

Investigating Consumers' Demand for Electric Scooter Usage Based on User-Product Interaction

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ABSTRACT

This paper investigates consumers' demand for electric scooters (e-scooters) through a questionnaire survey. User sensory experiences and product functionality, including battery range and charging/battery swapping services, were identified as important factors. Long-distance travel was found to be a significant factor influencing consumers' reluctance to purchase e-scooters, as they are not primarily designed for this purpose and two-wheeled vehicles are at a higher risk of road safety hazards. Speed, battery range, and charging/battery swapping services were identified as critical factors influencing users' decisions to purchase e-scooters. Consumers also value the aesthetic design of e-scooter products. To encourage the adoption of e-scooters, it is crucial to improve their performance and functionality, as well as the infrastructure of e-scooter services, and design products that meet consumers' needs and preferences. The study aims to promote the transition from gasoline-powered scooters to e-scooters.

Keywords: Sustainability transportation, Electric two-wheeler vehicles, User-centered design

INTRODUCTION

Scooters, which include motorcycles and motorbikes, are widely used as a means of transportation in Asia, particularly in Southeast Asian countries, where their usage is prevalent (Kitamura, Hayashi, & Yagi, 2018). In India, for example, with a population ranging from 1.37-1.38 billion, it has been the world's largest motorcycle market since 2016, with over 17 million motorcycles sold in 2019 (HKT, 2023). In Vietnam, with a population exceeding 95 million and approximately 58 million motorcycles, 87% of the population relies on motorcycles as their primary mode of transportation due to the lack of public transportation systems (Chen, 2021). In Taiwan, there were approximately 14,266,920 registered scooter units in 2021, with a population of approximately 23.26 million (Taiwan Environmental Protection Administration, 2022). In Thailand, with a population of approximately 71.13 million, there are roughly 200,000 registered motorcycle taxi drivers (Arphorn et al., 2018).

However, despite their prevalence in Southeast Asia, the regulatory framework for motorcycles remains underdeveloped compared to that of

automobiles. Additionally, internal combustion engine vehicles (ICEVs) contribute significantly more to the global warming potential impact than battery electric vehicles (BEVs), primarily due to the consumption of fossil fuels (Notter et al., 2010). Although BEVs also have an impact on certain categories during the manufacturing stage, this is mainly related to the battery (Carranza et al., 2022). Several epidemiological studies have established a significant association between PM_{2.5} concentrations and adverse health outcomes, including chronic obstructive pulmonary disease (COPD), lung cancer mortalities (Anenberg et al., 2010), acute and chronic respiratory illnesses such as pneumonia and chronic bronchitis, cardiovascular diseases such as coronary heart disease, congestive heart failure, and premature death (Pope et al., 2002; Dominici et al., 2006; Li et al., 2013).

To reduce tailpipe emissions and congestion, many cities are targeting the reduction of automotive vehicle miles travelled (VMT). Electric bicycles (e-bikes) or electric scooters (e-scooters) can be effective new solutions to accelerate mode shift transitions towards greener travel. These vehicles have recently been introduced in vehicle-sharing mode, offering a cheaper alternative to fuel-powered vehicles for travel. Riding an e-bike is a rewarding and enjoyable experience for many users, especially for those with limited mobility, and can even lead to a car-free lifestyle (MacArthur et al., 2018). E-bikes can be useful tools for reducing CO₂ emissions, urban noise, and inner-city traffic (Weiss et al., 2015). In order to reduce vehicle carbon emissions and improve public health, e-scooters have become a strategy to replace traditional gasoline-powered scooters.

This study employs a subjective assessment methodology to acquire feedback from individuals who have experience in riding e-scooter products but have not yet made a purchase in the context of Taiwan. With a user-centered approach, this study investigates users' perceived intention to purchase e-scooter products following their interactions with such products, identifies areas where their needs have been met or remain unfulfilled, and presents recommendations for improving products and services. The aim of the study is to propose suggestions for enhancing e-scooter products and services to meet consumers' needs for using e-scooter products and increase their willingness to purchase e-scooters.

SUBJECTIVE MEASURES OF USER-PRODUCT INTERACTION

In the domain of human factors engineering, achieving user-centered design and developing ready-to-use products requires a focus on user experience and usability. Addressing user needs in the relevant usage context is also crucial for long-term user satisfaction (Aguirre et al., 2019). Therefore, research on the relationship between user-product interaction is of great importance, as it can be described as a feedback loop between the user and the product that is connected through physiological responses. The most significant sensory modalities in consumer products are vision and touch, which provide valuable feedback data for user-product interaction and support consumer judgments (Schifferstein & Cleiren, 2005). In particular, vision can gather the largest amount of information about a product in the shortest time frame (Schifferstein and Desmet, 2007).

In Taiwan, scooters have traditionally been the most popular mode of transportation for the majority of the population who rely on two-wheelers. However, the government's active promotion of E2Ws in response to concerns about environmental sustainability and air pollution reduction has led to the adoption of E2Ws as a more sustainable and environmentally friendly alternative to gasoline-powered scooters. Despite these efforts, scooters still dominate the two-wheeler vehicle market in Taiwan, accounting for over 90% of sales in 2022, while E2Ws, including e-scooters, e-bikes, and Pedal Electric Cycle (Pedelec), account for only 2%.

To address this challenge, emerging products and services like e-scooters and battery swapping stations must be designed with a user-centered approach that fulfills their requirements, offers innovative solutions, and enhances competitiveness in the market. This study aims to obtain subjective feedback from users on their interaction with e-scooters, focusing on e-scooter products available in the market, in order to achieve successful user-centered design of e-scooters that ensures a smooth and pleasurable interaction between the user and the product (Wartzack et al., 2019). Obtaining the subjective feedback of users on their interaction with e-scooters is essential for designing products and services that meet their needs and preferences.

METHOD

The online survey study via Google involved a total of 124 individuals (70 males; 54 females) who have experience with e-scooter usage and completed the survey. The study was conducted in the northern region of Taiwan and involved the physical recruitment of participants who had ridden e-scooters but had not yet purchased one, with the aim of obtaining their subjective responses to e-scooter usage and understanding its impact on their intention to purchase one. The questionnaire comprised three sections: (1) personal information, which included questions on age and gender to obtain the participants' demographic data; (2) user experience, which included a question on the vehicle model design (aesthetic design), based on the visual perception of the e-scooter product, as well as two questions on the impact of the e-scooter's speed and performance on the users' purchase decision; and (3) product/service functionality, which included six questions on the impact of various functionalities of the current e-scooter products or services, such as battery range, vehicle price, charging/ battery swapping service fees, vehicle/battery maintenance costs, government subsidies, and marketing promotions, on the users' purchase intention.

RESULTS

The 124 participants in this study mainly rely on scooters as their primary means of transportation, with 105 using them, while 11 utilize public transportation (without owning a vehicle), and 8 use cars. Table 1 presents the descriptive statistics of the age of respondents who participated in this study. Of the 124 participants, 82 (66.1%) reported considering the purchase of

an e-scooter, 11 (8.9%) had already made a decision to purchase one, and 31 (25%) stated that they would not consider purchasing an e-scooter at all.

Table 1. Descriptive statistics of participants' age.

Age	N
Under 20 years old	3
20–29 years old	35
30–39 years old	37
40–49 years old	31
50–59 years old	17
60 years old and above	1

Descriptive Statistics

Feedback on the primary reasons for not purchasing an e-scooter among the two main groups of respondents, namely those considering and not considering a purchase, indicated that the most significant factor was the perceived insufficiency of government subsidies for vehicle purchase (selected by up to 108 respondents). Other factors that influenced users' willingness to purchase e-scooters were identified, including marketing and promotion, speed compared to conventional scooters, battery range, e-scooter performance, charging/battery swapping services, aesthetic design of e-scooters, and cost-related concerns such as e-scooter price, charging/battery swapping fees, and maintenance costs (for additional information, see Table 2). The purposes for which e-scooters were most commonly used by the respondents included local transportation, with 86 respondents selecting "Shopping around the neighborhood" as the primary purpose, followed by commuting, using in the vicinity of the workplace, and transporting children to and from school, respectively, with sports and leisure activities being the fifth most common purpose. Only 5 respondents reported purchasing e-scooters for the purpose of long-distance travel (see Table 3).

Table 2. Reasons for participants' decision not to purchase E-scooter.

Items	N
Government subsidies	108
Marketing promotions	34
Speed	24
Battery range	22
Performance	17
Charging/ battery swapping services	11
Aesthetic design	10
Vehicle price	7
Charging/ battery swapping services fees	4
Vehicle/battery maintenance costs	3

Table 3. List of the main purposes for which respondents consider using e-scooters.

Items	N
Shopping around the neighborhood	86
Commuting	49
Using in the vicinity of the workplace	46
Transporting children to and from school	25
Sports and leisure activities	21
Long-distance travel	5

Modelling

This study employed the SPSS statistical analysis software to perform a forward stepwise automatic modelling analysis to predict the willingness of e-scooter riders to purchase an e-scooter. The results of the study revealed that the model was composed of five primary predictor variables. The R^2 value was statistically significant, accounting for 69.5% of the total variance. The five primary predictor variables were: Long-distance travel (Coefficient = 1.050, $p = 0.000$, Importance = 0.589), Speed (Coefficient = 0.402, $p = 0.002$, Importance = 0.116), Aesthetic design (Coefficient = 0.219, $p = 0.009$, Importance = 0.080), Battery range (Coefficient = 0.342, $p = 0.010$, Importance = 0.076), and Inconvenience in charging (Coefficient = 0.316, $p = 0.024$, Importance = 0.058). Moreover, the correlation analysis indicated that Speed, Charging/battery swapping services, and Battery range were positively correlated with each other ($r = 0.234\sim 0.788$, $p < 0.001$).

DISCUSSION

This study employed a subjective questionnaire survey method to measure the primary factors influencing purchasing decisions of e-scooter products, including user sensory experiences and product functionality. Feedback was collected from 124 respondents who had experience using e-scooters, with 75% expressing willingness to consider purchasing e-scooters. The study investigated the reasons for this willingness and explored the reasons why the other 25% were not interested in purchasing e-scooters. User sensory experiences, such as visual aesthetic design and speed sensation during riding, and product/service functionality, including battery range and charging/battery swapping services, were identified as important factors influencing users' purchasing decisions. Gender and age were not significant factors. The study aimed to promote the transition from gasoline-powered scooters to e-scooters.

The study revealed that participants' demand for long-distance travel was a significant factor influencing their reluctance to purchase e-scooters. E-scooters, as well as scooters in general, are not primarily designed for long-distance travel, and two-wheeled vehicles are at a higher risk of road safety hazards compared to other types of vehicles. The research found that few

scooter riders choose to use scooters for long-distance travel due to various reasons. Consumers perceive e-scooters mainly as a service for short and medium-distance travel, so they consider riding distance as the most significant purchasing advantage of scooter products.

Furthermore, the study identified speed, battery range, and charging/battery swapping services as critical factors influencing users' decisions to purchase e-scooters. Although e-scooters have the same speed limit as traditional scooters under road riding regulations, their maximum speed is only up to 95 km/h, while traditional scooters can often exceed 100 km/h. Users who do not prioritize riding speed are tend to purchase e-scooters. Additionally, traditional scooters belong to a mature market with well-established infrastructure, such as gas stations and repair service stations, which contrasts with e-scooters that have only been available in the market for a little over a decade. High battery life efficiency and convenient charging/battery swapping services have a positive impact on users' willingness to purchase e-scooters.

Lastly, consumers also value the aesthetic design of e-scooter products. Improving the performance and functionality of e-scooters, as well as the infrastructure of e-scooter services, is crucial to encourage their adoption. Designing e-scooter products that meet consumers' needs and preferences will positively impact their willingness to purchase.

CONCLUSION

Based on the findings of this study, it is recommended that manufacturers of e-scooters prioritize user sensory experiences and product/service functionality, particularly battery range and charging/battery swapping services, in their product and service design. Furthermore, improving the infrastructure of e-scooter services and promoting the benefits of e-scooters for short and medium-distance travel may help increase their adoption and reduce reliance on gasoline-powered scooters.

Overall, this study contributes to the understanding of the factors influencing users' purchasing decisions of e-scooters and provides insights for manufacturers and policymakers to promote the transition to more sustainable modes of transportation. Future research could further explore the impact of other factors, such as cost, environmental concerns, and public transportation accessibility, on the adoption of e-scooters.

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