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Regional Differences in Car Sharing Adoption: Integrating TAM and TPB in Bangkok and Eastern Economic Corridor, Thailand

Tanawat Sarnvanichpitak[1], Aweewan Mangmeechai[2]

Tanawat.Sarn@stu.nida.ac.th, Aweewan.m@nida.ac.th

Abstract. This study explores the factors influencing car sharing adoption in Thailand, focusing on regional differences between Bangkok and the Eastern Economic Corridor (EEC). Using an integrated model of the Technology Acceptance Model (TAM) and Theory of Planned Behavior (TPB), data were gathered from 800 respondents through online surveys and analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The findings highlight notable regional distinctions: in Bangkok, perceived physical risk and environmental awareness significantly affect the perceived usefulness of car sharing services, while in the EEC, perceived value plays a critical role. Additionally, subjective norms have a stronger influence in Bangkok, reflecting the city's cultural emphasis on social conformity. In contrast, the industrial nature of the EEC underscores the importance of perceived behavioral control as a key determinant. This study adds to the body of literature by offering insights into regional variations in car sharing adoption and provides practical recommendations for policymakers and service providers to tailor their strategies to different urban settings.

Keywords: Carsharing, Sharing Economy, Theory of Planned Behaviour, Technology Acceptance Model

1. Introduction

Worldwide, and notably in large cities, rising incomes are significantly associated with rising automobile ownership rates (Hussain et al., 2022). Cities face significant obstacles as transportation infrastructure struggles to meet the increasing demand, such as extended travel delays, escalating transportation costs, severe traffic congestion, heightened safety concerns, increased pollution, and reduced overall transportation efficiency (Nugroho et al., 2017). In response, the concept of "Collaborative Consumption," also known as the "Sharing Economy," has emerged as a viable solution. This economic model emphasizes the shared use of resources, such as vehicles, to mitigate environmental impact and alleviate the financial burdens associated with ownership (Koller et al., 2011). Car sharing, a key component of this model, provides a practical solution to urban transportation problems by allowing users to access vehicles on demand while mitigating the costs related to car ownership, including fuel, insurance, and maintenance (Nansubuga & Kowalkowski, 2021). Despite its potential, car sharing remains relatively underutilized in Thailand, particularly in Bangkok and the EEC, regions facing significant transportation challenges such as traffic congestion, inadequate public transportation, and rising private vehicle ownership. Bangkok, with over 6.7 million vehicles registered, suffers from severe air quality issues and economic and health-related costs due to its transportation sector contributing to 25% of the city's carbon emissions (Croci et al., 2011). The EEC, aimed at enhancing Thailand's economy, faces similar challenges with increased pollution and congestion due to rapid development (Eastern Economic Corridor (EEC) Office, 2021). Despite the Thai government's initiatives to promote public transportation and alternative modes of travel to mitigate traffic congestion, these efforts have produced only modest results. In light of this, car sharing—an emerging online-to-offline business model—may offer a novel solution to the ongoing transportation challenges faced in these areas.

Although car sharing presents a promising solution to urban transportation challenges, its adoption in Thailand remains relatively low. The TPB or the TAM are the primary theoretical frameworks employed in current research on car-sharing services. Nevertheless, these studies frequently neglect to adequately account for regional variations in the adoption of car-sharing in a variety of urban environments. In numerous regions, such as Bangkok and the EEC, there is a significant disparity in comprehension regarding the impact of varying socioeconomic, cultural, and infrastructural factors on the adoption of car-sharing. This study aims to address the existing gap by integrating the TAM and the TPB to provide a comprehensive understanding of car-sharing adoption in Thailand. Specifically, the study seeks to:

- to examine the extent to which TPB and TAM characteristics, such as attitudes, subjective norms, perceived behavioral control, perceived usefulness, and perceived ease of use, can predict the intention to utilize vehicle sharing in Bangkok and EEC regions of Thailand.
- to investigate how external factors such as perceived physical risk, environmental concern, and perceived economic value effect on the intention to utilize car sharing in Bangkok and EEC, and to compare the effects of these external factors in the two regions.
- to analyze the role of socio-demographic factors (age, gender, income, marital status, and car ownership) on the intention to use car sharing in Bangkok and EEC
- to identify any region-specific factors that influence the intention to use car sharing in Bangkok and EEC
- to explore the barriers and enablers to car-sharing adoption in Bangkok and the EEC regions of Thailand, and to develop recommendations to private company or policy maker for addressing these barriers and leveraging these enablers to increase car-sharing adoption.

Bangkok and the EEC embody two distinct urban and industrial environments within Thailand. Bangkok is a densely populated metropolis characterized by significant traffic congestion, insufficient public transportation, and deteriorating air quality. In contrast, the EEC is an emerging industrial hub with limited transportation options, heavily reliant on private vehicles, a situation further intensified by industrial growth. Analyzing the disparities in car-sharing adoption between these two regions can yield valuable insights for formulating tailored strategies aimed at promoting sustainable transportation solutions. The subsequent sections of this paper are organized as follows: Section 2 provides a comprehensive review of the relevant literature and the formulation of hypotheses. Section 3 details the methodology employed in the study. Section 4 presents the analysis results, while Section 5 offers a discussion of the findings and their implications for policy and practice.

2. Literature Review

2.1. Carsharing as an alternative to vehicle ownership

Car sharing has emerged as an innovative alternative to traditional vehicle ownership, offering individuals short-term access to automobiles without the long-term financial and logistical responsibilities associated with full ownership. Unlike conventional car rental or leasing models, car sharing typically operates on a membership-based system, providing users with a variety of rental options, including hourly, distance-based, or monthly subscriptions (Giana, 2019). This model has become increasingly attractive as it allows for flexible, on-demand access to vehicles, catering to consumers who seek the utility of car use without incurring the costs of maintenance, insurance, and fuel. The integration of advanced information and communication technologies (ICT) has significantly enhanced the user experience. Mobile applications provide real-time data, alternative routes, and updates on journey delays (Shaheen et al., 2020). The rising adoption of car sharing globally signals a fundamental shift in consumer preferences, particularly in urban environments, where individuals are seeking alternatives to private vehicle ownership.

In Thailand, carsharing has emerged as a promising solution to address transportation challenges, particularly in areas such as Bangkok and the EEC, where issues like traffic congestion, air pollution, and heavy reliance on private vehicles are significant concerns. Despite the proliferation of private sector initiatives, with companies like Drivemate, Haupcar, and ASAP leading the charge, carsharing remains relatively underutilized. Notably, the Thai government has recognized carsharing in its 2015 transport master plan, incorporating it into its Transport Demand Management strategy (Boonsiripant et al., 2020). However, adoption and implementation have been slow, with limited policies that support the expansion of carsharing services. According to a research by Safdar et al. (2022) emphasize that government intervention, via policies and incentives, could significantly facilitate broader adoption, particularly in emerging markets such as Thailand.

2.2. Theoretical Foundations

The adoption and utilization of car-sharing services can be comprehensively analyzed through the lens of two established theoretical frameworks: the Theory of Planned Behavior (TPB) and the Technology Acceptance Model (TAM).

Theory of Planned Behavior (TPB)

The TPB framework asserts that behavioral intention, a significant predictor of actual behavior, is shaped by three key factors: attitudes, subjective norms, and perceived behavioral control. Attitudes represent an individual's positive or negative evaluation of engaging in a particular behavior, whereas subjective norms denote the perceived social pressure to participate in that behavior. Perceived behavioral control pertains to an individual's confidence in their ability to execute the behavior (Ajzen,

1991). Numerous studies have validated the application of the TPB in transportation-related decision-making. For instance Li and Zhang (2021) demonstrated its effectiveness in predicting behavioral intentions regarding transportation choices. The TPB framework offers a structured understanding of how various psychological factors can influence consumers' intentions to adopt car-sharing services.

Technology Acceptance Model (TAM)

TAM provides a complementary perspective by concentrating on user adoption and engagement with new technologies. According to the model, the likelihood of technology adoption increases when its usability is high, and its utility is well perceived. Notably, perceived usefulness directly influences users' attitudes toward the technology, whereas perceived ease of use indirectly affects these attitudes by enhancing the overall user experience (Fred, 1989). Recent studies, including the work of Das and Ahmed (2024) have further refined TAM's application in the context of emerging technologies.

Combining TPB and TAM: An Integrated Framework

Given the complementary nature of the TPB and TAM models, this study adopts an integrated framework that leverages the strengths of both theories. While TPB provides insights into the psychological and social factors influencing behavior, TAM offers a more specific focus on the technological aspects of adoption, such as perceived usefulness and ease of use. Combining these two models allows for a holistic understanding of car sharing adoption by considering both individual attitudes toward technology and broader social influences.

Figure 1 illustrates the conceptual framework that integrates TAM and TPB. This combined framework incorporates key variables from both models, such as perceived ease of use, perceived usefulness, attitudes, subjective norms, and perceived behavioral control, offering a comprehensive approach to studying car sharing adoption. By integrating these elements, the model aims to capture the full range of factors influencing behavioral intention and adoption of car sharing services.

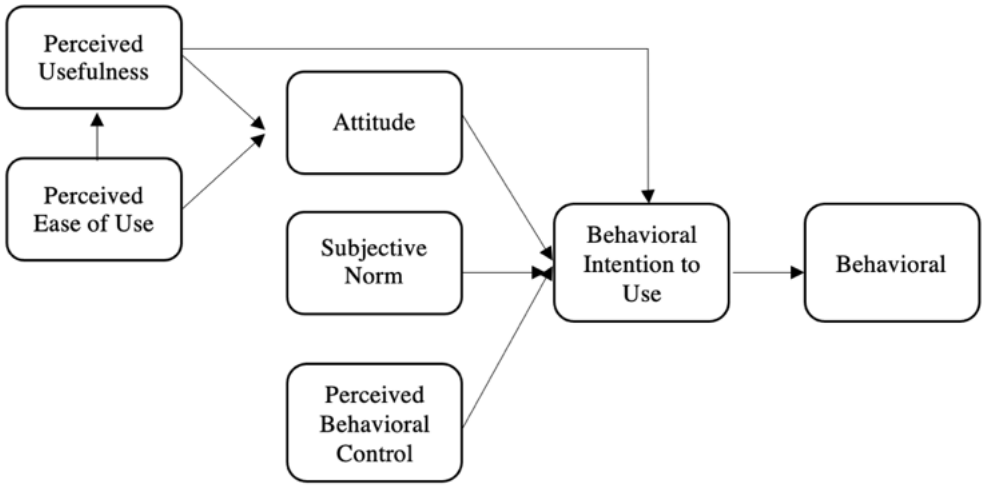

Fig.1: Combined TAM and TPB

2.3. Critique of Existing Literature and Identification of Research Gaps

Despite the extensive application of TPB and TAM in studying technology and transportation-related decisions, a notable gap exists in the literature regarding the integration of these frameworks to fully understand car sharing adoption. Much of the existing research has examined either TPB or TAM in isolation, with limited studies combining the two models to provide a holistic analysis of user intentions and behaviors. This research gap is particularly evident in the context of emerging markets, such as Thailand, where regional variations between urban and industrialized areas may lead to differing

consumer motivations and challenges. Specifically, there is a lack of region-specific studies that explore the factors influencing car sharing adoption in diverse settings, such as the urbanized metropolis of Bangkok versus the industrial-focused EEC.

Furthermore, while external factors such as perceived physical risk, environmental concerns, and perceived economic value are acknowledged as significant influences on the adoption of car sharing, the existing literature offers limited critical analysis of how these factors may differ across various geographic and cultural contexts. For instance, environmental concerns have been demonstrated to drive car sharing adoption, as users aim to mitigate traffic congestion, reduce energy consumption, and lower greenhouse gas emissions (Shaheen & Cohen, 2013). Nonetheless, the degree to which these concerns motivate adoption varies among regions and demographic groups, a subject that remains largely unexamined in current research. Additionally, Yang and Nair (2014) have identified perceived risks, such as health and safety concerns, as significant obstacles to the adoption of car sharing. Nevertheless, there is a significant dearth of research that investigates the evolution of these risks in the wake of the COVID-19 pandemic.

2.4. External Factors Influencing Car Sharing Adoption

Several external factors are critical for understanding consumer adoption of car-sharing services. These factors include perceived physical risk, environmental concern, and perceived value:

- **Perceived Physical Risk**

  Concerns regarding physical safety and hygiene, particularly in the context of the COVID-19 pandemic, have introduced new considerations for the adoption of car-sharing services. Issues related to the cleanliness of shared vehicles and potential exposure to illness negatively impact user perceptions and deter adoption (Yang & Nair, 2014). It is essential to explore how these concerns vary across regions, such as Bangkok and the EEC, as this remains a significant area for future research.

- **Environmental Concern**

  Environmental motivations also play a significant role in driving interest in car sharing, particularly in densely populated urban areas where air quality and traffic congestion are pressing concerns. Shaheen and Cohen (2013) found that environmental concerns, including efforts to reduce greenhouse gas emissions, are often key motivators for adopting car sharing services. However, these motivations may vary by region. Urban areas such as Bangkok confront more significant environmental challenges, primarily due to elevated pollution levels from the transportation sector, in contrast to the industrial zones of the EEC.

- **Perceived Value**

  The perceived value of car sharing, which reflects users' assessment of the costs versus the benefits, also plays a pivotal role in adoption decisions. Research by Chang et al. (2015) underscores the importance of perceived value in influencing car sharing usage. However, wealthier individuals may be less inclined to adopt car sharing services due to the convenience and availability of private vehicles, an area requiring further investigation to understand how economic factors influence adoption across socioeconomic groups. Recent studies, such as Rotaris (2021) emphasize the importance of incorporating environmental and economic factors into carsharing research to understand consumer motivations better.

Conceptual Framework

This study presents an integrated conceptual framework that combines the TPB, the TAM, and external factors such as perceived risk, environmental concern, and perceived economic value to offer a comprehensive analysis of car-sharing adoption. The framework aims to capture the intricacies of user intentions and behaviors, emphasizing the interactions of these factors in the distinct regions of

Bangkok and the EEC. A detailed explanation of the conceptual framework and the development of hypotheses will be provided in the next section.

3. Hypothesis Development

3.1. Perceived Risk, Perceived Usefulness and Perceived Ease of Use

Consumers' perceptions of risk when using sharing services are a significant barrier to adoption mentioned in previous research (Hailey Shin et al., 2022), making it crucial to consider these concerns in TAM. TAM's focus on the perceived ease of use and perceived usefulness represents positive user attitudes towards technological innovations. However, when consumers perceive high risks, their positive perceptions decrease, leading to lower adoption rates. In the context of car-sharing, these risks are more pronounced, with concerns about personal safety, maintenance standards, and potential risks of infection or criminal activity during the use of shared vehicles. Thus, perceived risk can diminish both the perceived usefulness and ease of use of car-sharing services. This leads to the following hypotheses:

Hypothesis 1: Perceived physical risk has a negative influence on perceived usefulness of carsharing service.

Hypothesis 2: Perceived physical risk has a negative influence on perceived ease of use of carsharing service.

3.2. Environmental concern and Perceived Usefulness

Environmental concern is the understanding of the impact of actions on the natural world. It motivates individuals to adopt eco-friendly practices and engage in green activities. Car-sharing systems, for example, contribute to reducing carbon emissions and protecting the environment. Studies show that environmental concerns influence the intention to use car-sharing (Efthymiou et al., 2013), which improves traffic flow, reduces emissions, and ensures the future sustainability of the transportation sector. The perceived usefulness of car-sharing systems is linked to users' evaluation, leading to the proposal of hypotheses.

Hypothesis 3: Attitude towards environmental sustainability has a positive influence on perceived usefulness of carsharing service.

3.3. Perceived Value and Perceived Usefulness

The sharing economy promotes sharing assets instead of owning them, maximizing utility. Online platforms connect providers with consumers, reducing costs and increasing usage. Financial incentives play a role in users' participation, driven by economic challenges. This behavior shift is fueled by societal, economic, and technological advancements, with financial gain being a key incentive for sharing (Möhlmann, 2015). Based on the research analysis mentioned, car sharing system users evaluate usefulness and convenience of use. Car sharing systems are particularly appealing to financially challenged drivers, as they increase perceived financial benefits for users.

Hypothesis 4: Perceived value has a positive influence on perceived usefulness of carsharing service.

3.4. Perceived Usefulness, Perceived Ease of Use and Attitudes Toward Use (TAM)

Perceived usefulness in TAM refers to how individuals believe a system benefits task execution. Car-sharing programs can reduce traffic congestion, emissions, and parking needs, fostering

sustainability. Positive user attitudes are influenced by perceived usefulness, as seen in studies on consumer behavior and commercial bike and electric vehicle sharing services (Schlüter & Weyer, 2019). Users' perception of benefits influences their willingness to use such services.

TAM considers perceived ease of use as a factor in product usability. Users prefer products that are easy to understand and operate. In car-sharing systems, minimal effort is needed for tasks like unlocking and payment, leading to a favorable user impression. Users' perception of a system's ease of use directly affects their view of its usefulness, impacting their willingness to adopt technological innovations. Studies show a strong link between perceived ease of use and perceived usefulness, influencing users positively (Kaplan et al., 2017).

Hypothesis 5: The perceived usefulness has a positive influence on the attitude toward using carsharing service.

Hypothesis 6: The perceived ease of use has a positive influence on perceived usefulness of carsharing service.

Hypothesis 7: The perceived ease of use has a positive influence on the attitude toward using carsharing service.

3.5. Attitude, Subjective Norm, Perceived Behavioral Control and Behavioral Intention (TPB)

Attitude is a crucial factor in TPB, as it influences a person's perception of a behavior. A positive attitude is associated with more positive actions, while a negative attitude leads to less positive ones. In the context of car-sharing services, individuals with positive attitudes toward these services are more likely to express a strong intention to use them (Haldar & Goel, 2019). Therefore, the hypothesis is proposed.

Hypothesis 8: The attitude towards using of car sharing service has a positive influence on behavioral intention to use its services.

Subjective norm refers to an individual's perception of their expectations to conform to certain behavior standards set by peers, family, and society. People are strongly influenced by the opinions of others they look up to when deciding whether to engage in a given conduct. Intentions to act are positively correlated with attitude toward behavior and the presence of subjective norms. A stronger positive subjective norm makes it easier to motivate individuals to engage in the behavior (Li & Zhang, 2023). In the context of car-sharing programs, individuals are more likely to participate if they believe the majority of others adhere to a strong subjective norm of using a car sharing system.

Hypothesis 9: Subjective norm has a positive influence on behavioral intention to use carsharing services.

Perceived behavioral control refers to an individual's belief in their ability to control their behavior, influenced by internal and external factors. It is a direct predictor of behavior and provides valuable information about actual strength. A positive perception of control increases when individuals believe they have more resources and opportunities, and decreases expectations of potential barriers (Zhang et al., 2015). This concept is particularly relevant in public transportation and car-sharing systems, where individuals are more likely to use these systems if they feel more control over their experiences.

Hypothesis 10: Perceived behavior control has a positive influence on behavioral intention to use carsharing services.

The conceptual model is demonstrated in figure 2.

Figure 2. Conceptual Model

4. Research Methodology

4.1. Sampling

The study focused on local populations in Bangkok and the Eastern Economic Corridor (EEC), selecting these regions based on factors such as the study's objectives, population characteristics, heterogeneity, practicality, and available resources. Sample size determination followed Yamane's simplified formula (Yamane, 1967), which provides an easy method for calculating sample size when the population is known.

$$n = \frac{N}{1 + N(e)^2}$$

Given the populations of Bangkok (5.5 million) and the EEC (3.1 million), a minimum representative sample size of 400 respondents from each region was calculated, assuming a 95% confidence level and a 5% margin of error (e = 0.05). This results in a total sample of 800 respondents, deemed sufficient for achieving statistical significance and generalizing the findings to the broader population of car-sharing users in these regions.

Participants were recruited using a combination of convenience and snowball sampling techniques. Convenience sampling targeted easily accessible individuals who met the study's criteria, while snowball sampling helped reach participants who might not have been accessible through conventional means, increasing the sample's diversity. This mixed-method approach was appropriate given the researcher's connections in the target areas, allowing for efficient data collection and a wide range of perspectives on car-sharing services in both Bangkok and the EEC.

Although non-probability sampling methods, such as convenience and snowball sampling, carry limitations—such as potential bias and reduced representativeness—these techniques were selected for their practical advantages, including time efficiency and access to specific subgroups of interest (Albert et al., 2010). To minimize sampling bias, deliberate efforts were made to recruit participants from diverse demographic backgrounds.

4.2. Questionnaire

The questionnaire used in this study was developed based on preexisting, validated scales from prior research, as this approach has proven to yield reliable outcomes (Va, 2012). Leveraging established scales ensures both validity and comparability with other studies. The primary variables were initially measured using English-language scales, which were translated into Thai to accommodate local respondents. To maintain the accuracy and conceptual equivalence of the scales, a back-translation process was utilized (Son, 2018). This method involved translating the survey items into Thai and subsequently back-translating them into English by an independent translator to identify and correct any discrepancies. This iterative process ensured that the meaning of the items remained consistent with the original versions, thus enhancing the reliability of the questionnaire.

Before full-scale data collection, a pilot test was conducted with 30 participants who completed a paper-based version of the survey. The pilot phase aimed to assess the logical coherence, contextual relevance, sequence of items, and ease of comprehension of the questionnaire. Based on the feedback from the pilot participants, the item scales were refined to ensure clarity and appropriateness for the target population. The final questionnaire was divided into three main sections: (1) socio-demographic information and commuting habits, (2) participants' familiarity with and opinions on car-sharing services, and (3) factors influencing motivation and barriers to adopting car-sharing. To assess participants' attitudes toward car-sharing, a five-point Likert scale (ranging from 1 = strongly disagree to 5 = strongly agree) was employed.

4.3. Data Collection

The data was collected through online self-administered questionnaires, with potential respondents being contacted via email and social media platforms. An invitation to participate in the survey was sent to participants, along with a link to the Informed Consent document. The title of the study, the risks associated with it, the voluntary nature of participation, the right to withdraw at any time, the purpose of the survey, the eligibility criteria, data protection measures, and the potential for publication were all detailed in this consent form. In order to guarantee informed and voluntary participation, participants were obligated to check the "I Do Consent" box before accessing the survey. It is crucial to note that no personally identifiable information, such as names or national identification numbers, was collected, thereby ensuring the anonymity and confidentiality of the respondents.

This study was guided by the principles of voluntary participation, informed consent, confidentiality, and anonymity, with ethical considerations being of the utmost importance. Individuals were informed of their ability to withdraw from the study at any time without incurring any penalties, and participation was entirely voluntary. Data protection measures were implemented in accordance with ethical guidelines for research involving human participants, and all responses were treated as confidential.

4.4. Data Analysis

Following data collection, the survey responses were exported to Excel for preliminary filtering, which involved identifying and removing incomplete responses, outliers, and inconsistencies within the data. The cleaned dataset was subsequently imported into IBM SPSS Statistics version 25 for further analysis. Initially, reliability testing was conducted using Cronbach's alpha, with a threshold of 0.7 or higher indicating acceptable reliability. Descriptive statistics—including frequency, mean, mode, range, standard deviation, and the percentages of minimum and maximum scores—were calculated to provide an overview of the dataset. Additionally, correlation analysis was performed to examine the relationships between key variables and to address the research questions. A significance level of 0.05 was employed, with p-values less than or equal to 0.05 suggesting the rejection of the null hypothesis and indicating statistical significance (Ghasemi & Zahediasl, 2012).

To test the hypotheses and model the relationships between variables, this study employed Partial Least Squares Structural Equation Modeling (PLS-SEM). PLS-SEM was selected for its ability to analyze complex models, especially in cases where data distribution may not meet the assumptions of traditional covariance-based SEM. PLS-SEM is well-suited for exploratory research and is increasingly popular in fields like transportation due to its flexibility in modeling relationships between latent variables and handling measurement error (Ferreira et al., 2010). It simplifies data analysis and simplifies the prediction process. PLS-SEM is gaining popularity in various fields, including transportation, due to its advantages (Popova & Fesyuk, 2022). Moreover, PLS-SEM facilitates the

testing of multiple mediation and moderation relationships within a single model, which was essential for identifying the factors influencing car-sharing adoption in progressive urban areas. The application of PLS-SEM in this study allowed for the prediction of relationships and ensured that both direct and indirect effects were accounted for in the analysis.

5. Research Results

5.1. Descriptive statistic: Sample Characteristics

The data for this study were gathered from a total of 1,375 respondents in Bangkok and the Eastern Economic Corridor (EEC) between September and October 2023 through online surveys. After screening for incomplete responses, 800 completed questionnaires were included in the final analysis, resulting in a response rate of 58.95%. The characteristics of the respondents from Bangkok and the EEC are summarized below:

- **Bangkok Sample**: Among the 400 respondents, 193 were male (48.1%) and 207 were female (51.7%), with a mean age of 32.55 years. A significant majority were married (78%), while 22% were single. In terms of education, 98% held a bachelor's degree, 1% possessed a master's degree, and 1% had a high school diploma. The primary employment status was full-time, accounting for 89.5% of respondents, with freelancers (7.25%) and self-employed individuals (4%) making up the remainder. The mean income reported by respondents was 29,592 THB. A notable portion of respondents (93%) held a valid driver's license, and 88% owned a private automobile.
- **EEC Sample**: The EEC sample also comprised 400 respondents, of whom 238 (59.5%) were female and 162 (40.5%) were male, with ages ranging from 20 to 54 years. In terms of marital status, 74% were married, while 26% were unmarried. Educational attainment mirrored that of the Bangkok sample, with 93% holding a bachelor's degree, 9% a high school diploma, and 2% a master's degree. The majority of respondents were employed full-time, with a mean income of 31,034 THB. Consistent with the findings from Bangkok, 86.5% of respondents owned a private vehicle, and 90% possessed a valid driver's license.

5.2. Reliability Test

The study employed two key reliability measures: Cronbach's Alpha and composite reliability, to assess the internal consistency of the constructs.

- **Cronbach's Alpha**: The Cronbach's Alpha for all constructs exceeded the minimum acceptable value of 0.70, indicating satisfactory internal consistency across the scales (Fornell & Larcker, 1981). This is important for ensuring that the measured items within each construct reliably assess the same underlying concept.
- **Composite Reliability**: In line with PLS-SEM recommendations, composite reliability values were also examined. All constructs exceeded the 0.70 threshold, confirming the constructs' internal consistency (Chin & Marcoulides, 1998). Notably, composite reliability scores were consistently higher than their respective Cronbach's Alpha values, further reinforcing the acceptability of the measurements.

5.3. Validity test

The validity of the constructs was examined using **convergent** and **discriminant validity** tests to ensure the constructs measured the correct variables.

- **Convergent Validity**: Convergent validity was assessed by examining the Average Variance Extracted (AVE) values. All constructs exceeded the minimum threshold of 0.50 for AVE, indicating that the observed variables adequately explain the variance in their respective constructs (Hair et al., 2011). Additionally, factor loadings and cross-loadings were assessed, and all indicators exhibited loadings above the acceptable level of 0.70 on their corresponding constructs.
- **Discriminant Validity**: Discriminant validity, assessed using the Fornell-Larcker criterion, confirmed that the square root of the AVE for each construct was greater than its correlation with any other construct, demonstrating that each construct is empirically (Fornell & Larcker, 1981). The results from both Bangkok and EEC samples met these requirements, supporting the validity of the measurement model.

5.4. Structural Model and Hypothesis test

PLS-SEM analysis uses various measurement concepts to explain results. The p-value determines the acceptance or rejection of the null hypothesis, with a p-value below 0.05 indicating statistical significance. Path coefficient analysis reports the strength of the relationship between variables, with a beta value greater than zero indicating a positive correlation and a negative beta value indicating a negative correlation. The r-squared coefficient indicates the proportion of dependent variables accounted for by independent variables. PLS-SEM analysis can work with distribution-free data, small sample sizes, and bootstrapping data, enabling statistical inference (Henseler et al., 2009).

Key Hypotheses and Path Coefficients

Several hypotheses yielded significant results, demonstrating the relationships between various constructs and behavioral intention to use carsharing services:

- Perceived Risk had a negative influence on perceived usefulness in Bangkok ($\beta = -0.186$, $p < 0.001$), but was not significant in the EEC, indicating that safety concerns are more prevalent in urban areas like Bangkok.
- Environmental Concern positively influenced perceived usefulness in Bangkok ($\beta = 0.183$, $p < 0.001$), suggesting that environmentally conscious individuals in urban areas are more inclined to adopt carsharing. This relationship was not significant in the EEC, where environmental concerns may be less critical to service adoption.
- Perceived Value had a positive effect on perceived usefulness in the EEC ($\beta = 0.292$, $p < 0.001$), but was not significant in Bangkok, suggesting that individuals in more economically diverse areas like the EEC view the practical value of carsharing as a key driver for adoption.
- Perceived Ease of Use significantly influenced both perceived usefulness and attitude toward using carsharing services in both regions, with strong effects in Bangkok ($\beta = 0.395$ and $\beta = 0.301$, $p < 0.001$) and slightly lower but significant effects in the EEC ($\beta = 0.233$ and $\beta = 0.222$,

$p < 0.001$). This underscores the importance of a user-friendly service interface across both regions.

- Attitude toward carsharing was a significant predictor of behavioral intention in both Bangkok ($\beta = 0.266$, $p < 0.001$) and the EEC ($\beta = 0.132$, $p = 0.005$), though the effect was stronger in Bangkok.
- Subjective Norm significantly influenced behavioral intention only in Bangkok ($\beta = 0.212$, $p < 0.001$), suggesting that social influences, such as peers and community acceptance, are more critical in urban settings. This was not significant in the EEC ($\beta = 0.079$, $p = 0.106$).
- Perceived Behavioral Control was a significant predictor of behavioral intention in the EEC ($\beta = 0.217$, $p < 0.001$), indicating that respondents in this region feel their ability to use carsharing services is crucial in determining whether they would adopt the service. This relationship was not significant in Bangkok ($\beta = 0.044$, $p = 0.286$).

The summary of results is presented in the table 1.

Table 1. PLS SEM Result

	Bangkok			**EEC**		
	β	P - Value	Result	β	P-Value	Result
H_1	-0.186	**	Supported	-0.046	0.431	Not supported
H_2	-0.010	0.859	Not Supported	-0.041	0.554	Not Supported
H_3	0.183	**	Supported	0.043	0.494	Not Supported
H_4	0.06	0.379	Not Supported	0.292	**	Supported
H_5	0.319	**	Supported	0.285	**	Supported
H_6	0.395	**	Supported	0.233	**	Supported
H_7	0.301	**	Supported	0.222	**	Supported
H_8	0.266	**	Supported	0.132	**	Supported
H_9	0.212	**	Supported	0.079	0.106	Not Supported
H_{10}	0.044	0.286	Not Supported	0.217	**	Supported

Note: ** and * denote p-values less than 0.01 and less than 0.05, respectively

Control Variables: Gender, Income, and Car Ownership

Control variables added important insights into carsharing adoption across both regions:

- Gender had a significant negative correlation with behavioral intention in both Bangkok ($\beta = -0.166$, $p = 0.074$) and the EEC ($\beta = -0.288$, $p < 0.001$). Women were less likely than men to use carsharing services, with the effect being stronger in the EEC.

- Income was negatively correlated with behavioral intention in both Bangkok ($\beta = -0.668$, $p < 0.001$) and the EEC ($\beta = -0.470$, $p < 0.001$). Individuals with lower incomes expressed a stronger intention to use carsharing services, highlighting the price sensitivity of these groups.
- Car Ownership had a strong negative relationship with behavioral intention in both regions. In Bangkok ($\beta = -0.870$, $p < 0.001$) and the EEC ($\beta = -1.063$, $p < 0.001$), individuals who owned private vehicles were significantly less likely to use carsharing services.

Age and marital status did not show statistically significant effects on behavioral intention in either region.

R-Squared (R^2) Values

The R^2 values for behavioral intention were 0.40 for Bangkok and 0.28 for the EEC, indicating that the model explained 40% of the variance in Bangkok and 28% of the variance in the EEC. These values suggest that the model has moderate explanatory power in both regions, though with stronger predictive power in Bangkok.

5.5. Regional Differences: Bangkok vs. EEC

Upon further analysis, several regional differences emerged in the factors influencing carsharing adoption:

- **Bangkok**: In Bangkok, perceived physical risk, subjective norms, and car ownership were the strongest predictors of carsharing intention. The strong negative influence of car ownership reflects the relative convenience of owning a private vehicle in a city with extensive public transportation options. Gender differences were present, but less pronounced than in the EEC. The role of subjective norms suggests that social influence plays an important role in the decision to use carsharing in Bangkok.
- **EEC**: In the EEC, perceived value and perceived behavioral control were the most significant factors affecting carsharing intention. The stronger influence of income on behavioral intention in the EEC suggests that carsharing is viewed as a more attractive option for lower-income individuals who may not have access to private vehicles or sufficient public transportation. The negative correlation between gender and behavioral intention was stronger in the EEC than in Bangkok, indicating that women in this region may face additional barriers to using carsharing services

6. Conclusion

This study offers significant insights into the factors affecting car-sharing adoption in Bangkok and the EEC, emphasizing the regional differences in perceptions of car-sharing services. By employing an integrated framework that combines the TAM and the TPB, while incorporating external variables such as perceived physical risk, environmental concern, and perceived value, this research enhances both theoretical and practical discussions within the realms of sustainable transportation and technology adoption.

6.1. Discussion

The findings reveal notable distinctions between Bangkok and the EEC, reflecting how urban environments shape perceptions and adoption behavior for car-sharing services.

One unexpected outcome of this study is that perceived physical risk significantly influences the perceived usefulness of car-sharing services in Bangkok, but not in the EEC. In Bangkok, the crowded streets, high traffic congestion, and erratic driving behavior (Suriyawongpaisarn, 2011) have rendered physical risk a critical concern for individuals, directly affecting their perception of car-sharing as a viable alternative. In contrast, the EEC experiences less traffic congestion and safer driving conditions, which diminishes the relevance of physical risk as a determining factor. This discrepancy prompts a reevaluation of the contextual nature of risk within technology adoption models and challenges the assertions made by studies such as Ma et al. (2019), which advocate for the generalizability of physical risk concerns across varying environments.

The role of environmental concern also varies between the two regions, with respondents in Bangkok showing a stronger tendency to consider car-sharing as an environmentally friendly solution. Bangkok, facing severe air pollution and environmental degradation (Thi Phuoc Lai Nguyen, 2023), positions car-sharing as a more attractive option for environmentally conscious individuals. This result corroborates studies such as Acheampong and Siiba (2020), which found that environmental concerns influence the adoption of sustainable transportation options. In contrast, the EEC, where environmental concerns are less pressing, shows a weaker link between eco-consciousness and car-sharing adoption. This disparity underscores the importance of regional environmental issues in shaping transportation behavior, highlighting the need for further exploration of the moderating effects of environmental factors in car-sharing adoption models.

As anticipated, perceived value has a more significant influence in the EEC. This region's economic sensitivity, coupled with a lack of public transportation alternatives, makes the cost-effectiveness of car-sharing services particularly appealing. This observation aligns with the findings of Wang et al. (2019), who noted that populations with limited access to affordable transportation options are more likely to embrace car-sharing. Conversely, in Bangkok, where public transportation is both accessible and varied, the cost-saving advantages of car-sharing may not exert the same level of influence. This underscores the necessity for region-specific marketing strategies that highlight the financial benefits of car-sharing in areas like the EEC, where economic factors play a critical role.

Perceived Usefulness, Perceived Ease of Use, and Attitude

The combined TAM and TPB models show that in both regions, attitudes toward car-sharing are significantly influenced by perceived usefulness and ease of use, which in turn drive behavioral intentions. This finding is consistent with previous studies, such as Liu and Yang (2018), and Li and Zhang (2023), which highlight the importance of positive attitudes in shaping behavioral intentions. The model’s explanatory power is higher in Bangkok, where residents’ familiarity with rental cars and the integration of car-sharing with public transport make it a desirable option. In the EEC, however, the industrial setting and reliance on employer-provided transportation reduce the perceived need for car-sharing.

Contrary to expectations, the influence of subjective norms and perceived behavioral control varied significantly across regions. In Bangkok, where cultural values such as collectivism are deeply ingrained, subjective norms played a substantial role in shaping intentions toward car-sharing, aligning with findings from Zhang and Li (2020) in China. In contrast, the EEC, which emphasizes individual autonomy and industrial growth, exhibited a diminished impact of subjective norms. In the EEC, perceived behavioral control was found to significantly influence intentions, whereas in Bangkok, this factor was comparatively less impactful. This discrepancy challenges previous studies Haldar and Goel (2019) and Yang and Lee (2022), which generally assert that perceived behavioral control is more

influential in urban settings. This may be attributed to Bangkok's well-developed public transportation infrastructure, which lessens the necessity for individuals to exert personal control over their transportation choices. Conversely, in the EEC, where transportation options are more limited, the ability to manage one's mobility becomes a critical factor in determining car-sharing intentions.

The results suggest that the intention to utilize car-sharing services is substantially influenced by gender, income, and car ownership, with significant regional variations. According to prior research Prieto et al. (2017), men, particularly those in the EEC, are more inclined to demonstrate enthusiasm for car-sharing. Income also plays a role, as individuals who earn more money, particularly in Bangkok, are less likely to implement car-sharing. This is consistent with the notion that wealthier individuals, who frequently own private vehicles, perceive shared services as having less value Le Vine (2014). Furthermore, the intention to utilize car-sharing is negatively correlated with car ownership, particularly in the EEC. This is due to the fact that higher rates of vehicle ownership are likely to diminish interest in alternative transportation options, which is consistent with the findings of Dias et al. (2017). Conversely, no statistically significant correlations were identified between marital status or age and intentions to share a vehicle in either region.

6.2. Contribution

The TAM and TPB models are expanded in this study to account for regional variations in the adoption of car-sharing, thereby contributing to the existing literature. It illustrates that factors such as perceived physical risk, environmental concern, and perceived value are substantially different between urban environments and are highly context-dependent. The integration of these external variables into conventional technology adoption models theoretically bridges the divide between sustainable transportation and technology acceptance literature.

Additionally, the research contributes to our comprehension of the ways in which the urban environment affects transportation behavior. It challenges the notion that technology adoption models are inherently applicable across various regions and advocates for a more nuanced approach that takes into account regional factors, including traffic conditions, environmental concerns, and economic context. This research also contributes to the expanding body of literature on sustainable urban mobility by emphasizing the potential of car-sharing services to resolve both environmental and economic challenges in a variety of urban environments.

6.3. Practical Implications

The findings highlight the necessity of regionally specific strategies to promote car-sharing services from a practical standpoint. The following are factors that service providers and policymakers should take into account:

The emphasis should be placed on the environmental advantages of car-sharing, particularly in the reduction of traffic congestion and air pollution, as well as on safety concerns in Bangkok. Promotional campaigns should underscore the ways in which car-sharing can enhance the convenience of users in densely populated areas and contribute to the city's environmental sustainability.

The EEC should prioritize the economic value and affordability of car-sharing services, as well as the enhancement of access to these services in regions with restricted public transportation options. Car-sharing should be promoted as a cost-effective alternative to private car ownership, and providers should consider offering competitive pricing models.

Furthermore, policymakers should investigate incentives, including subsidies for car-sharing services, tax rebates for users, and the establishment of specialized infrastructure, such as car-sharing parking spaces. These measures have the potential to considerably improve the accessibility and appeal of car-sharing in both urban and suburban areas.

6.4. Limitation

While this study provides valuable insights into the factors influencing car-sharing adoption in Bangkok and the EEC, several limitations warrant consideration.First, the research utilized a cross-sectional design, The cross-sectional design captures only a snapshot of attitudes and intentions at a single point in time, hindering the ability to make causal inferences. Second, the sample was confined to respondents from two specific regions in Thailand. Although these areas offer a useful comparison between an urban setting and a more industrialized context, the findings may not be fully generalizable to other regions with varying socioeconomic, cultural, or infrastructural characteristics. Future research should aim to include a broader array of regions to enhance the external validity of the results. Third, this study predominantly relied on self-reported data, which may be susceptible to social desirability bias or inaccuracies regarding actual intentions and behaviors. The incorporation of objective data sources, such as real usage statistics from car-sharing platforms, could provide a more accurate depiction of adoption patterns. Lastly, while the integrated TAM and TPB employed in this study effectively elucidate car-sharing intentions, the inclusion of additional psychological and behavioral theories could yield further insights into adoption behaviors. For instance, theories related to environmental psychology or habit formation could enhance our understanding of how individuals transition from traditional car ownership to shared mobility services.

6.5. Future research

Based on the limitations and findings of this study, several possibilities for future research are proposed. First, conducting longitudinal studies could provide insight into how the factors influencing car-sharing intentions evolve over time and how actual usage patterns develop as car-sharing services become increasingly available and accessible. This approach would facilitate a deeper understanding of the long-term adoption process, shifting focus from mere intentions to actual behaviors. Second, future research should explore the moderating effects of contextual factors, such as urban infrastructure, government policies, and technological advancements, on the relationship between intentions and car-sharing behavior. For instance, how do enhancements in public transportation networks or the introduction of electric vehicles affect the appeal of car-sharing services? Additionally, cross-cultural and multi-regional studies are recommended to examine how cultural differences, economic conditions, and levels of urbanization influence car-sharing adoption. Expanding the geographical scope beyond Bangkok and the EEC would enrich our understanding of car-sharing and technology adoption in transportation on a global scale. Third, a mixed-methods approach could be employed, integrating quantitative surveys with qualitative methods such as focus groups or in-depth interviews. This would yield more nuanced insights into users' motivations, concerns, and experiences with car-sharing services, helping to identify hidden barriers or facilitators that might not be captured through quantitative data alone. Finally, advanced analytical techniques, such as structural equation modeling or latent growth curve modeling, could be utilized to better understand the complex interactions among various factors influencing car-sharing adoption. These models could investigate how variables like environmental concern, perceived risk, and ease of use interact over time and across different populations. By addressing these areas, future research can facilitate the development of more effective, regionally tailored car-sharing strategies, ultimately promoting broader adoption of sustainable mobility options.

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