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Factors Influencing Sustained Use of Shared E-Scooter Services in Urban Taiwan

Fei-Hui HUANG

kiki_huangs@yahoo.com, Asia Eastern University of Science and Technology, Department of Marketing and Distribution Management

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ABSTRACT

This study investigates the factors that drive users to sustain their usage of shared electric scooter (e-scooter) services in Taiwan, distinguishing itself from the conventional focus on predicting consumers' initial adoption and behavioural intentions. It employs subjective rating questions, incorporating constructs related to user acceptance, attitudes and user experience (UX). Through hierarchical regression analysis of quantitative survey data, the study identifies key factors such as users' modes of transportation, environmental attitudes, acceptance of shared services, attitudes towards private scooters, UX, total usage instances and age. However, reliance on private scooters as a mode of transportation and frequent usage of shared e-scooters negatively impact the sustained usage of these services. The research further highlights early development challenges in shared vehicle services, including concerns over personal data security, user-unfriendly system designs, lack of convenience, inadequate parking infrastructure and ineffective financial incentives. Based on these findings, the study provides recommendations for service providers and government entities to enhance service design and proactively address these challenges. Implementing these recommendations is expected to mitigate the impact of these challenges and potentially improve user acceptance, UX, and the overall sustainability of shared vehicle services.

KEYWORDS

environmental sustainability; sustained behavioural intention; transportation mode; shared e-scooter service; user experience.

1. INTRODUCTION

Transportation plays a significant role in contributing to air pollution, accounting for nearly a quarter of direct CO_2 emissions. In efforts to combat climate change and align with the goals of the Paris Agreement, the transportation sector is undergoing a transformation from traditional fuel-powered vehicles to more environmentally friendly alternatives, with a strong emphasis on electric vehicles (EVs).

Asia consistently stands out as a core region for global scooter sales, with India, Mainland China and Indonesia ranking as the top three markets in the region [1]. Since 2017, the global electric scooter (e-scooter) market has maintained an annual growth rate exceeding 20%, with Asia representing over 80% of the market and Europe at 8% [2]. Specifically, in 2020, while India's annual scooter sales declined by 13.2% to 15.12 million, the e-scooter segment saw remarkable growth, nearly eightfold from the previous year to 2,456 units sold, though this constituted only 0.016% of the overall scooter market. Meanwhile, Mainland China witnessed a modest decline in scooter sales of 2.3% to 14.84 million, but e-scooter sales surged by 20.91%, reaching 2.2954 million and accounting for 13.40% of the scooter market. In Indonesia, scooter sales plummeted by 43.6% to 3.66 million, with e-scooters achieving a market penetration rate ranging from 0.7% to 0.9%. This widespread acceptance of scooter products in the Asian market underscores the challenge of transitioning from traditional scooters to electric alternatives.

In Taiwan, annual scooter sales in 2022 reached 734,000 units, with e-scooter sales totalling 87,691 units, resulting in an e-scooter market share of 10.66%. Additionally, KYMCO is a well-known manufacturer of scooters and e-scooters in Taiwan. KYMCO's system has drawn the attention of Grab, the largest shared transportation provider in Indonesia, leading to a partnership in establishing an e-scooter system. Gogoro, Taiwan's leading e-scooter manufacturer, teamed up with Hero, India's largest scooter manufacturer, in 2021 to create a battery-swapping and charging network, along with e-scooter technology. They also formed a joint venture with Haojue, China's largest scooter manufacturer, and Yadea Technology, the largest e-scooter manufacturer, to establish an energy exchange network company. Gogoro has licenced its battery and battery-swapping station (BSS) technology for this initiative [1].

With a population of 23 million, Taiwan faces significant challenges due to its more than 14 million privately owned scooters. These scooters often have low utilisation rates, especially during peak hours, leading to road congestion. On average, scooters are used for 5.2 days a week, with each journey lasting 51.1 minutes [3]. The underutilisation of scooters, coupled with inadequate parking space, exacerbates traffic issues in urban areas. To address this challenge, Taiwan can draw valuable insights from the successful implementation of its YouBike bike-sharing programme. With approximately 300,000 daily YouBike users, an impressive 36.63% choose it as their primary daily commuting solution, effectively reducing the need for personal scooters [4]. The success of YouBike demonstrates the potential of shared mobility services to alleviate the congestion issues caused by the high number of privately owned scooters in the country. Additionally, research findings from other nations underscore the positive impact of shared mobility services on reducing private car ownership. Studies indicate that each shared vehicle can replace multiple private cars, with impacts ranging from 6 to 23 in North America and 4 to 10 in Europe [5]. Furthermore, individuals with car-sharing exposure are more inclined to reduce their private vehicle ownership or delay car purchases compared to those without such exposure [6]. They also tend to abandon their plans to purchase a personal vehicle compared to non-members [7]. These findings highlight the potential benefits of shared mobility services in transforming the transportation landscape.

In response to the emerging trend of shared mobility, Taiwan has witnessed the introduction of several service platforms. As detailed in *Table 1*, WeMo, iRent, and GoShare are key players in this evolving market, launched at various times since 2016 across different cities. These services offer a diverse range of vehicles, from e-scooters to cars, and vary significantly in scale and operations. Each service provider has customised its features and infrastructure to cater to specific demographic groups and usage patterns. In addition to the basic service features listed in the table, each provider offers unique additional features that enhance the user experience. For example, WeMo provides exclusive parking spaces and comprehensive logistics services, which include relocating idle e-scooters to areas with higher demand, significantly enhancing service convenience and accessibility. iRent, with its vast membership base, boasts over 1 million members, reflecting its widespread popularity and user trust. Meanwhile, GoShare's extensive infrastructure, featuring over 1.05 million batteries across 2,419 battery swapping stations (BSSs), ensures the high availability and reliability of their e-scooters throughout Taiwan. To better illustrate the types of scooters typically used in these services, *Table 2* provides a visual comparison of selected scooter models from WeMo, iRent, and GoShare, highlighting the specific styles and features that cater to the local market.

Shared e-scooter usage in Taipei increased by 5.4% in 2021, reaching 22%, marking it as the highest utilisation rate globally [11]. Taiwan's transition towards shared mobility has resulted in an increase in the number of two-wheeled vehicles, including 14.039 million privately owned scooters, 583,000 private e-scooters and 21,000 shared e-scooters [12]. However, the coexistence of these services has contributed to traffic issues, primarily due to the growing number of two-wheeled vehicles on the road.

Table 1 – Comparative overview of shared mobility services in Taiwan by provider, vehicle type, and usage statistics

Service provider	Origin city	Launch year	Vehicle types	Vehicles	BSSs	Usage	User demographics
WeMo	Taipei	2016	e-scooters	10,000	2,000	Every 2.7 seconds [8]	
iRent	Taipei	2019	e-scooters cars	4,000 8,000	N/A	Every 5.2 seconds [9]	20-39 years: 79%; 50-69 years: 60% ↑
GoShare	Taoyuan	2019	e-scooters	7,000	2,419		
GoKube	Kaohsiung	2019	e-bikes	1,200	N/A	120,000 rentals [10]	

Table 2 – Sample scooter models from WeMo, iRent, and GoShare's diverse fleets in Taiwan

		
(a) WeMo	**(b) iRent**	**(c) GoShare**

In light of the growing importance of shared e-scooter services and their potential to address transportation challenges in densely populated urban areas, this study aims to identify the factors influencing travellers who have experience using these services. Understanding these factors is crucial for both policymakers and service providers as they seek to promote sustainable and efficient short to medium-distance travel options. By investigating the attitudes, experiences and acceptance levels of shared e-scooter users, this research provides valuable insights that can inform improvements to existing services and regulations, ultimately contributing to the optimisation of shared mobility solutions.

2. 2. LITERATURE REVIEW

2.1. Electric vehicle development and sustainable shared mobility

Achieving zero-carbon emissions by 2050 requires rapid decarbonisation across various systems, encompassing energy, land, urban infrastructure, and industry [13]. With the intensification of urbanisation, opportunities for innovation and the preservation of natural ecosystems arise [14]. Over the past decade, urbanisation has surged, particularly in developing economies, notably in Asia and Oceania. The urbanisation rate increased from 43.3% in 2011 to 50.0% in 2021, with Africa experiencing a 4.6 percentage points increase during the same period [15]. By 2030, an estimated 61% of the world's population will reside in urban areas [16], potentially leading to annual energy cost savings of $26 per person [17]. However, the transportation sector introduces negative externalities such as air pollution and congestion, offsetting the benefits of urbanisation [18]. To harness these urbanisation benefits, sustainable strategies must be promoted, including compact cities, public transport [17, 19], the phasing out of fossil fuel vehicles [20], and the adoption of cleaner fuels [21]. Among these, promoting EVs is a crucial strategy.

The development of the EV industry in some Asian countries is outlined as follows:

- China: China has solidified its position as a global leader in the EV sector, capitalising on early government and industry initiatives, along with a comprehensive supply chain supported by a vast domestic market. The competitive landscape and continuous technological advancements have contributed to China's cost advantages in manufacturing EVs. According to TrendForce, global sales of new energy vehicles, including battery electric vehicles (BEV), plug-in hybrid electric vehicles (PHEV), and fuel cell vehicles (FCV), are estimated to reach around 12.8 million units in 2023, with China accounting for an impressive 60% of the market share [22].
- India: In pursuit of achieving net-zero emissions by 2070, India has implemented the National Electric Mobility Mission Plan, providing incentives for EV sales and plans to exclusively sell EVs after 2030. Actively working on establishing a localised supply chain for EVs and batteries, India is positioning itself as a global hub for EV manufacturing and sales. As of May 2023, boasting a population of 1.428 billion, India possesses a substantial domestic market where two-wheelers constitute 54%, and cars, though only 8%, achieved car sales of 42.5 million in 2022, ranking it as the world's third-largest market. There is an anticipation that India will emerge as the largest global market by 2030 [23]. In the EV market, between 2022 and 2023, India has witnessed the sale of over a million EVs, including two-wheelers, three-wheelers, buses, and cars [24], making it highly promising.
- Vietnam: Ho Chi Minh City and Hanoi aim to achieve a 50% adoption rate of green energy buses by 2030, reaching 100% by 2035. Vietnamese EV manufacturer VinFast has developed a charging station system, featuring over 150,000 e-scooters and EV charging stations nationwide [25]. The penetration rate of electric two-wheelers (E2Ws) in Vietnam increased from 1.5% in 2015 to 9.7% in 2021, driven by favourable government policies, growing environmental awareness, and advancements in EV technology [26].

– Indonesia: In 2022, Indonesia revised its Enhanced Nationally Determined Contribution (ENDC), committing to a 31.89% reduction in carbon emissions by 2030 through domestic efforts and a 43.2% reduction through international cooperation. According to the Ministry of Industry's Ministerial Regulation No. 6/2022, Indonesia aims to manufacture 400,000 four-wheeled or larger EVs by 2025, 600,000 by 2030, and 1 million by 2035. The targets for two-wheelers and three-wheelers are set at 6 million by 2025, 9 million by 2030, and 12 million by 2035. Indonesia's EV industry is in its nascent stage. However, with the government's swift implementation of EV-related policies and measures, coupled with the country's ample land and nickel resources, a substantial opportunity exists to catalyse the growth of the EV industry [27].

However, Asian mega-cities have been grappling with an escalating number of vehicles. For instance, China's private car ownership in Shanghai surged from 12 million in 2003 to 93 million in 2012. Singapore witnessed a 3.4% annual growth in car numbers from 2000 to 2010, with scooters increasing by 1.2%. Myanmar experienced a steady 5.2% yearly growth in car numbers and 0.8% in scooters between 2004 and 2008 and before 2007, respectively. Laos saw a 9% annual increase in scooters, and Bangkok sees approximately 52,000 cars added to the streets every month. The Philippines reported a 7% annual growth rate in private vehicles from 2007 to 2009 [28]. Over the years, the increasing number of road vehicles has posed significant challenges, leading to ever-growing urban transport problems. These challenges include threats to personal safety and public health, high energy consumption, a substantial decrease in urban air quality and noise pollution, necessitating the implementation of effective measures.

Sustainable transportation offers numerous benefits for cities, such as reduced pollution and congestion, as well as improved urban energy and social cohesion [29, 30]. To achieve smart and green cities, we must encourage modal shifts, promote walkable urban design, shorten commuter distances [31, 32], and implement transit-oriented development [33]. Effective governance is vital for overcoming barriers to sustainable transport [34, 35]. In the context of sustainable transportation, shared mobility allows short-term access to shared vehicles, replacing individual ownership [36]. This approach includes various modes such as bike-sharing, e-scooter sharing and car-sharing, which can be either station-based or free-floating [37], promoting fewer vehicle owners [38]. Encouraging the development of e-car, e-scooter or bicycle-sharing businesses is essential to address the challenges of the growing number of road vehicles [28].

2.2. Sustained acceptance of shared vehicles

The integration of information and communications technology (ICT) has become essential in shared mobility services, utilising widespread internet connectivity and smartphone adoption as a foundational infrastructure for app-based accessibility. This integration has led to the development of various theoretical models aimed at understanding the factors influencing ICT adoption and usage in the consumer context. One widely used model is the unified theory of acceptance and use of technology (UTAUT) [39], which consolidates eight existing technology adoption models. Initially designed for organisational settings, the UTAUT model has been adapted to the consumer context through the development of the extended unified theory of acceptance and use of technology (UTAUT2) [40]. UTAUT2 introduced new constructs, including hedonic motivation, price value, and habit, while excluding the moderator of voluntariness of use [41]. Previous research has primarily utilised the UTAUT2 framework to identify factors influencing consumers' initial adoption and behavioural intention, with less emphasis on sustained acceptance. Behavioural intention refers to an individual's likelihood of engaging in a specific behaviour, which is essential for understanding technology adoption and utilisation [42]. In contrast, sustained usage intention pertains to a user's willingness to continue using a product or service over an extended period [43]. Assessing sustained usage intention is critical for evaluating the long-term viability and success of a product or service in the market.

Research findings regarding the impact of various constructs on users' behavioural intention toward innovative vehicle services or shared vehicles are as follows:

– Performance expectancy: This plays a pivotal role in users' acceptance and adoption of new technologies [41] and strongly predicts users' intention to adopt innovative vehicle services like car sharing [44] and electric car sharing [45].
– Effort expectancy: Influences users' initial acceptance of new technology, particularly their perception of its ease of use, and has been validated in the acceptance of automated vehicles [46].

- Social influence: This holds significant implications in the context of vehicle acceptance and has been empirically demonstrated to exert a substantial influence in predicting the acceptance of automated vehicles [46] and shared autonomous vehicles [47]. It also facilitates the transition to alternative fuel vehicles for climate change mitigation [48], making it a crucial factor for potential policy measures aimed at incentivising the adoption of cleaner vehicle fuel technologies.
- Price-value: Price-value has been acknowledged to influence user acceptance of shared automated vehicles and car-sharing systems [49]. Factors like travel cost, time, capital cost, and registration fees have been found to strongly impact user acceptance of such systems [50].

Additionally, other factors not mentioned above have been found to be significant for users' adoption of innovative vehicle services or shared vehicles, including:

- Environmental attitude: Encompasses an individual's environmental sensitivity, perception of environmental issues, and commitment to environmental preservation [41]. A strong environmental attitude is considered essential for long-term environmental protection and reducing environmental impacts [51]. It is also a crucial factor in consumers' electric vehicle purchase decisions [52] and the adoption of car-sharing services [53] or shared autonomous vehicles [54], reflecting their consideration and awareness of environmental issues.
- Trust: Trust has been empirically demonstrated to have a significant impact on the acceptance of shared autonomous vehicles [48], shared motorcycles [55], and automated vehicles [56].

Other confirmed factors include income, age [54], service quality [49], psychological needs and effective marketing, and promotion strategies [47]. These constructs have been identified as significant factors for predicting users' initial adoption and behavioural intention toward novel vehicle services. Building upon this foundation, this study employs these constructs to identify the factors influencing users' sustained usage of shared e-scooters.

2.3. Attitude

One of the primary challenges in transitioning to shared mobility is the need to modify travellers' behaviour, which involves shifting attitudes and cultural norms away from personal vehicle ownership and towards the use of multiple transportation modes [57]. Behavioural changes can result from shifts in perspectives or changes in circumstances [58]. These changes can be categorised as either structural or psychological. Psychological changes encompass alterations in an individual's perceptions, beliefs, and attitudes [59].

Attitudes consist of cognitive, affective, and behavioural components [60], and reflect an individual's inclination toward a specific person, phenomenon or thing, as well as their response to a stimulus [61]. Positive attitudes encourage behaviours that align with, support or enhance the attitude object, whereas negative attitudes lead to behaviours that avoid, oppose or hinder the object [62]. Furthermore, attitudes can predict individual behaviour by representing an individual's evaluation of behaviour as favourable or unfavourable [63].

Understanding attitudes is crucial in various fields, including marketing and psychology, as attitudes play a pivotal role in predicting consumer behaviour, such as purchase intentions [64] and long-term purchasing habits [65, 66]. Additionally, attitudes have been shown to impact the adoption of new technologies, such as shared autonomous vehicles [67] and vehicle-sharing systems [47, 53]. This study further investigates whether attitudes significantly influence users' sustained usage intentions of shared e-scooters.

2.4. User experience

UX originated from the field of human-computer interaction (HCI) intending to design computer systems optimised for human use while considering design limitations. Initially, it focused on efficiency and utility, and the evolution of user interface design emerged from computer science and human factors. UX is a dynamic and iterative process influenced by the interplay between the product, environment, users' experiences, and feedback. Its objective is to create high-quality interactive systems that are enjoyable, useful, and enhance users' lives [68]. UX is considered a cognitive process that can be modelled and measured [69].

In the context of consumer product interfaces, the overall value of UX can be considered as the aggregation of pragmatic qualities, hedonic qualities, aesthetics qualities, and satisfaction. Pragmatic quality has been introduced as a fundamental foundation closely related to usability. Pragmatic quality represents the degree to which a system enables effective and efficient goal achievement [70]. Aesthetics refers to the pleasure elicited through sensory perception by a product, encompassing positive or negative sensations related to its aesthetic appeal, regardless of its visual or non-visual nature [71, 72]. Aesthetics strongly influence users' perception of usability [73, 74], and beauty has become a central objective in product design due to its strong correlation with aesthetic ratings [74]. Hedonic quality refers to a system's capacity to provide stimulation through novel and challenging features or by reflecting personal values [70].

This study applies UX to gain insights into the subjective aspects of riding two-wheeled vehicles and to understand the differences in UX between shared e-scooters and private scooters, as well as their impact on users' sustained usage intentions of shared e-scooters.

3. METHODS

This study aimed to investigate user perceptions of sustained usage intentions for shared e-scooter services in Taiwan. Participants were recruited through both online and in-person channels, with the questionnaire distributed via Google Forms between September 2022 and February 2023. The in-person recruitment was conducted via convenience sampling, where paper flyers with QR codes for accessing the questionnaire were distributed to individuals currently using or returning shared e-scooters at various high-traffic locations, selected to ensure a diverse demographic spread. This approach aimed to capture a representative cross-section of users directly engaged with these services. Online recruitment involved placing electronic flyers on social media pages specifically dedicated to e-scooter enthusiasts, ensuring that participants are likely to have relevant experiences and interests in shared e-scooter services. To avoid selection bias and to represent different user perspectives, recruitment efforts targeted a variety of online communities and geographic areas. Interested individuals who were at least 20 years old and had experience riding shared e-scooters were directed to the provided link, leading them to Google Forms for questionnaire completion. Participation was voluntary, and no incentives were offered.

This study was approved by the Research Ethics Committee of National Tsing Hua University with the IRB protocol number 11006EC085.

3.1. Measurements

The subjective rating of shared e-scooter services comprised five sections. The first section, personal information, consisted of five items designed to gather socio-demographic data, including age, sex, occupation, annual income, and mode of transportation. The second section, attitude towards private two-wheelers, consisted of ten items aimed at measuring the respondent's ownership and usage of private two-wheelers, as well as their UX of private scooters. The third section, shared e-scooter usage, included five items designed to measure the adoption of shared e-scooter services, such as the total usage instances, average riding time, reasons for adoption and reasons for continued usage. The fourth section, acceptance of shared e-scooters, utilised eleven items to collect categorical data on factors such as performance expectancy, effort expectancy, social influence, price-value, environmental attitudes, trust, and sustained behavioural intention. These factors were assessed using a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). Finally, the fifth section, UX, consisted of four items aimed at collecting categorical data on the perceived aesthetic quality, hedonic quality, pragmatic quality, and overall satisfaction of shared e-scooter services, using a 10-point scale ranging from 1 (very dissatisfied) to 10 (very satisfied).

Additionally, the survey included an open-ended question at the end, allowing respondents to provide additional feedback freely on their experiences and intentions regarding the use of shared e-scooters.

3.2. Participants

A total of 333 valid questionnaires were analysed. The demographic information of the respondents, including gender distribution (159 males and 174 females), as well as age and annual income distribution, is presented in *Table 3*. *Table 4* presents the transportation usage of the respondents, including their modes of transportation, the total number of times they have used shared e-scooters, and the average duration of each shared e-scooter ride.

Table 3 – Respondent demographic information

Item	Frequency (N)	%
Gender		
Female	174	52.3%
Male	159	47.7%
Age		
20-29	112	33.6%
30-39	63	18.9%
40-49	78	23.4%
50-59	54	16.2%
60-65	26	7.8%
Personal annual income		
Less than 10,000 USD	60	18.0
Between 10,000 and 20,000 USD	91	27.3
Between 20,000 and 50,000 USD	131	39.3
Above 50,000 USD	51	15.3
Industrial attributes by occupation		
Service, security officer or insurance	45	13.5%
Manufacturing or construction	37	11.1%
Cultural and educational institutions, religious groups, public utilities or fiscal and taxation practitioners	34	10.2%
Information industry	30	9%
Students or unemployed	30	9%
News, advertising or entertainment	28	8.4%
Health or healthcare	25	7.5%
Hospitality or tourism	24	7.2%
Retail or wholesale trade	24	7.2%
Transportation	21	6.3%
Housewife	15	4.5%
Agriculture, forestry, fisheries or mining	14	4.2%
Professional sports personnel	6	1.8%

Table 4 – Transportation usage

Item	Frequency (N)	%
Transportation (multiple choice)		
Car	142	20.2%
Scooter	215	30.5%
Bike	31	4.4%
E2W	20	2.8%
Public transportation	180	25.6%
YouBike	47	6.7%
Shared e-scooter	69	9.8%
Shared e-scooter usage (multiple choice)		
GoShare	212	29.5%
WeMo	179	24.9%
iRent	196	27.3%
HeyGo	67	9.3%
others	64	8.9%
Total usage instances of shared e-scooters		
1 time	28	8.4%
1 to 5 times	132	39.6%
more than 5 times	173	52%
Riding duration category		
Less than 30 minutes (short duration)	141	42.3%
Between 30 minutes and 1.5 hours (medium duration)	140	42.0%
More than 1.5 hours (long duration)	52	15.6%

Notes: Riding duration category: These categories represent the respondents' average estimated durations for most rides on shared e-scooters.

3.3. Data analysis

Data analysis was performed using SPSS software Version 22.0. The analysis involved evaluating the variables through reliability analysis, t-tests, correlation analysis, hierarchical multiple regression analysis and analysis of variance (ANOVA). Two-tailed tests were conducted, and the significance level was set at $p < 0.05$.

4. RESULTS

4.1. Descriptive statistics and reliability analysis

The internal consistency of the UX scores for private scooter rides (α = .796), the UX scores for shared e-scooter rides (α = .812), and user acceptance scores (α = .829) in this study was found to be high.

Table 5 presents the descriptive statistics for private scooter rides and shared e-scooter rides. The results indicate that over 90% of respondents rated their overall user experience satisfaction as 7 or higher on a 10-point scale for both private scooters and shared e-scooters, reflecting a high level of satisfaction. Descriptive statistics for user acceptance of shared e-scooters are displayed in *Table 6*. The findings reveal that over 80% of participants rated their agreement as 5 or higher on a 7-point scale for items A1, A3, A4, A6, and A11, suggesting strong acceptance of these aspects of shared e-scooter services. However, a lower percentage of respondents agreed (rated 5 or higher) that the interaction with the shared e-scooter system is easy to understand or that it protects their personal data (items A2 and A8). Furthermore, *Table 7* presents the results of multiple-choice questions regarding the use and sustained use of shared e-scooters.

Table 5 – Descriptive statistics of UX of scooter ride and shared e-scooter ride

Item	Very dissatisfied							Very satisfied			Mean score
	1	2	3	4	5	6	7	8	9	10 (%)	
Scooter ride											
UXs1: Aesthetic quality	0.3	0.3	1.2	2.4	4.2	9.3	15.0	26.4	27.9	12.9	*7.88*
UXs2: Pragmatic quality	0.3	0	0.3	0	3.3	6.9	9.0	23.7	28.8	27.6	*8.48*
UXs3: Hedonic quality	0.3	0	0.9	0.9	3.9	6.9	14.4	26.1	26.1	20.4	*8.17*
UXs4: Overall satisfaction	0.6	0	0.3	0.3	3.9	6.0	12.0	21.3	33.0	22.5	*8.35*
Shared e-scooter ride											
UXe1: Aesthetic quality	1.2	0.3	1.8	0.9	9.3	12.9	17.4	21.6	21.9	12.6	*7.53*
UXe2: Pragmatic quality	0.3	0.3	0	0.9	4.5	8.7	13.5	24.9	25.2	21.6	*8.17*
UXe3: Hedonic quality	0.6	0.3	0.9	2.4	4.5	9.3	19.8	27.3	23.1	11.7	*7.74*
UXe4: Overall satisfaction	0.3	0.3	0.3	1.2	3.3	9.6	15.3	27.6	27.9	14.1	*8.02*

Table 6 – Descriptive statistics of acceptance for shared e-scooter services

Item	Strongly disagree				Strongly agree			Mean score
	1	2	3	4	5	6	7(%)	
A1. Using a shared e-scooter service enables me to access e-scooter products more quickly	0.6	0.3	5.4	9.9	26.1	24.9	32.7	*5.66*
A2. The interaction with the shared e-scooter system would be clear and easy to understand for me	7.2	7.8	9.0	18.0	18.0	20.7	19.2	*4.71*
A3. Learning to ride the shared e-scooters is easy for me	0.3	0.6	2.4	7.8	22.5	30.9	35.4	*5.86*
A4. I would find the shared e-scooters easy to use	0.6	0.6	2.4	8.4	20.1	30.3	37.5	*5.88*
A5. People who are important to me think that I should use the shared e-scooter system	1.5	5.1	5.4	14.1	22.8	27.6	23.4	*5.28*
A6. Even under the influence of the pandemic, I still choose to use shared e-scooters with confidence	0.3	1.5	1.8	12.3	23.1	35.1	25.8	*5.65*
A7. I have trust in the shared e-scooter services	2.4	3.6	6.6	11.4	27.0	26.1	22.8	*5.27*
A8. I am confident that the shared e-scooter system can protect my personal data	2.7	4.5	9.3	14.4	23.1	25.2	20.7	*5.09*
A9. I find the pricing of shared e-scooters to be reasonable	0.6	2.7	6.0	14.4	25.5	28.8	21.9	*5.36*
A10.I choose to use shared e-scooters for environmental reasons	0.3	1.8	3.9	16.2	21.9	25.2	30.6	*5.56*
A11.I would like to continue using shared e-scooter services	0.6	1.2	5.4	12.3	26.4	43.5	10.5	*5.35*

Table 7 – Reasons for adopting and continuing to use shared e-scooters (multiple choice questions)

Item	**Adopting shared e-scooters**		**Continuing use of shared e-scooters**	
	Frequency (N)	**%**	**Frequency (N)**	**%**
Providing more shared e-scooters that enable users to rent e-scooters anywhere	148	17.1%	160	18.0%
Meeting the travel needs	142	16.4%	157	17.6%
Promoting quality of life	83	9.6%	78	8.8%
Promoting environmental benefits	79	9.1%	89	10.0%
Providing a free trial ride	77	8.9%	59	6.6%
Promoting shared e-scooter services	73	8.4%	51	5.7%
The shared e-scooter app has been designed to be accessible and easy to use	68	7.8%	81	9.1%
Providing rewards to shared e-scooter users	53	6.1%	50	5.6%
Reasonable fees	52	6.0%	78	8.8%
I do not have a two-wheeler	51	5.9%	34	3.8%
Recommended by family and friends	42	4.8%	54	6.1%

4.2. T-test

The results of the t-test indicated that females exhibited significantly higher agreement levels than males in terms of shared e-scooter service design. Conversely, males demonstrated significantly higher agreement levels than females regarding their own understanding of scooters (refer to *Table 8*). Additionally, the results of the paired sample t-test demonstrated significant differences in the UX between private scooters and shared e-scooters (refer to *Table 9*).

Table 8 – Means and standard deviations of attitude factors by gender

Items	Gender	Mean	SD	T-value	Sig.
Attitude towards two-wheelers					
I have a good understanding of scooters	Female	5.00	1.714	-2.038	0.042
	Male	5.35	1.378		
User acceptance of shared e-scooters					
A2. The interaction with the shared e-scooter system would be clear and easy to understand for me	Female	4.96	1.701	2.650	0.008
	Male	4.43	1.901		
A7. I have trust in the shared e-scooter services	Female	5.47	1.376	2.651	0.008
	Male	5.04	1.564		
A8. I am confident that the shared e-scooter system can protect my personal data	Female	5.29	1.516	2.394	0.017
	Male	4.88	1.585		
A9. I find the pricing of shared e-scooters to be reasonable	Female	5.48	1.176	2.082	0.038
	Male	5.22	1.065		
UX of shared e-scooter rides					
Aesthetic quality	Female	7.76	1.74	2.391	0.017
	Male	7.28	1.89		
Hedonic quality	Female	7.95	1.527	2.471	0.014
	Male	7.52	1.695		
Overall user satisfaction	Female	8.22	1.407	2.712	0.007
	Male	7.79	1.54		

Table 9 – Means and standard deviations of UX factors by two-wheeler ride

Items	Two-wheeler ride	Mean	SD	T-value	Sig.
Aesthetic quality	Scooter ride	7.88	1.62	3.10	0.002
	Shared e-scooter ride	7.53	1.83		
Pragmatic quality	Scooter ride	8.48	1.54	3.34	0.001
	Shared e-scooter ride	8.17	1.43		
Hedonic quality	Scooter ride	8.17	1.53	4.20	0.000
	Shared e-scooter ride	7.74	1.62		
Overall user satisfaction	Scooter ride	8.35	1.50	3.66	0.000
	Shared e-scooter ride	8.02	1.47		

4.3. Hierarchical multiple regression analysis

The correlation analysis revealed positive associations among all constructs related to shared e-scooter service acceptance and user experience (UX). To explore deeper into the factors influencing sustained behavioural intention toward using shared e-scooters (Y), we conducted a hierarchical multiple regression analysis, introducing variables in three stages: (1) predictor variables, (2) moderator variables, and (3) interaction terms for moderation analysis.

– Step 1 identified significant predictors including user acceptance variables (A2, A3, A5, A8, A10), UX, and total usage instances of shared e-scooters. These variables explained 64.4% of the variance in sustained behavioural intention ($R^2 = 0.644$, $F(12, 320) = 42.280$, $p < 0.001$). The beta coefficient for shared e-scooters ($\beta = 0.45$, $p < 0.001$) indicates a robust positive impact on the dependent variable, suggesting that increased use of shared e-scooters as a transportation mode significantly boosts sustained behavioural intention. Conversely, a negative coefficient for traditional scooter usage ($\beta = -0.20$, $p < 0.05$) suggests a detrimental effect on the intention to use shared e-scooters (refer to *Table 10*).

- Step 2 introduced demographic variables such as age, gender, annual income, and occupation as moderators. The inclusion of these variables marginally increased the explained variance to 64.9% ($\Delta R^2 = 0.005$, $F(13, 319) = 45.354$, $p < 0.001$), indicating a moderate effect size [75]. The positive beta coefficient for age ($\beta = 0.06$, $p < 0.05$) further implies that older individuals may exhibit stronger sustained behavioural intentions toward using shared e-scooters.
- Step 3 involved the inclusion of interaction terms to assess potential moderation effects among the variables. The results showed no significant moderation effects, indicating that the main effects of the predictors are consistent across different demographic strata included in this study.

The absence of multicollinearity was confirmed by the VIF values consistently below 2, suggesting a moderate level of correlation among the predictor variables [76], which validates the reliability of our regression results. The findings highlight that user acceptance factors (i.e. A2, A3, A5, A8, and A10), UX, total usage instances, and demographic variables such as age significantly influence sustained behavioural intentions toward using shared e-scooters.

Table 10 – Hierarchical multiple regression results for Y

Model	Step		Step 1		Step 2		R^2	$\triangle R^2$
			β	VIF	β	VIF		
Y	*1*	Shared e-scooters	0.45***	1.30	0.40***	1.37	0.644	0.631*
		Promotion	0.28**	1.11	0.26**	1.12		
		A10	0.23***	1.36	0.23***	1.37		
		A8	0.12***	1.44	0.12***	1.44		
		A2	0.12***	1.38	0.12***	1.38		
		A5	0.11***	1.45	0.12***	1.45		
		Attitude	0.12***	1.30	0.11***	1.34		
		UXe4	0.07*	1.79	0.07*	1.79		
		A3	0.07*	1.16	0.07*	1.16		
		UXe2	0.06*	1.72	0.07*	1.74		
		Scooters	-0.20*	1.10	-0.22**	1.11		
		Usage count	-0.14*	1.22	-0.14*	1.22		
	2	Age			0.06*	1.24	0.649	0.635*

Notes: 1. Shared e-scooters = using a shared e-scooter as one of my main forms of transport; Promotion = environmental benefits promotion is one of the reasons for me to adopt shared e-scooters; A10 = I am using shared e-scooters for protecting the environmental quality; A8 = I believe that the shared e-scooter system can protect my personal data; A2 = my interaction with the shared e-scooter system would be clear and understandable; A5 = people who are important to me think that I should use shared e-scooters in the transportation needs; Attitude = I think I know scooters well; UX_{e4} *= overall user satisfaction of shared e-scooter ride; A3 = learning to ride the shared e-scooters is easy for me;* UX_{e2} *= pragmatic quality of shared e-scooter ride; Scooters = using a scooter as one of my main forms of transport; Usage Count = total usage instances of shared e-scooters.*
*2. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. 3. VIF (variance inflation factor).*

4.4. ANOVA

The results of a one-way ANOVA indicated significant mean differences in respondents' perceived behavioural intentions towards sustained use of shared e-scooter services among different age groups [F (4, 328) = 7.057, p = 0.000], annual income groups [FWelch (3, 136.459) = 13.302, p = 0.000], and occupation groups [FWelch (12, 89.695) = 2.763, p = 0.003]. The Scheffé tests revealed that the age groups between 20 – 29 ($\bar{X}$ = 4.95; SD = 1.26) and 40 – 49 ($\bar{X}$ = 5.6; SD = 0.998) were significantly different (p = 0.003). Furthermore, the age groups between 20 – 29 ($\bar{X}$ = 4.95) and 50 – 59 ($\bar{X}$ = 5.76; SD = 0.89) were also significantly different (p = 0.001). The Dunnett T3 test showed that the annual income groups between "less than 10,000 USD" ($\bar{X}$ = 4.60; SD = 1.265) and "between 10,000 and 20,000 USD" ($\bar{X}$ = 5.23; SD = 1.175) (p = 0.015), between "less than 10,000 USD" and "between 20,000 and 50,000 USD" ($\bar{X}$ = 5.66; SD = 0.866) (p = 0.000), between "less than 10,000 USD" and "between 10,000 and 50,000 USD" ($\bar{X}$ = 5.69; SD = 1.049) (p = 0.000), and between "between 10,000 and 20,000 USD" and "between 20,000 and 50,000 USD" (p = 0.022) were significantly different.

5. DISCUSSION

This study aimed to investigate users' attitudes, acceptance, and UX by utilising subjective ratings to explore the factors influencing users' sustained usage of shared e-scooters. The survey results indicated that 80.4% of the respondents expressed their intention to sustain using shared e-scooter services. Hierarchical multiple regression analysis identified twelve factors that positively and uniquely influenced users' sustained behavioural intention and two factors that had a unique and negative impact on sustained behavioural intention.

5.1. Modes of transportation

The mode of transportation significantly influences users' intentions to sustain their usage of shared e-scooters, underscoring the pivotal role of typical transportation choices in determining the sustained adoption of shared vehicles. The findings suggest that individuals who primarily rely on shared e-scooters as their mode of transportation show a strong preference for sustained usage. Moreover, the results indicate that individuals with middle or high incomes and those in the middle-aged group (40 – 59 years old) exhibit a higher propensity to choose shared e-scooters as their mode of transportation while travelling, in comparison to other groups. Conversely, individuals who primarily rely on privately owned traditional scooters experience an adverse impact on their sustained behavioural intention to use shared e-scooters. Addressing the research outcomes related to the mode of transportation issue, the following recommendations are proposed for shared e-scooter operators and policymakers.

This study underscores the imperative for shared e-scooter operators to prioritise service design, positioning shared e-scooters as a preferred transportation option. Efforts should be directed at overcoming challenges faced by individuals who still heavily depend on private vehicles, representing more than 50% of respondents' modes of transportation. To achieve this, marketing and promotion strategies should emphasise the environmental benefits and quality of life improvements associated with sustained usage of shared e-scooters. Despite the current smaller market size of shared e-scooters compared to privately owned scooters, comprehensive research is essential to identify pain points in the usage behaviour of travellers who opt for private scooters or shared e-scooters. Such research may pave the way for designing shared vehicles with unique advantages, fostering user acceptance, and sustained usage of shared vehicle services.

Additionally, this study suggests that policymakers play a crucial role in creating an environment conducive to the long-term sustainability of shared vehicle services. Initial policy interventions should target addressing the advantages of privately owned scooters, including reducing available parking spaces, decreasing the number of gas stations, and increasing fuel costs and associated expenses. Simultaneously, enhancing the advantages of shared vehicle services is recommended to strengthen the position of shared e-scooters and attract a larger user base. The findings emphasise the importance of considering the traveller's primary mode of transportation as a crucial factor in future research on transportation usage, indicating a need for policies that align with the diverse needs and preferences of travellers in different transportation modes.

5.2. Environmental attitudes

Environmental attitudes play a crucial role in shaping users' intentions to sustain their use of shared e-scooters. Environmental attitude, defined as an individual's sensitivity towards the environment, perception of environmental issues and commitment to adopting appropriate measures for environmental protection [41], is paramount for long-term environmental preservation and can effectively mitigate environmental impacts over time [51]. The findings of this study suggest that individuals influenced by promotional activities emphasising the environmental benefits of shared vehicles, and who choose to use them for environmental reasons, are more likely to sustain their usage of shared e-scooters.

To enhance the sustained usage of shared e-scooters, it is recommended that shared e-scooter operators actively engage in targeted marketing strategies emphasising the environmental advantages of EVs, particularly within shared transportation services. Additionally, operators should implement educational initiatives that highlight the environmental benefits of shared vehicle services. This approach may contribute to heightened environmental awareness among users and encourage sustained usage of shared vehicles.

Furthermore, it is advised that policymakers focus on creating a supportive regulatory framework that encourages shared e-scooter operators to prioritise and promote environmental sustainability. Policymakers can play a vital role in incentivising operators to implement eco-friendly practices, ensuring that shared e-scooter services align with broader environmental goals. By fostering collaboration between operators and policymakers, the shared e-scooter industry may significantly contribute to sustainable urban mobility.

5.3. User acceptance and sustained usage intention of shared e-scooter services

This study validates that user acceptance of shared e-scooters, encompassing confidence in personal data protection, ease of interaction, ease of learning to ride and social influence, positively influences their intention to sustain using shared e-scooters as a mode of transportation.

Regarding their overall experiences with the shared e-scooter service, including app usage, travellers raised concerns, and provided feedback. Here, the study proposes recommendations for shared e-scooter operators to address two main issues based on user feedback. Firstly, the findings emphasise that users perceiving the interaction with the shared e-scooter system and the learning process of using shared e-scooters (such as renting and returning them through an app) as effortless can positively impact their willingness to sustain using them. This underscores the importance of identifying factors that enhance user interaction and provide a user-friendly experience for shared vehicle users. Given that the shared mobility app can serve as a platform for continuous feedback and system improvement [77], operators are recommended to offer a user-friendly app service and real-time customer support to address immediate issues, collect feedback and further improve the interaction and ease of learning in shared vehicle services. Secondly, addressing concerns about personal data, 16.5% of respondents expressed worries about data protection within the shared e-scooter system, indicating a lack of confidence in the security of their personal data. Shared e-scooter providers should ensure the provision of a secure and dependable service, as user data related to vehicle registration, app usage, and rental fee payments are stored in the cloud system. Addressing this concern is crucial to instil confidence in users that their personal data is effectively safeguarded.

Furthermore, based on the findings regarding the impact of social influence on travellers' intention to sustain using shared e-scooters, recommendations are proposed for policymakers. The study reveals that the majority of respondents agreed that social influence can impact their sustained usage of shared e-scooters, indicating that perceptions of how others will perceive them can influence their decision-making regarding transportation usage. To address this, policymakers are encouraged to focus on creating supportive regulatory frameworks that encourage shared e-scooter operators to implement effective marketing strategies. These strategies should target attracting users and influencing their social circles to adopt shared vehicle services, particularly during the initial stages. Implementing appropriate marketing strategies to encourage individuals within the same social circle to join the shared vehicle services trend is expected to enhance the willingness of traveller groups to sustain using shared vehicles.

5.4. User experiences of shared e-scooters

This study confirmed that the UX, in terms of pragmatic quality and overall satisfaction, positively influences respondents' intentions to sustain using shared e-scooters. Additionally, significant gender disparities in UX, attitudes and acceptance of shared e-scooters were observed. Male respondents demonstrated a higher level of comprehension regarding scooters, suggesting greater familiarity and confidence in using scooter products. However, this perception favoured private over shared scooters, aligning with prior research that indicates, despite greater vehicle knowledge, males show less interest in vehicle-sharing services (e.g. Zhang et al. [78]) and exhibit lower willingness to engage in shared mobility (e.g. Robinson [79]). In contrast, female respondents reported higher satisfaction with the UX of shared e-scooter rides, encompassing aesthetic and hedonic qualities, as well as overall satisfaction. Although female respondents demonstrated greater agreement with the design of shared e-scooter services, this factor did not significantly impact their intentions to sustain using these services.

In response to these findings, the study suggests that strategies to enhance UX, focusing on pragmatic quality and overall satisfaction, should take into account gender differences. Specifically, regarding female users, this study recommends leveraging their high satisfaction levels to boost their sustained usage intentions. For instance, since females have expressed specific concerns regarding vehicle safety (e.g. [80]), which is a critical factor in their vehicle usage decisions, providers in the Taiwanese market should prioritise enhancing service comprehensiveness and vehicle safety. The diverse range of vehicle models offered may pose heightened risks for users unfamiliar with these products. Consequently, enhancing safety features and service comprehensiveness could cater to the needs of users who lack familiarity with these vehicles.

In addition to UX, the total number of times shared e-scooters are used has been found to negatively affect individuals' sustained usage of shared e-scooters (refer to *Table 10*). This suggests that although e-scooter sharing services in Taiwan can provide a positive UX, frequent users of the service demonstrate a decreased tendency to sustain using shared e-scooters. Therefore, it is necessary to investigate the underlying factors that contribute to this decreased willingness to sustain usage. This study explores this issue through qualitative feedback obtained from open-ended questions. The findings highlight convenience as the primary driver for sustained usage of shared e-scooters, followed by financial incentives provided by the shared service providers or the government.

Regarding convenience, respondents emphasised the importance of easily accessible shared vehicles in close proximity, the presence of BSSs during their trips and the availability of parking spaces when returning the vehicle. However, during the initial stages of implementing shared vehicle services, such resources were scarce. Concerning vehicle availability, the results indicate that respondents primarily utilise shared e-scooters for short-term transportation, with some also using them for travel or business trips. These findings support previous research suggesting that business travellers or tourists often rely on shared mobility services (e.g. Li and Voege [81]). However, several respondents have encountered difficulties in quickly locating a vehicle due to the low density of shared vehicles, leading them to choose alternative transportation modes. To address these challenges for shared service providers, the study proposes the following recommendations:

– Target specific groups: It is recommended to focus on specific groups, including tourism businesses (e.g. homestays, hotels, and popular attractions) and companies with transportation needs for their employees (e.g. delivery services, parking billing services, and courier services).
– Continuous user feedback: Continuously gathering user feedback and implementing tailored solutions, along with marketing strategies that address the unique requirements of each target group, are crucial for effective market promotion.

As the market's dependence on and usage of shared vehicles increases, providers' intentions to expand the provision of shared vehicles are expected to be positively influenced, thereby significantly enhancing convenience from an optimistic perspective.

In addition to vehicle management, the study highlights the importance of managing essential equipment in vehicles to improve users' willingness to sustain the usage of shared e-scooters, based on feedback from respondents in the open-ended questions. For instance, shared e-scooter providers offer two helmets in the scooter's storage compartment for free use, complying with regulations requiring helmet usage while riding. However, helmets are consumables and are susceptible to loss, damage, dirt or deformation. Furthermore, the COVID-19 pandemic significantly impacted transportation options for travellers. Among these options, shared systems were perceived to have an average riskiness of 27% [82]. In response to the pandemic, shared e-scooter providers took proactive measures to reassure users by equipping their vehicles with cleaning alcohol and disposable helmet covers. However, several respondents encountered management issues while renting available shared e-scooters, leading them to choose not to use them. These issues included concerns regarding the quality, hygiene, and availability of safety helmets. To address these challenges for shared e-scooter providers, the study proposes the following recommendations:

– Effective management: Effectively managing both the vehicles and the essential equipment is crucial to ensure a positive user experience.
– Continuous improvement: Implementing measures to address concerns regarding the quality, hygiene and availability of safety helmets is vital for encouraging sustained usage of shared e-scooters.

Concerning the availability of parking spaces, the findings indicate that when these spaces are unavailable, shared vehicle users may encounter difficulties in returning the vehicles, causing inconvenience. This insight was drawn from the qualitative feedback provided by respondents in the open-ended questions, highlighting real-world challenges experienced by users. In such situations, some users may resort to parking in unauthorised areas, negatively impacting other road users and the reputation of shared vehicle service providers. Affected individuals can contact customer service to report the issue or engage in retaliatory actions, such as damaging or forcefully moving the vehicle. This can result in physical damage to the vehicle, discouraging subsequent users from renting damaged vehicles. To address this concern and enhance the user experience, shared e-scooter operators are advised to implement effective solutions for parking-related challenges. Strategies should include improving the availability of designated parking spaces for shared vehicles, implementing regular logistics management, and providing clear guidelines for users on proper parking practices. By prioritising these measures, operators can significantly reduce the occurrence of parking-related issues, ensuring the convenience of users, and maintaining the overall integrity of shared vehicle services. Furthermore, policymakers play a pivotal role in creating a supportive regulatory framework that encourages shared e-scooter operators to prioritise and address environmental sustainability, particularly in the management of parking spaces. Policymakers should collaborate with operators to establish guidelines and regulations that promote responsible parking practices, ensuring the efficient use of public spaces, and minimising disruptions to other road users. The collaboration between operators and policymakers is expected to tackle parking problems, improve user convenience, minimise the risk of vehicle damage, and ensure the rights of other road users to safely utilise the road.

Regarding financial incentives, some respondents expressed satisfaction with the incentive system provided by shared e-scooter operators. For instance, these operators offer bonus incentives to renters who assist in battery swapping at a BSS during their rental period. The bonus amount varies based on the number of times user assistance is utilised. This approach not only improves the battery life of the vehicles but also facilitates subsequent rentals, reduces the workload of the service provider's logistics personnel, and minimises downtime of shared vehicles in parking spaces due to insufficient battery power. For shared e-scooter operators, it is suggested to consider implementing additional financial incentives in the form of fee waivers. For example, offering complimentary rides or discounted fares to users who rent shared vehicles for connecting public transportation or short-distance commuting, such as buses, mass rapid transit, and rentals within 30 minutes. The study also recommends operators to establish loyalty programmes or rewards for frequent users. These measures can encourage sustainable choices and emphasise the environmental benefits, energy conservation, and transportation convenience that travellers can enjoy by choosing shared vehicles over high-carbon emitting transportation options.

5.5. Demographic characteristics of travellers

This study reveals that the willingness of travellers to sustain the usage of shared e-scooters generally increases with age. Specifically, the 20–29 age group exhibits the lowest inclination to sustain their usage, with only 65.2% expressing agreement. Despite young people often being early adopters of shared mobility services [79], their willingness to sustain usage remains a challenge. This decreased willingness among young individuals may be attributed to their simpler mobility patterns and limited financial resources [81]. On the other hand, the economically stable 40–59 age group demonstrates a stronger tendency to sustain their usage. Additionally, the results indicate that both middle-aged and senior individuals, as well as those with moderate to high-income levels, exhibit a stronger inclination to sustain their usage of shared vehicles. In contrast, younger generations and higher-income earners show a stronger tendency towards initially adopting or using shared vehicles [80]. However, higher-income households are found to be more resistant to giving up their private mobility holdings and transitioning to a vehicle-free lifestyle [83]. Moreover, the results highlight that young and low-income individuals tend to rely on private scooters as a mode of transportation. This conclusion was derived from analysing the transportation preferences reported by different age groups and income levels in the survey responses.

To further improve the intention of these groups to sustain the use of shared vehicles, it is recommended to identify specific strategies that address the observed age differences and cater to the distinct preferences and concerns of different age groups of users. For example, when aiming to maintain a long-term user base for shared vehicles, service providers should prioritise targeting middle-aged and senior individuals, as well as those with with moderate to high-income levels. Simultaneously, for young and low-income individuals, providing subsidies to incentivise sustained usage of shared vehicle services is recommended. By implementing targeted measures, such as tailored educational programmes, user support initiatives, and age-specific promotional campaigns, shared vehicle providers may effectively address the identified age-related variations and contribute to a more inclusive shared mobility environment. Furthermore, shared e-scooter operators need to consider these age-related patterns when designing marketing strategies and user engagement initiatives. Policymakers, on the other hand, should explore ways to support and incentivise these targeted efforts, fostering a collaborative approach to enhance the sustainability of shared e-scooter usage across diverse demographic groups.

5.6. Study limitations and future research

The present study sheds light on the factors influencing sustained preference for shared e-scooters among Taiwanese travellers, including main modes of transportation, environmental attitudes, gender differences, age-related variations, and a negative correlation with the total usage instances of shared e-scooters. However, its generalisability may be limited by the specific geographical focus and the modest sample size of 333 respondents. To enhance the external validity of the findings, future research should consider increasing the sample size and conducting a more in-depth exploration.

Concerning the main modes of transportation, future studies should delve into the motivations behind travellers' preferences for private transportation modes, contributing to a nuanced understanding of shared mobility challenges and potential solutions. Addressing gender-based differences in UXs and the challenges faced by frequent travellers through qualitative research can offer practical solutions for service providers. Tailoring strategies to enhance the UX for both genders and addressing challenges faced by frequent travellers can optimise shared e-scooter services. Furthermore, future research could explore age-specific interventions and investigate the impact of tailored campaigns on sustaining shared e-scooter usage across diverse age brackets. This targeted approach could provide valuable insights into the factors influencing different age groups' sustained usage patterns. Additionally, examining the impact of targeted marketing initiatives on shaping environmental attitudes and sustaining shared e-scooter usage can offer actionable insights for service providers to promote environmentally friendly transportation choices among travellers.

6. CONCLUSION

The diversification of shared mobility services has shifted the conventional ownership-based vehicle usage model to a usage-based one, catering to the diverse travel needs of commuters. However, this transformation has led to a continuous increase in vehicle numbers, negatively impacting urban traffic management, people's quality of life, and environmental conditions.

This study offers valuable insights into the factors influencing travellers' sustained usage of shared e-scooters as a sustainable alternative to private vehicles. By utilising subjective rating measurements covering transportation mode, user acceptance, attitudes toward vehicles, UX, and traveller demographics, the study has identified significant factors affecting sustained usage intentions. Based on these findings, actionable recommendations have been proposed, emphasising the importance of addressing critical aspects such as promoting the environmental benefits of shared vehicles, implementing a riding incentive system, leveraging social influence, and improving the convenience of shared vehicle services to enhance users' intention to sustain their usage.

While the primary focus of the present study is on the scooter market, its implications extend to the broader context of shared mobility services. As transportation services continue to evolve, traveller preferences related to shared mobility may change. The study provides valuable insights that can inform future developments in the transportation industry. In essence, continuous efforts to understand traveller preferences, make service or governance improvements, and create value for users are essential for developing sustainable transportation, overcoming barriers to change and achieving zero-carbon emissions in the transportation sector. This ongoing commitment may contribute to the future realisation of sustainable transportation in urban areas.

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黃斐慧

影響臺灣城市地區民眾持續使用共享電動機車服務的因素探討

摘要

本研究招募具有騎乘共享電動機車經驗的受訪者作為研究對象，透過問卷調查進行量化研究，探討影響台灣民眾持續使用共享電動機車服務的因素及其行為意向。問卷設計採用主觀評量法，涵蓋使用者的接受度、態度及使用者經驗等研究面向。回收的量化資料經層級迴歸分析，成功找出預測持續使用共享電動機車服務的關鍵因素。研究結果顯示，使用者的交通工具選擇、環保態度、對共享服務的接受度、對私人電動機車的態度、使用者體驗、總使用次數及年齡等，對持續使用共享電動機車的行為具有顯著且正向的影響。相對而言，過度依賴私人機車作為交通工具及擁有多次使用共享電動機車經驗的受訪者，對於持續使用該服務的意向則顯示出負向影響。此外，研究也發現台灣的共享車輛服務在初期發展階段面臨一些挑戰，包括個人資料安全的疑慮、用戶不友善的系統設計、服務設計便利性不足、停車位基礎設施缺乏，以及財政激勵措施效果不彰等。綜合以上結果，研究者針對如何減輕相關挑戰所帶來的影響，以及提高共享車輛服務的使用者接受度、使用者體驗及服務的永續性，提出改善共享車輛服務設計的建議。

關鍵詞

環境永續性；持續使用意向；交通工具選擇；共享電動機車服務；使用者經驗。