An analysis by SCB's Economic Intelligence Center (EIC) identified four critical factors influencing the success of car-sharing businesses in many countries: high population density, a comprehensive public transportation system, supportive government policies, and collaboration between public and private sectors to provide adequate parking spaces (Phantaweesak, 2017). Netipunya (2005) examined the factors affecting access to mass rapid transit stations. The findings showed that when the distance from a residence to a station is substantial, travelers tend to prefer using cars due to their convenience and speed. Moreover, individuals with families are more likely to travel by car, regardless of distance, due to the need to accommodate baggage and family members. Unsurprisingly, car ownership reduces the likelihood of walking or traveling on foot. Piriyawat and Narupiti (2009) investigated the factors deterring motorcycle usage intentions among teenagers in educational institutions. Using the Theory of Planned Behavior (TPB) and the Theory of Habit to define variables, the study employed Structural Equation Modeling (SEM) for analysis. The results indicated that the frequency of daily motorcycle use had a significant negative impact on attitudes toward reducing motorcycle usage, which, in turn, affected intentions to decrease reliance on motorcycles. Halden (2003) explored the challenges faced by individuals traveling via private cars and public transportation. The study revealed that comfort and safety were decisive factors in encouraging people to shift to public transportation. Banister (1978) studied the influence of habits on the decision to purchase private cars. By examining a sample of individuals choosing between private cars and public transportation, the research found that travel habits, expenses, and time were key determinants in car usage decisions. Beirao and Cabral (2007) conducted in-depth interviews to further understand the factors influencing car ownership decisions. The study identified social acceptance and environmental concerns as the primary factors driving individuals' choices to purchase private vehicles. Enable (2005) conducted a study on people's attitudes toward travel in England using the Theory of Planned Behavior (TPB) as a framework. The findings revealed that perceived behavioral control (PBC), a component of control beliefs, significantly influenced individuals' choices of transportation. Additionally, the study highlighted that younger and highly educated individuals were more likely to adopt environmentally conscious attitudes, preferring public transportation over private car usage.

## 3. Research Methodology

In this research, the sample is the commuters using their private cars to depart from condominiums to the destination and live in condominiums in the Bangkok Metropolitan Area, which is located near the rail transit stations. The data collection was done by an online questionnaire survey. After data surveying, 237 respondents who were living in condominiums in Bangkok and commuting to the destination by their private car were chosen as the research sample. This number of samples is sufficient as compared to the minimum requirement number of samples recommended by Loehlin (1992), who stated that the propagated sample for SEM is about 200-400 samples. The survey methods can be divided into two methods. The first method is Revealed Preference, which is conducted by collecting information in real situations. The second method is Stated Preference, which is used in an unprecedented situation. This research applies this method to survey the car-sharing adoption intention. Moreover, the Accidental Sampling is used in the random sample method, which means that the sample is any commuters who can give traveling information.

The data relevant to the variables was collected from the samples and divided into three parts: 1) Travel characteristics 2) Distance, Time and Traveling expense and 3) Travel Attitudes. Moreover, the questions related to the socio-demographic characteristics of respondents such as gender, age, status, level of education, occupation, and income level were also asked in the questionnaire survey. All travel attitudes were rated by the respondents on a five-point Likert scale, which ranges from "strongly disagree" (=1) to "strongly agree" (=5) as shown in Table 1.

Table 2 shows the attitudinal questions related to the factors influencing the car-adoption intention of the residents living in condominiums in Bangkok.

**Table 1. Scoring Range of Likert Scale of Survey (compiled by the authors)**

| Evaluation criterion | Value | Range |
|---|---|---|
| Strongly Disagree | 1 | 1.00-1.80 |
| Disagree | 2 | 1.81-2.60 |
| Neither/Nor agree | 3 | 2.61-3.40 |
| Agree | 4 | 3.41-4.20 |
| Strongly Agree | 5 | 4.21-5.00 |

**Table 2. Attitudinal questions related to the car adoption intention of condominium residents in Bangkok (compiled by the authors)**

| Variable groups | Subgroups of the variables | Var. | Questions |
|---|---|---|---|
| Travel Characteristics | | MOW | Mode of working traffic |
| | | MOP | Mode of personal errand |
| | | FOW | Frequency of using own car for work |
| | | FOP | Frequency of using own car for personal errands |
| Distance, time, and travel expenses | | TOP | Time to office by private car: Total time to go to work from the condominium per day. |
| | | PTX | Private car travel expense: Total travel cost per day. |
| | | TD | Transportation Distance: The distance between the rail station and the condominium |
| Traveling Attitudes | Service Quality Attitude | CSQ1 | Safety in car-sharing use |
| | | CSQ2 | Availability of car-sharing in rush hour |
| | | CSQ3 | Convenience of car-sharing use |
| | | CSQ4 | Convenience of finding car-sharing parking lots |
| | Perception of Car-sharing (PC) | PC1 | Willing to use car-sharing if distance between parking lot and residence is closer. |
| | | PC2 | Willing to use car-sharing if more special car-sharing parking lots are provided in public areas such as shopping malls and rail stations. |
| | | PC3 | Willing to use car-sharing if car-sharing decreases the traveling cost more than using private car. |
| | | PC4 | Willing to use car-sharing if various types of cars are provided such as Sedan, SUV, Hatchback, and Mini MPV. |
| | | PC5 | Willing to use car-sharing if various brands of cars are provided, such as Japanese and European cars. |
| | | PC6 | Willing to use car-sharing if various types of electric cars are provided such as Hybrid, PHEV, and EV |
| | Behavioral Intention (BI) | CUBI1 | In the following 1-3 months, I intend to use car-sharing more frequently instead of using a private car. |
| | | CUBI2 | I have an interest in using car-sharing in the next travel occasion. |
| | Social Acceptance (SA) | SA1 | Agree that the car brand reflects the social status. |
| | | SA2 | Agree that a private car is the necessary goal in your life. |
| | | SA3 | Agree that a private car is the necessary asset to possess. |
| | Environmental Concerns (EC) | EC1 | Want to decrease the use of private cars due to the pollution emissions. |
| | | EC2 | Want to decrease the use of private cars as it contributes to traffic jams. |
| | | EC3 | Prefer to use an electric car rather than an engine car. |
| | Perceived Behavioral Control (PBC) | PBC1 | The more difficult it is to find the car-sharing parking lot, the less intention to adopt car-sharing. |
| | | PBC2 | The further the distance between the car-sharing parking lot and destination, the less intention to adopt car-sharing. |
| | | PBC3 | Insufficient car-sharing parking derails the intention to use car-sharing. |
| | Subjective Norm (SN) | SN1 | If your intimate friends or family recommend using car-sharing, you tend to use car-sharing. |
| | | SN2 | If your intimate friends or family use car-sharing, you tend to use car-sharing. |
| | Personality (P) | P1 | You have lots of baggage. |
| | | P2 | You need privacy for the car, you do not like to share a car with other persons. |
| | | P3 | You like walking. |

| Variable groups | Subgroups of the variables | Var. | Questions |
|---|---|---|---|
| | | P4 | You do not like the burdens of owning a private car, such as the repair expenses, annual tax for the vehicle, and insurance fees. |
| | | P5 | You like security and safety, such as first-class car insurance and repaired service. |
| | | P6 | You can schedule your travel plan before the traveling day, such as book a car-sharing before the traveling day. |

The data analysis was conducted by descriptive statistic and confirmatory factor analysis (CFA), which is for testing the validity of the latent construct and observed variables. The researchers used AMOS version 26th and SPSS version 26th for analyzing the data. For estimating the parameter, the Cronbach's α is used to confirm the reliability of the latent variables. After verifying the reliability process, the observed variables, which are the elements of the latent variables, will be confirmed by Confirmatory Factor Analysis (CFA). Lastly, the Structural Equation Modeling (SEM) is used for finding the factors influencing car-sharing adoption intention. The detailed instruments are described as follows:

- Chi-Square $\chi 2$ if Chi-Square is low and non-significant in statistics (p-value $\geq 0.05$) means that the model fits with the empirical data (Bollen, 1989)
- $\chi 2/df$ Typically, the good range of $\chi 2/df$ is lower than 2.00. If in the range 2-5 is acceptable (Bollen, 1989)
- Root of Mean Square Residual (RMR) Typically, an RMR under 0.10 is acceptable (Kline, 1998)
- Comparative Fit Index (CFI) If CFI >0.95, the model appropriately fits with the empirical data. If CFI in the range 0.90-0.95 is acceptable. (Diamantopoulos and Siguaw, 2000)
- Root Mean Square error of Approximation (RMSEA) If RMSEA $<0.05$ means the model suitably fits with the empirical data. The acceptable case is $0.05 < RMSEA < 0.10$ (Diamantopoulos and Siguaw, 2000)

The main hypothesis of this research is based on the TPB, which identifies three key factors: Subjective Norms regarding reducing private car usage (SN), Attitude toward car-sharing (AT), and Perceived Behavioral Control over reducing private car usage (PBC). These factors are considered to influence the intention to travel using car-sharing. Additionally, factors such as Environmental Concern (EC), Social Acceptance (SA), and Travel Characteristics (TC) are hypothesized to have a direct impact on the intention to switch to car-sharing and to influence attitudes toward car-sharing. They are shown in the six hypotheses as follows:

H1: Subjective norms toward the adoption of car-sharing (SN) positively influence the intention of car-sharing adoption.

H2: Service Quality Attitude toward car-sharing (AT) positively influences the intention of car-sharing adoption.

H3: Perceived Behavioral Control (PBC) negatively influences the intention of car-sharing adoption.

H4: Environmental Concerns (EC) positively influence the intention of car-sharing adoption.

H5: Social Acceptance (AC) positively influences the intention of car-sharing adoption.

H6: Travel Characteristic (TC) negatively influences the intention of car-sharing adoption.

# 4. Results

### *4.1 Descriptive data*

From the 237 samples, we found that most samples are in 25-40 ages, the proportion of males and females is approximate. Most samples are middle-income living in upper- middle-class condominiums (100,000-149,999 THB/square meters). Their monthly incomes are 20,001-40,000 THB/month, and 78% of them are office workers. Besides, 99% of them graduated with a bachelor's degree. Most samples' condominiums are located near the rail stations in the perimeter areas, and 40% of the samples live in outer beltway areas. Moreover, 78% of the samples solely use their car, they do not have to share a car with their family. However, the samples can be separated into 2 groups which consist of frequent car users and non-frequent car users. First, the frequent car users can be divided into 3 groups which comprise of 3-4 days users, 5-6 days users, and everyday users. Obviously, the 5-6 days users and everyday users have the same travel behavior; 90% of them drive from condominiums to their destinations either on a working trip or a personal trip. Comparably to 3-4 days users, they probably use public transportation such as BTS or MRT for their working trip instead of using private cars. Nevertheless, for a personal trip this group still used their private car to the destinations.

Moreover, the non-frequently car users mostly use public transportation for a working trip. However, for a personal trip, they still drive from their condominiums to destinations that do not differ from the frequent users.

Besides, the commuters' traveling expense is approximately 88.6 THB/day (around 2.59 USD/day). The highway fee is the largest expense of traveling expenses. In addition, the frequent users have more additional expenses, including the highway fee and the transit cost more than the non-frequent users approximately 22 THB/day (around 0.64 USD/day).

According to the data in Table 3, the samples were considerably interested in traveling by car-sharing. The most important factor influencing the car-sharing interest is financial savings from reducing traveling expenses (PC3), which is cheaper than using a private

car. It is shown as the highest average score of 3.90. The second highest average score of 3.72 is that they will use car sharing if more special car-sharing parking lot is provided in public areas such as malls and around rail transit stations (PC2). The lowest average score is PC1, which is 3.54. This implied that if the condominium residents have a parking lot near their residence, they are less likely to use car-sharing. Other factors were rated similarly, and the samples were probably interested in using car-sharing.

**Table 3. Summary of Samples' Perception on Car-Sharing (PC) (compiled by authors)**

| Attitudinal questions | Var. | Mean | S.D. | Level Agree |
|---|---|---|---|---|
| Willing to use car-sharing if distance between parking lot and residence is closer. | PC1 | 3.54 | 1.07 | Agree |
| Willing to use car-sharing if more special car-sharing parking lots are provided in public areas such as shopping malls and rail stations. | PC2 | 3.72 | 1.05 | Agree |
| Willing to use car-sharing if car-sharing decreases the traveling cost more than using private car. | PC3 | 3.90 | 1.02 | Agree |
| Willing to use car-sharing if various types of cars are provided such as Sedan, SUV, Hatchback, and Mini MPV. | PC4 | 3.69 | 1.00 | Agree |
| Willing to use car-sharing if various brands of cars are provided, such as Japanese and European cars. | PC5 | 3.60 | 1.06 | Agree |
| Willing to use car-sharing if various types of electric cars are provided, such as hybrid, PHEV, and EV. | PC6 | 3.6 | 1.05 | Agree |

CBRE (2023) classified the Bangkok Condominium into 6 categories based on the price per sq.m. from the lowest to highest price as follows.

Class-1 - "Entry Level" is a price under 69,999 THB/sq.m. (under 2,048.79 USD/sq.m)

Class-2 - "Mid-range" is a price between 70,000-99,999 THB/sq.m.(2,048.82-2,926.86 USD/sq.m.)

Class-3 - "Upper-Mid-Range" is a condominium price between 100,000-149,999 THB/sq.m. (2,926.89-4,390.30 USD/sq.m.)

Class-4 - "High-End" is a price between 150,000-249,999 THB/sq.m.(4,390.33-7,317.19 USD/sq.m.)

Class-5 - "Luxury" is a price between 250,000-349,999 THB/sq.m.(7,317.22-10,244.07 USD/sq.m.)

Class-6 - "Super Luxury" is a price above 350,000 THB/sq. m. (above 10,244.10 USD/sq.m.)

Note: Based on the exchange rate of 1 USD = 34.1660 THB. (Source: Bank of Thailand (BOT) on December 13, 2024. https://www.bot.or.th)

According to the data in Table 4, most samples would occasionally use car-sharing, which means that they tend to use car-sharing 1-2 times per month and the most occasion they probably use is for shopping. Merely, the upper-middle group interest to use for working trip.

**Table 4. Condominium Segment and the Car-sharing adoption intention (compiled by authors)**

| Condominium Segment | Income (THB/month) | Frequency of use | Model of car-sharing adoption intention | Occasions |
|---|---|---|---|---|
| Luxury (N=5) | > 100,000 | 1-2 day/week | Absolutely use (Use > 4 Times/month) | Go to the shopping mall |
| High (N=43) | 40,000-60,000 | Every day use | Occasionally use (Use 1-2 Times/month) | Go to the shopping mall |
| Upper Middle (N=69) | >100,000 | 1-2 day/week | Occasionally use (Use 1-2 Times/month) | Go to work |
| Middle (N=57) | 20,000-40,000 | 5-6 day/week | Occasionally use (Use 1-2 Times/month) | Go to the shopping mall |
| Low (N=63) | 20,000-40,000 | Every day use, 5-6 day/week | Occasionally use (Use 1-2 Times/month) | Go to the shopping mall |

In the reliability testing method, Cronbach's α is used to measure the reliability of the empirical data. If Cronbach's α is even or more than 0.6, it is acceptable, but if above 0.7 means the empirical data is unquestionably reliable (Clare et al., 2006).

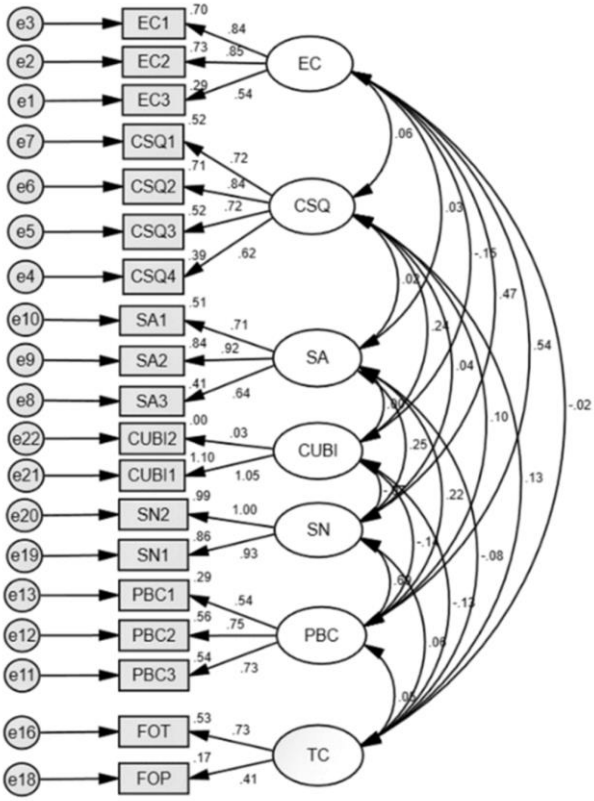
According to the data in Table 4, most latent variables have Cronbach's α above 0.7, which means unquestionably reliable. However, the Personality factor is non-acceptable, which has only 0.495. Consequently, it is necessary to delete this group of latent variables because if this group of variables was added into the confirmatory factor analysis (CFA) or added into the structural equation modeling (SEM), it might affect the model fit indexes and lead to an unreasonable model that cannot be applied to describe the traveling behavior.

**Table 4: Result of Cronbach's α Analysis (compiled by authors)**

| Variables | Var. | Number of observed variables | Cronbach's α |
|---|---|---|---|
| Service Quality Attitude toward car-sharing | AT | 4 | 0.815 |
| Subjective Norm | SN | 2 | 0.961 |
| Perceived Behavioral Control | PBC | 3 | 0.709 |
| Behavioral Intention | BI | 2 | 0.619 |
| Environmental Concerns | EC | 3 | 0.782 |
| Social Acceptance | SA | 3 | 0.793 |
| Perception of Car-sharing | PC | 6 | 0.793 |
| Personality | P | 6 | 0.495 |

### *4.2 Confirmatory Factor Analysis*

According to the Confirmatory Factor Analysis (CFA) result, all the model fit indexes are acceptable and unquestionably reliable. Together with the correlations between groups of latent variables are not too high, there are no groups of the latent variable has correlations figure more than 0.8 which means the groups of variables do not have the same meanings. In summary, the groups of latent variables are correlated with the questions in the questionnaire and correspond with the TPB.



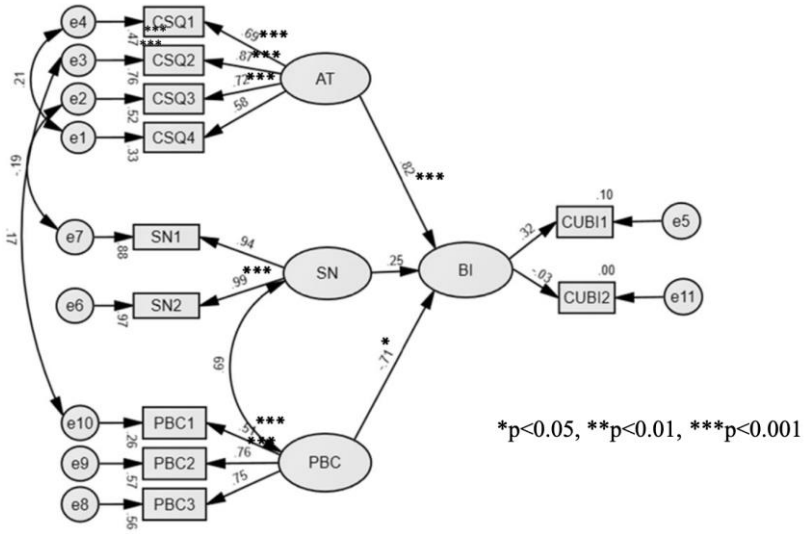

$\chi 2 = 171.984$, df = 131, $\chi 2/df = 1.313$, RMR = 0.045, CFI = 0.975, GFI = 0.931, RMSEA = 0.036, AGFI = 0.900

**Figure 1. Confirmatory Factor Analysis (CFA) Result (developed by the authors)**

**<u>Model 1</u>: The Theory of Planned Behavior (TPB) model with Standardized Coefficients (N =237)**

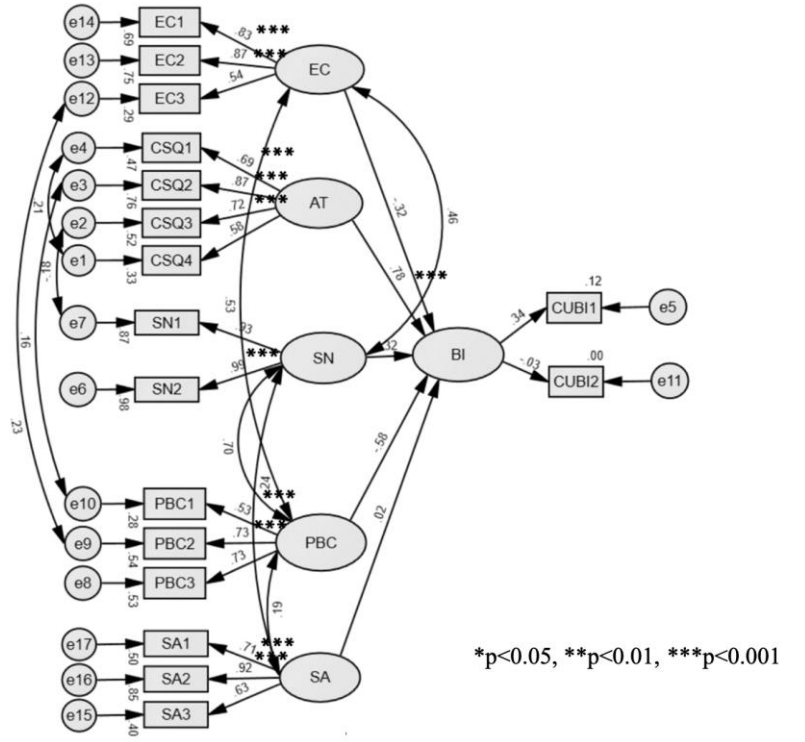
According to the TPB model result, all the model fit indexes are acceptable and unquestionably reliable as guaranteed by the significant p-value of all observed variables at $p<0.001$. In summary, this SEM model is considered reliable and can be applied to describe the car-sharing adoption intention according to the TPB. This model has two significant variables, which consist of Service Quality Attitude toward car-sharing (AT) and Perceived Behavioral Control (PBC). The Service Quality Attitude toward car-sharing (AT) is the most significant factor among three factors which has positive effect toward car-sharing adoption intention with a factor loading of 0.82. This implies that if car-sharing service quality is good enough, such as the certainty of car availability in a rush hour, the first-class insurance is provided, the convenience of finding a car-sharing parking lot, the commuters are ready to switch from using a private car to car-sharing. On the other hand, the PBC has negative effect toward car-sharing adoption intention with the factor loading at 0.71, which indicates that the further distance between a car-sharing parking lot and the destination, the difficulty of finding a car-sharing parking, and the

insufficient car-sharing parking are the factors deterring the car-sharing adoption intention. However, in this TPB model, the Subjective Norm (SN), which relates to the closed persons of commuters, has no significant influence on car-sharing adoption intention (see Figure 2).




$\chi 2$= 34.252, df = 38, $\chi 2$/df = 0.901, P-Value = 0.643, RMR = 0.036, GFI = 0.975, RMSEA = 0.000
CFI = 1.000, AGFI = 0.957, HOELTER = 368

**Figure 2. The results of the TPB-based structural equation modeling (SEM) analysis using Standardized Coefficients (N = 237) (developed by authors)**




$\chi 2$= 82.653, df = 67, $\chi 2$/df = 1.193, P-Value = 0.094, RMR = 0.043, GFI = 0.955
RMSEA = 0.031, CFI = 0.988, AGFI = 0.929, HOELTER = 249

**Figure 3. The results of the structural equation modeling (SEM) analysis incorporating the additional variables of Environmental Concern (EC) and Social Acceptance (SA) using Standardized Coefficients (N = 237) (developed by authors)**

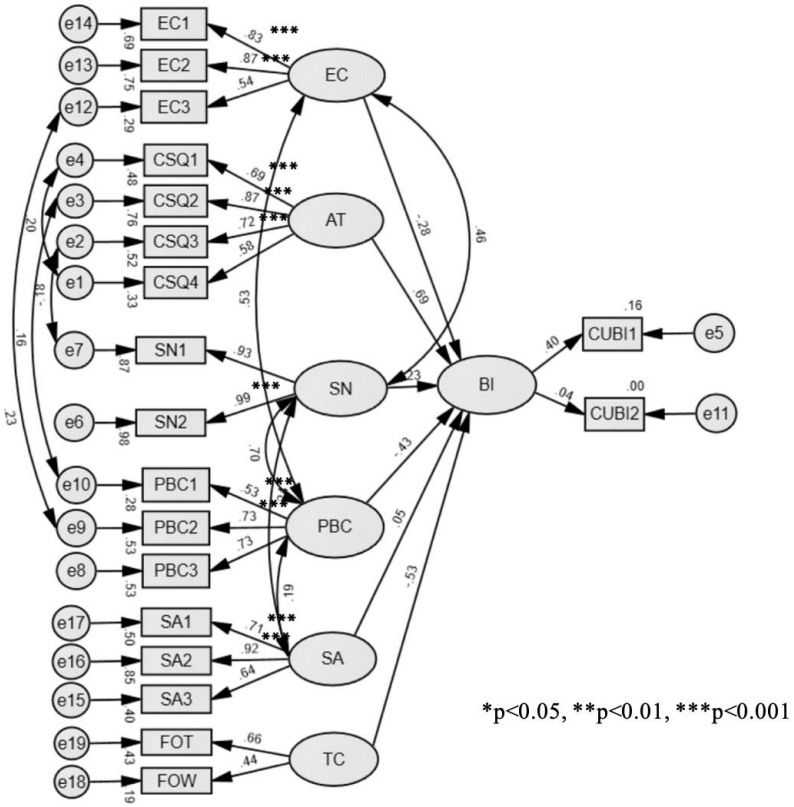
**<u>Model 2</u>: TPB model adding Environmental Concerns (EC) and Social Acceptance (SA) with Standardized Coefficients (N =237)**

According to the TPB model adding Environmental Concerns (EC) and Social Acceptance (SA) (Figure 3), the EC is added from Meijkamp (1999) study which found that environmental concerns was the most significant factor influencing car-sharing adoption in a European country and the SA is added from Banister (1978) who found that social status from car brand

affected the intention to use car. Consequently, this model is applied to test these two hypotheses.

The result of the TPB model adding EC and SA indicates that both EC and SA factors do not significantly influence car-sharing adoption intention in the Bangkok Metropolitan area as the factor loading and p-value indexes are extremely low.

The last model is designed to test whether the Travel Characteristic (TC) affects the car-sharing adoption intention or not. As for TC, it negatively affects public transportation use, which was found by Banister (1978) and Chen & Chao (2011). They described that the frequency of private car use negatively affects the public transportation use, which is in accordance with the Theory of Habit. Therefore, the following model was created to test this hypothesis.




$\chi 2$= 158.130, df = 138, $\chi 2$/df = 1.146, P-Value = 0.116, RMR = 0.051, GFI = 0.936
RMSEA = 0.025, CFI = 0.988, AGFI = 0.912, HOELTER = 249

**Figure 4. The results of the structural equation modeling (SEM) analysis, incorporating the additional variable of Travel Characteristics (TC) using Standardized Coefficients (N = 237) (developed by authors)**

**Model 3: TPB model adding Environmental Concerns (EC), Social Acceptance (SA) and Travel Characteristics (TC) with Standardized Coefficients (N =237)**

According to the model with added Travel Characteristic (TC) (see Figure 4), this model explained that TC does not significantly affect the car-sharing adoption intention as shown by the low p-value of this factor. However, the insignificant P-value of this factor might be caused by the added structure into the model, and when the model consists of many structures, it may contribute to an insignificant result. In summary, from the last model, the TPB factors still influence in the same way as the two previous models. Furthermore, the three added factors do not influence the car-sharing adoption intention.

From Table 5, the standardized coefficients for all three models, which are based on the core variables of the Theory of Planned Behavior (TPB), are consistent across all models. Despite the addition of other factors into the models, the influence of the original three factors remains unchanged, and their weights have not significantly deviated. Among the factors derived from TPB, the most influential is Attitude toward using car-sharing (AT), followed by Perceived Behavioral Control regarding car-sharing (PBC). The least influential factor is Subjective Norms related to reducing private car usage (SN). Notably, when the travel characteristic variable (TC) was added to Model 3, the TC variable exhibited a negative weight on the intention to travel using car-sharing (CUBI), with a factor weight of -0.53. This influence was greater in magnitude than the negative weight of Perceived Behavioral Control (PBC), which had a factor weight of -0.43.

**Table 5. Comparison of results from Model 1-3 (compiled by authors)**

| Relationships | SEM Model results-standardized coefficient | | |
|---|---|---|---|
| | Model 1 | Model 2 | Model 3 |
| BI ← AT | 0.82*** | 0.78*** | 0.69 |
| BI ← SN | 0.25 | 0.32 | 0.23 |
| BI ← PBC | -0.71* | -0.58 | -0.43 |
| BI ← EC | | -0.32 | -0.28 |
| BI ← SA | | 0.02 | 0.05 |
| BI ← TC | | | -0.53 |

*Note:* *Significant at p<0.05, ** significant at p<0.01, *** significant at p<0.001

The testing of all six hypotheses through the analysis of the SEM model in all three forms concluded that only Hypothesis 2 and Hypothesis 3 were supported by the tests. Specifically, Service Quality, Attitude toward car-sharing (AT), and Perceived Behavioral Control (PBC) were found to have an impact on Car-sharing adoption (See Table 6).

**Table 6. Summary of hypothesis testing (compiled by authors)**

| Hypotheses | Result |
|---|---|
| Hypothesis 1: Subjective norms toward the adoption of car-sharing (SN) positively influence the intention of car-sharing adoption. | Not confirmed |
| Hypothesis 2: Service Quality Attitude toward car-sharing (AT) positively influences the intention of car-sharing adoption. | Confirmed |
| Hypothesis 3: Perceived Behavioral Control (PBC) negatively influences the intention of car-sharing adoption. | Confirmed |
| Hypothesis 4: Environmental Concerns (EC) positively influence the intention of car-sharing adoption. | Not confirmed |
| Hypothesis 5: Social Acceptance (SA) positively influences the intention of car-sharing adoption. | Not confirmed |
| Hypothesis 6: Travel characteristics (TC) negatively influence the intention of car-sharing adoption. | Not confirmed |

# 5. Conclusion

The findings of this research can be applied to the real estate sector, particularly by real estate developers and city planners, to incorporate car-sharing parking lots in high-rise condominiums in Bangkok. This approach benefits both developers and residents by reducing construction costs through a decrease in the need for private car parking spaces. As a result, the price per square meter of condominiums would decrease, making homeownership more accessible to a larger segment of Bangkok's population.

The research reveals that most residents of condominiums in the Bangkok Metropolitan area hold a positive attitude toward car-sharing, especially those in the Gen Y age group (25-40 years). This demographic is more likely to adopt car-sharing, provided the service meets key quality standards. These standards include the certainty of car availability during peak hours, comprehensive first-class insurance, and the convenience of locating car-sharing parking spaces. These service quality factors are critical in encouraging a shift from private car ownership to car-sharing.

Additionally, descriptive statistics indicate that most respondents expressed environmental concerns. Offering electric car-sharing services could attract these environmentally conscious individuals. Electric vehicles not only align with eco-friendly values but also help reduce fuel costs, which is a significant expense for many respondents. Furthermore, respondents showed interest in various car types, such as city cars and SUVs, to meet the diverse needs of single individuals and families. However, the research suggests that luxury car brands are unnecessary. Structural Equation Modeling (SEM) analysis revealed that subjective norms toward car-sharing adoption (SN) and social acceptance (SA) from using car-sharing have an insignificant influence on adoption intention. However, environmental concerns (EC) have a negatively insignificant influence on adoption intention. Therefore, it recommends that condominiums focus on offering a variety of practical car options rather than luxury and green vehicles such as hybrid electric vehicles, plug-in hybrid electric vehicles, battery electric vehicles and natural gas vehicles.

Respondents also commented that car-sharing rates should be approximately 20% lower than the costs associated with owning and operating a private car. Given the respondents' average daily travel expense of 88.6 THB (around 2.59 USD.), car-sharing rates should ideally start at 70.88 THB per day (around 2.075 USD.). Additionally, car-sharing should be priced lower than taxis for comparable distances. However, current travel policies in Thailand create pricing challenges, making car-sharing relatively expensive. Policy changes could lower car-sharing rates to make the service more competitive.

Moreover, if the government and private sectors were to subsidize car-sharing programs, it would encourage the development of car-sharing parking spaces in public areas, such as near rail stations, shopping malls, and transit hubs. Policy measures such as tax deductions for car-sharing users could further promote adoption. These combined efforts; enhanced service quality, pricing adjustments, and government support, could significantly increase car-sharing usage among commuters.

## Author Contributions

Conceptualization, P.P.; methodology, P.P.; software, C.V.; formal analysis, C.V.; investigation, C.V.; resources, P.P.; data curation, C.V.; writing-original draft preparation, all authors contributed equally; writing – review and editing, P.P.; visualization, C.V.; supervision, P.P.; project administration, P.P. All authors have read and agreed to the published version of the manuscript.

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## Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki.

## Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

## Data Availability Statement

The data presented in this study are available on request from the corresponding author.

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## Conflicts of Interest

The authors declare no conflicts of interest.

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