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Determining the role of self-efficacy in sustained behavior change: An empirical study on intention to use community-based electric ride-sharing

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ABSTRACT

This study aims to explore the role of travel-related self-efficacy in sustained behavior change. Community-based electric ride-sharing as a pilot project has been introduced to reduce residents' reliance on private cars in Bangkok, Thailand. This study integrated the Theory of Planned Behavior (TPB), Technology Acceptance Model (TAM), and goal-framing theory to explain the cognitive process from intending a trial ride to sustaining behavioral change to substitute present travel modes. A sample of 101 valid responses was collected from the service users. The findings show a pivotal role of travel-related self-efficacy in encouraging users to keep using the promoted service by finding eudaimonic and normative goals during the intervention. Multi-group analysis was further applied to examine the moderating roles of transport mode preferences on hypothesized relationships. Pilot service users showed overall high self-efficacy associated with community-based mobility, and the stated self-efficacy was positively related to the intention to sustain behavior change. However, a drastic decrease was shown in user intention to pay for the service. Additional evidence was given to inform the importance of an affordable mobility service to secure residents' self-efficacy in daily transport. Based on research findings, this study provides recommendations on practical applications and future research directions.

1. Introduction

Developing countries are undergoing dramatic economic growth compared to the mature economies of developed countries. Major cities in Southeast Asia are experiencing explosive growth in motorization following economic development (United Nations, 2020). However, the infrastructure and traffic management have not kept pace with this growth, resulting in severe traffic congestion and car parking issues. Heavy traffic leaves citizens facing extremely long commutes, leading to economic productivity loss and high air pollution levels (The World Bank, 2022). Most major cities in this region, except for Singapore, have not prioritized the development of a well-connected public transport network. The lack of seamless connectivity between metro stations and travelers' origin/destination, commonly known as the "first and last-mile" problem, is one of the critical reasons for commuters' dissatisfaction with public transport (Dunn, 2019). In developing countries, private cars are the preferred travel mode due to their significant instrumental utility in

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providing basic daily mobility. However, car ownership can be influenced by various factors, such as personal preferences, lifestyles, and cultural norms, in addition to the availability and reliability of public transport. Symbolic values (e.g., social status) and affective values (e.g., driving pleasure) also play a substantial role in influencing mode choice decisions among Southeast Asian residents (Le Loo et al., 2015), aligning with a Western study by Steg (2003). While convenient public transport can reduce the need for owning a car, it may not eliminate it entirely due to the unique advantages that cars offer.

In view of this, ride-sharing shows as a promising solution to the pressing challenge of finding ways to curb emissions from transport while still improving accessible, safe, and affordable ways for people to travel, especially for developing countries (International Transport Forum, 2022). Ride-sharing entered Southeast Asia in 2013, changing the nature of transport in the region, especially in urban areas. In 2021, the ride-hailing industry amounted to appropriately USD 13 billion in Southeast Asia. Grab has the leading role by serving more than 187 million users in over 330 cities across eight countries (Consumer News and Business Channel, 2020). Having a dominant role in Indonesia, Gojek competes with Grab by achieving 190 million application downloads and 38 million monthly active users across 7 countries (Rai & Kshirsagar, 2022). In addition to hailing a ride, food and parcel delivery services are also available on both platforms. In addition to Grab and Gojek, numerous local ride-hailing applications are available in major cities across the region (Chalermpong et al., 2023). A variety of ride-sharing and taxi services has been used to cater to dynamic travel demand while simultaneously bringing risks, particularly to road safety, traffic congestion, and distribution of liability (Icasiano & Taeihagh, 2021).

Given this context, the Smart Small Vehicle Service (SSVS) has been introduced in Bangkok, Thailand since December 2021 as a part of the research activity of the SATREPS Program (JST/JICA Science and Technology Research Partnership for Sustainable Development) – Project of Smart Transport Strategy for Thailand 4.0 (Japan International Cooperation Agency [JICA], 2018). The SSVS as a pilot project has taken place with the purpose of reducing reliance on private vehicles and promoting sustainable transport as a means to ease traffic congestion and encourage a low-carbon society. Centered on the SSVS, this study explores the viability and receptiveness of implementing a novel community-based ride-sharing initiative. This service utilizes compact and electric vehicles to enhance public transport accessibility and promote sustainable neighborhood development.

1.1. *Community-based mobility services*

Car sharing offers a sustainable urban mobility alternative (Esfandabadi, Diana, & Zanetti, 2022). It is verified that one-way car sharing can reduce as many as 11 cars from streets, cutting greenhouse gas emissions by around 13 metric tons per year (Martin & Shaheen, 2016). In recent years, community-based car sharing has attracted increasing attention. It is usually non-commercial initiatives and organized locally (Dorner & Berger, 2018). This characteristic offers a solution for places where commercial operators of sharing systems are absent. Electric car sharing enhances economic and environmental benefits. As of July 2022, the average price for an electric vehicle (EV) was about 18,000 USD more than the average for cars generally (Kelley Blue Book, 2022). EVs are commonly considered inaccessible and unaffordable for the general public. However, shared EVs provide cost-effective mobility solutions.

Community-based electric car sharing is an innovative service that has received limited attention in current literature, but a project case in Portland, Oregon, serves as an example (Herman, 2022). This concept aims to improve access to public transport, particularly in areas lacking diverse and affordable transportation choices. Notably, participants in such programs experienced significant shifts in travel behavior, increasing transit use, walking, and cycling, leading to a 44 percent reduction in average vehicle miles traveled (Forth, 2020). Additionally, each shared vehicle removed around 15 privately owned cars from the community, as participants either sold their vehicles or abandoned planned purchases (Forth, 2020). Electric carsharing can cut emissions by up to 43 percent per user compared to gasoline-powered travel (Nicholas & Bernard, 2021), offering clean, safe, and economical mobility that mitigates health issues and long commutes. However, shared mobility presents challenges related to shared contributions and requests (Hartl & Hofmann, 2022), with criticism of favoring those willing and able to drive (Dorner & Berger, 2018; Herman, 2022). Resolving these issues is crucial for the sustainable consumption of shared vehicles within communities.

The combination of car sharing and ride-sharing is not a new concept, and its implementation within a community holds promise, particularly because trust plays a vital role in sharing vehicles and rides (Dorner & Berger, 2018). In such a scenario, the shared car can be driven either by a voluntary member or a hired driver. Previous research focused on developing tools to facilitate ride-sharing practices within car sharing communities, with a particular emphasis on rural areas where car dependency is high (Dorner & Berger; 2018). A quantitative survey was conducted on car-sharing community members in rural regions of Austria and Germany to assess their willingness to be ride-sharing drivers. Dressing a similar concept, a recent study introduced an optimization model for community-based trip sharing, utilizing the structure of communities and commuting patterns to optimize car or ride-sharing in urban communities (Hasan et al., 2018). The study demonstrated that the implemented trip-sharing platform reduced daily car usage by up to 44 percent. Furthermore, another study evaluated the benefits of autonomous vehicles for community-based trip sharing (Hasan & Van Hentenryck, 2021).

Community-based mobility, whether involving EVs or ride-sharing, is a novel and evolving concept. Limited research mainly relies on simulations or hypothetical scenarios. This study contributes to understanding how to integrate these concepts at the community level for sustainable transport. Promoting such services relies on residents' willingness to adopt them; however, empirical investigations into usage factors are scarce (Dorner & Berger, 2018; Hartl & Hofmann, 2022). Without personal experience, it not easy for respondents to provide actual opinions regarding innovative services. In reality, enabling people to undergo trial trips is a precondition for making a real decision on transport choices. Current research on community-based electric car sharing mainly focuses on rural areas (Dorner & Berger, 2018) or developed urban contexts like Portland (Herman, 2022). This study offers new insights by focusing on Bangkok, a developing city with distinct challenges and conditions (e.g., traffic congestion and walking environment). Specifically, we surveyed pilot project participants in Bangkok, Thailand.

1.2. Self-efficacy to sustain behavior changes in interventions

A pilot service aiming to promote more sustainable transport options is an intervention-program approach for travel behavior change. An intervention-program approach attempts to make people try new and change existing behavior. Travel behavior interventions are commonly implemented to reduce private car use and encourage more sustainable transport options, such as infrastructure development (e.g., cycling lanes, sidewalks), public transport campaigns, or financial incentives (Javaid et al., 2022). According to the review articles on around 400 worldwide cases of behavioral intervention, it was revealed that interventions could encourage intention on sustainable travel modes like walking, cycling, and public transport. However, they have limited effects on sustained behavior change, that is, shifting commuters from private cars to sustainable transport modes (Arnott et al., 2014; Javaid et al., 2022). This result raises the issue of the limited interventional effectiveness in the reduction of greenhouse gas emissions.

A recent study has tried to address the aforementioned gap by exploring the important factors to measure travel mode shift in an intervention that offered temporary free public transport to reduce private car use (Skarin et al., 2019). The study proposed an intervention-program approach divided into two phases of voluntary change, each involving different psychological determinants influencing participants' decision-making. In the "pre-intervention phase", personal motivation (e.g., interests and willingness to change) played a crucial role in encouraging voluntary participation in the program. However, the "intervention phase" introduced various psychological factors that influenced an individual's ability to sustain behavior change throughout the intervention. One significant psychological factor identified in the study was self-efficacy, which refers to an individual's belief in their own capability to successfully accomplish specific tasks or perform certain behaviors (Bandura, 1977). It has been also identified as an important determinant for behavior change in different areas (Holly & Watson, 2002). Travel-related self-efficacy, in particular, pertains to an individual's confidence in dealing with daily transport challenges. Unlike other motivational factors like curiosity or interests, transport-related self-efficacy have broader and long-term effects on continuous and voluntary behavior change in travel behavioral intervention. The study suggested that, during a travel behavior intervention, travel-related self-efficacy had a more profound impact on sustaining behavior change than motivations; However, the psychological process underlying the development of this change remains unclear (Skarin et al., 2019).

Theories of behavior change have been widely applied to support interventions (United Nations Development Group, 2017). The theory of planned behavior (TPB, Ajzen, 1985) has dominated as the underlying theoretical framework of travel behavioral interventions. It defines what factors affect choice-making (i.e., motivations in the pre-intervention phase) but lack to explicitly explain the cognitive process of how a change occurs and which particular behavioral alternative is chosen (Adjei & Behrens, 2012). There is still considerable potential for theoretical innovation in travel behavior construction (Adjei & Behrens, 2012). This study attempts to bridge the gap by proposing an integrated model designed to elucidate how a particular intervention is anticipated to contribute to specific developmental changes, drawing from an analysis grounded in available evidence. Specifically, the proposed model focuses on exploring the role of self-efficacy in fostering enduring behavior change resulting from the intervention. By delving into the relationship between self-efficacy and sustained behavioral intentions, particularly in the context of a community-based electric ride-sharing service, this study aims to provide deeper insights into the mechanisms driving ongoing user engagement and commitment.

2. Hypothesis development

Theories of behavior change cite personal, social, and environmental characteristics to explain human behavioral determination. They have been applied to study the intention for changing the existing or adopting new behaviors across a variety of disciplines. In behavioral science, a distinction has been introduced between behavior models and theories of change (Darnton, 2008). Behavior models focus more on identifying determinant psychological factors to explain a given behavior; Meanwhile, theories of change are process-oriented and aid in understanding how behaviors can be changed over time. Understanding behavior and exploring behavior changes are two distinct but highly complementary lines for research. To reduce private car use by providing an alternative transport choice, which is community-based electric ride-sharing in this study, there are two complementary lines for investigation. The first one is to explore the determinant factors that affect behavioral intention to use the service, and the other one is to identify the cognitive process of users to decide to keep using the service to substitute their current mobility choices.

2.1. Key constructs affecting behavioral intention

The TPB is a significant behavioral model widely used in various domains. With the rapid development of EV and the sharing economy, there has been an increasing interest in applying the TPB to predict user intentions towards emerging mobility services (Zhang et al., 2018; Mattia, Mugion, & Principato, 2019; Eccarius & Lu, 2020). The TPB provides a concise framework that explains intended behavior, which is determined by three core constructs: attitudes toward behavior, subjective norm, and perceived behavior control. Each construct is based on antecedent beliefs, specifically behavioral, normative, and control beliefs (Ajzen, 1985).

While the TPB has proven useful in numerous previous studies, scholars have attempted to enhance its explanatory power and specificity by integrating additional variables within specific contexts (Sommer, 2011). For instance, some studies have integrated the TPB with the Technology Acceptance Model (TAM, Davis, 1989) to consider the effects of perceived ease of use and perceived usefulness on users' attitudes towards new transport services or technologies (Chen & Chao, 2011; Haldar & Goel, 2019).

In this study, we adopt an integrated TPB and TAM model as a fundamental framework to explore the determining factors for community-based mobility as an innovative transport service. Additionally, drawing on previous research, we incorporate trust as an additional psychological factor in the hypothesized model. Trust refers to "the attitude that an agent will help achieve an individual's

goals in a situation characterized by uncertainty and vulnerability" (Lee & See, 2004, p51). It has been identified as a key construct influencing individual intentions to adopt new transport technologies such as autonomous vehicles (Abraham et al., 2017; Chen, 2019) and mobility-management tools or applications (Dastjerdi et al., 2019). In the following subsections, we first reviewed the cited core constructs and discussed the applicability and sufficiency of these constructs in determining residents' intention to use the service.

2.1.1. Attitudinal variables

Either in a TPB or TAM model, attitudes toward behavior refer to the degree of a favorable or unfavorable evaluation toward a person's interested behavior (e.g., Moon & Kim, 2001). According to Ajzen (1985), attitudes entail considering the outcomes of performing the behavior. This study thus argues that the attitudes toward a specific transport mode should consider travelers' service performance expectations. In recent years, increasing studies have introduced the concept of consumer value creation to describe the different aspects of attitudes toward using EVs (Schuitema et al., 2013).

The most mentioned values are instrumental and hedonic values. Instrumental value refers to the functionality or utility that the service performs to fulfill customers' desired goals (Smith & Colgate, 2007). The instrumental attitudes of a traveler could be their expected functional outcomes of using the service, such as effectiveness and safety. On the other side, hedonic value concerns whether the service could create positive experiential feelings and emotions for the customers (Smith & Colgate, 2007). The hedonic attitudes reflect a traveler's expectations of the positive emotions derived from the mobility experiences, such as enjoyability and pleasure. Both attitudes have been highlighted in several empirical studies, and have been suggested that they have different roles in adopting emerging mobility services like electric mopeds, scooters, and small cars (Curtale & Liao, 2020; Kopplin, Brand & Reichenberger, 2021; Putri et al., 2021).

2.1.2. Normative beliefs and norms

Subjective norm pertains to an individual's perception of social pressures dictating certain behaviors, influenced notably by significant others like family and friends. Nonetheless, within the context of TPB, the connection between subjective norm and behavioral intention is considered relatively feeble when contrasted with attitudes and perceived behavior control. Armitage and Conner (2001) attributed these modest correlations to the restricted scope of subjective norms. A call exists for further research and improvement on the used norm measures (Krueger et al., 2000; Rivis & Sheeran, 2004).

Social norm refers to the shared beliefs and expectations within the society. It represents the collective understanding of what is considered acceptable or appropriate within a particular social context. From a practical view, UNICEF (2021) suggested that social norms exist when individuals practice a behavior because they believe that others in their community perform the behavior (i.e., descriptive norms) or because they believe that those who matter to them approve of them practicing the behavior (i.e., injunctive norm). Being green has been a shared social norm (Welsch & Kühling, 2017), which is the shared value aids in lasting positive behavior change in interventions (UNICEF, 2021).

To emphasize once more, social norm represents the shared beliefs and behavioral standards within a society or social group, while subjective norm has a narrower focus on an individual's perception of the social pressure from significant others. Subjective norm has been verified as a significant value in studying green purchase intention (e.g., buy an EV) (McCoy & Lyons, 2014; Dutta & Hwang, 2021; Zhuang, Luo, & Riaz, 2021), while social norm has been suggested a more significant determinant in engaging environmental behavior (Steg & Vlek, 2009; Binder, Blankenberg, & Welsch, 2019). Using a shared electric transport service instead of private cars or traditional petroleum-fueled taxis represents a more eco-friendly mode-choice decision. Thus, this study incorporates social norms as a determinant due to their established correlation with environmental behaviors. Social norms hold normative sway over individual behavior, offering insights into how people's environmental actions align with the expectations of their social group. This understanding informs effective interventions and policies, allowing policymakers and service providers to design strategies that leverage social norms to encourage and maintain pro-environmental behaviors.

2.1.3. Self-efficacy in transport

As an extension of the theory of reasoned action (Ajzen & Fishbein, 1980), TPB was developed by incorporating the concept of perceived behavioral control, which emerged from self-efficacy theory. Self-efficacy is a widely recognized and fundamental factor in various behavior change theories, including social cognitive theory (Bandura, 1991, 1999, 2001), the health belief model (Rosenstock, 1974), and the health action process approach (Schwarzer, 1992). Self-efficacy refers to an individual's belief in their capacity to control their functioning and navigate daily life events (Bandura, 1977). It reflects an overall confidence in one's ability to succeed in specific situations. On the other hand, perceived behavior control (Ajzen, 1985) was introduced to capture individuals' perceptions of their control over engaging in a particular behavior, considering obstacles or constraints. The original TRA, which preceded TPB, primarily focused on the direct effects of intentions on behavior. However, it became evident that individuals may possess the intention to engage in behavior but still encounter external or internal limitations that impede their ability to perform the behavior.

It is important to know that self-efficacy and perceived behavior control are distinct yet related concepts within the field of psychology and behavior change. While both concepts pertain to individuals' beliefs and perceptions about their behavioral capabilities, self-efficacy primarily focuses on personal competence and effectiveness, whereas perceived behavior control encompasses the evaluation of the ease or difficulty of performing the behavior in consideration of internal and external factors. In this study, our focus lies on the broader and long-term effects of self-efficacy on individuals' adapting attitudes and behaviors. According to Bandura (1982), self-efficacy plays a crucial role in motivation, goal-setting, and persistence in the face of challenges or obstacles. By investigating the role of self-efficacy, this study aims to shed light on its significance in understanding and promoting sustained behavior change.

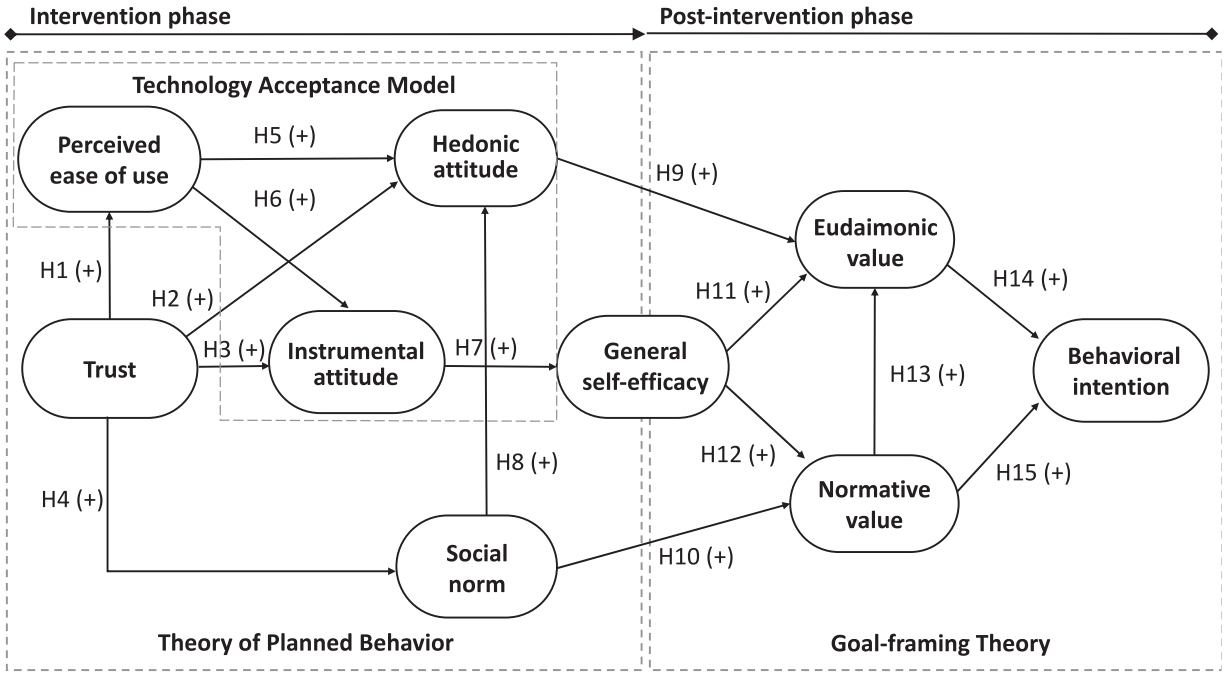

Fig. 1. The proposed model.

Self-efficacy can be task-specific or general. Task-specific self-efficacy examines an individual's perception of the ability to perform a specific task. In contrast, general self-efficacy has broader impacts on performance across various daily situations. Individuals' general self-efficacy shapes their behaviors, influences how they interpret and perceive information, and further affects their performance in completing specific tasks (Bandura, 1994; Wilde & Hsu, 2019).

Transport and mobility are essential fundaments to support and satisfy a wide range of daily activities. It is vital to satisfy residents' general self-efficacy in daily transport by developing an efficient transport system with sufficient mobility options before encouraging the residents to reduce private car use. Despite plenty of research studying the role of self-efficacy in encouraging public transport use or adopting new transport technologies, most previous studies focused on task-specific self-efficacy (e.g., Castel et al., 2019; Lee et al., 2019; Zhu, Zheng, & Chen, 2022). In other words, the cited self-efficacy in behavior models evaluated users' confidence or perceived ease of using a specific service. A more comprehensive evaluation is necessary to assess the impact on daily transport. In this study, residents' general efficacy in daily transport, defined as travel-related self-efficacy, is considered. The objective is to assess whether the promoted service can effectively meet residents' travel needs and serve as a viable option to decrease their dependence on private vehicles.

2.2. Cognitive process to decide a sustained behavior change

Goal-framing theory (Lindenberg & Steg, 2007), which was strongly influenced by research in cognitive social psychology, emphasizes the leading role of goals on cognitive processes to sustain a behavior. It cites three specific goals to explain human motivation to engage in pro-environmental behaviors, which are hedonic goals (i.e., to feel better), normative goals (i.e., to do the right things), and gain goals (i.e., to save resources and effort). Pro-environmental behaviors indicate conscious actions performed to minimize the negative impact on the environment or even enhance the quality of the environment (Jensen, 2002; Steg & Vlek, 2009). This theory has received growing attention in recent years and has been applied to explain behavior changes across different contexts (Hameed & Khan, 2020; Onwezen, 2023).

Though the goal framing theory is scarcely applied in explaining travel behavior, a recent Sweden study (Westin et al., 2020) examined the influences of the three goal frames on citizens' acceptability of the transport-related measure, which was to increase car parking fees to reduce private car use. This study conveyed the reasons for conducting the measure in three ways related to hedonic, normative, and gain values. The results showed that differently framed messages influenced the perception of the fairness, justice, and effectiveness associated with the proposed measure. It was suggested that messages were more effective in generating acceptance of the policy than no communication (i.e., control group). This study supports the theoretical hypothesis empirically that finding goals are essential for encouraging behavior changes during and even after an intervention.

Goal-framing theory posits that the way an individual frames or perceives a goal significantly influences their motivation and subsequent behavior. The theory explains sustained behavior intention by highlighting how the way individuals frame their goals influences their motivation, perception of benefits, and alignment with personal values, all of which contribute to their intention to continue the behavior over time.

2.3. Hypothesized model

The integration of the TPB and the goal-framing theory provides a comprehensive framework for understanding sustained behavioral intention. While TPB forms the foundation for comprehending the initial determinants of behavioral intention, the goal-framing theory enhances our understanding of the mechanisms that perpetuate this intention over time. In adapting TPB for this study, an additional factor - trust in the new transport service – was introduced to align with the study context, with the aim of enhancing the model's explanatory capacity.

Within this integrated framework, individual travel-related self-efficacy assumes a crucial role as a mediator. It fosters the identification of goals and assigns meaning to the perpetuation of travel behavior change prompted by interventions. Self-efficacy, a cornerstone of human motivation, is expected to influence goal setting, action execution, persistence, and self-accomplishment (Bandura, 1997, 1986; Schunk & DiBenedetto, 2021). Drawing on the literature (Bandura, 1982), this study argued that external influences, such as the measures provided in an intervention, primarily exert an indirect effect on human functioning through the mediating role of self-efficacy. The proposed correlations between these extended factors and the existing model are established through a review of antecedent-consequence relationships. The model is presented in Fig. 1.

Initiating trust as a critical antecedent influencing individuals' intention towards the new mobility service, we first consider its effect on perceived ease of use. Trust is anticipated to have a positive effect on perceived ease of use by reducing uncertainty and enhancing the perceived reliability of the service (Lee & See, 2004), as indicated by hypothesis H1 in Fig. 1. Earlier studies by Chen (2019) and Shao et al. (2020) have indicated that trust can facilitate or hinder individuals' behavioral intention by influencing attitudinal variables (H2-H3). Additionally, trust can shape individuals' normative expectations by establishing a foundation for shared beliefs within a social group, thereby influencing individuals to align their behavior with the perceived norm (H4). The link between trust and normative beliefs finds support in previous research by Wu and Chen (2005), emphasizing the significance of trust as an antecedent of normative belief.

The study adapts attitudes toward behavior as instrumental and hedonic attitudes, and subjective norm is adapted as social norm, as described in the previous sections. Drawing on the TAM, perceived ease of use is expected to affect attitudinal variables (H5-H6). Guided by the concept of gain goals (i.e., the pursuit of desired outcomes) from the goal-framing theory, instrumental attitude is hypothesized to positively influence travel-related self-efficacy (H7). Social norm is anticipated to enhance hedonic value in using community-based ride-sharing (H8). By conforming to the perceived norm, individuals could derive greater enjoyment from eco-friendly transportation practices, as suggested by Flores and Jansson (2022).

Furthermore, a factor termed eudaimonic value is introduced to replace the role of hedonic goals within the goal-framing theory. Eudaimonic value refers to individuals' pursuits of quality of life through the realization of their potential and the fulfillment of personally expressive and self-concordant goals (Waterman et al., 2010). While hedonic and eudaimonic values are interconnected yet distinct, a well-established definition can be found in Kashdan et al. (2008). In the hypothesized model, hedonic attitude towards using the service (reflecting short-term happiness) is expected to positively affect eudaimonic value (representing long-term well-being), as indicated by hypothesis H9. Moreover, normative value describes personal values concerning moral obligations towards the environment. Social norm is hypothesized to exert a positive influence on normative value (*H*10).

Drawing from Bandura (1982), the study hypothesizes that travel-related self-efficacy, acting as a mediator, will positively influence behavioral intention by enhancing eudaimonic value (*H*11) and normative value (H12). Referencing the goal-framing theory, normative value is expected to positively affect eudaimonic value (H13). In addition, both eudaimonic and normative values are projected to positively affect the intention to sustain behavior changes (H14-H15).

3. Material and methods

3.1. Study site and contexts

The urban structure of Bangkok is characterized by the presence of large superblocks surrounded by arterial roads, lacking an internal network of cross streets. Instead, there are numerous narrow side streets, known as "sois" in Thai, which branch off the major streets and extend into the central blocks (Pujinda & Yupho, 2017). These sois, once used as waterways, often function as dead-end roads, posing challenges for two-way traffic. However, they currently serve as vital local residential streets, connecting various services and facilities for daily activities. The unique urban structure of Bangkok hampers convenient access to public transit and results in severe traffic congestion and air pollution within the neighborhood. Given this context, community-based development presents a valuable approach, considering the typology of the urbanization in Bangkok with more dense and small areas of street spaces (Pujinda & Yupho, 2017), which require alternative connectivity by friendly mode choice.

3.1.1. Pilot project

A community-based electric ride-sharing service, named Smart Small Vehicle Service (SSVS), has taken place in the Vadhana district, the center of Bangkok, from December 2021 to March 2023. The pilot project aims to explore the possibility of implementing community-based electric mobility services and evaluate its level of service in terms of integration with public transport systems. Before targeting local Thai residents, SSVS served international condominiums as the initial target for feasibility analysis. The target foreign residents showed high dependency on ride-hailing services or more expensive private hire vehicles (e.g., limousine service) to get from place to place in their neighborhood. To reduce reliance on private cars or taxis, it was first questioned whether the promoted service could satisfy users' travel demands if they do not own a car or cannot drive. Thus, this study targets these residents to study whether the promoted service can be a sufficient transport option in a no-private car scenario.

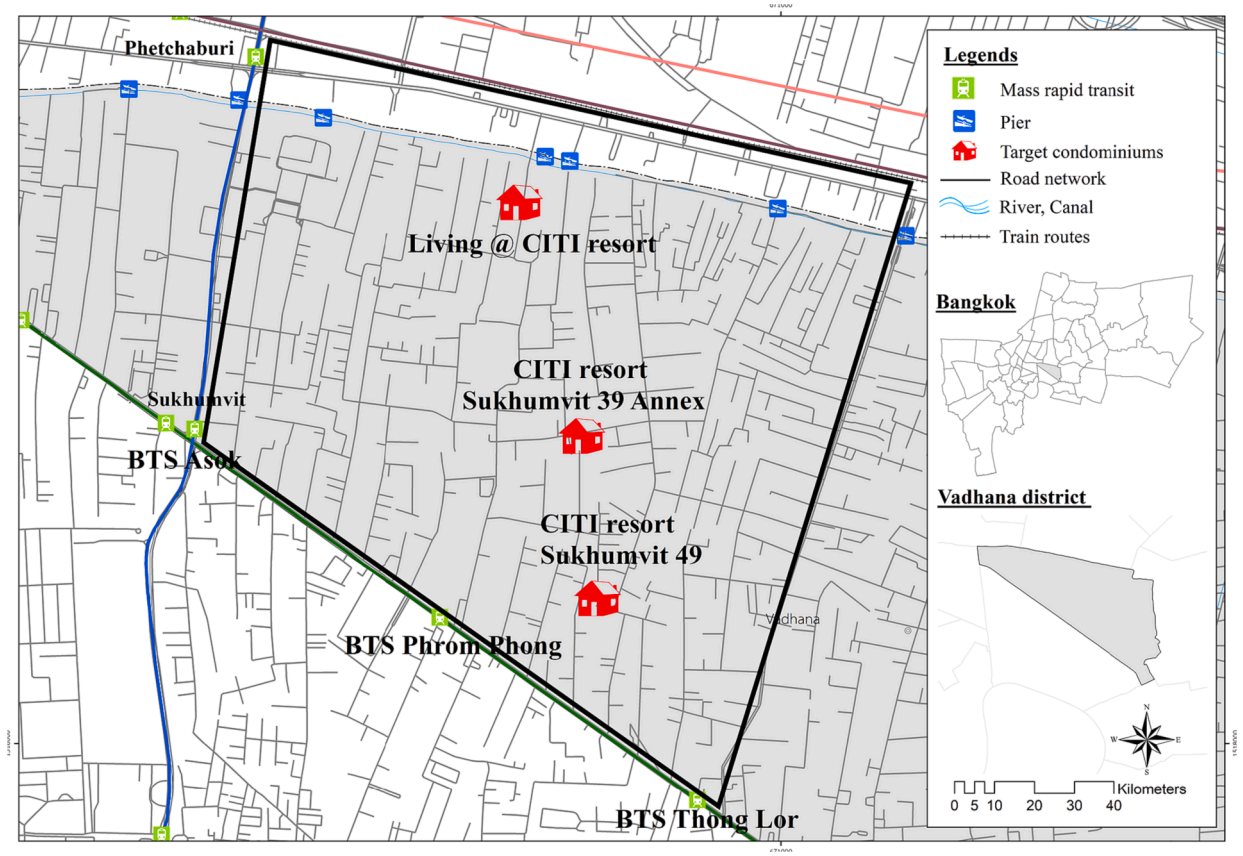

Fig. 2. Map showing the service area and its location in Bangkok. The area framed with solid black lines indicates the service area of community-based electric ride-sharing.

There are three collaborative condominiums situated within the service area, accommodating a total of 280 Japanese residents (refer to Fig. 2 for the map). The service area encompasses a central portion of the Vadhana district, extending eastward from Asok/Sukhumvit transit, westward from Thong Lor station, southward to Sukhumvit road, and northward to the Saen Saeb Canal. SSVS goes through the narrow streets "sois," connecting the target condominiums to the main facilities (e.g., hospitals, local shops) within the neighborhood area and nearby public transport. These condominiums are located at relatively short to medium distances from the nearest transit station, specifically 1.8 km, 1.3 km, and 1.1 km from BTS Phrom Phong. The commonly cited acceptable walking distance (AWD) is typically 400 m to a bus stop and 800 m to a rapid transit station (El-Geneidy et al., 2014; Pueboobpaphan et al., 2022). However, it is important to note that the AWD standard may not be appropriate for Thailand due to its tropical climate. In Bangkok, the average walking distance to rapid transit stations is approximately 320 m (Townsend & Zacharias, 2010), which is significantly smaller than the recommended international standard. The proximity of the condominiums to the mass transit stations were targeted to fulfill the function of the last-mile ride-sharing.

The vehicle type is FOMM ONE, a compact four-seat EV that measures 2.6 m long and 1.3 m wide. With permission to drive on public roads in Thailand, the vehicle size occupied by road space is approximately 60 % of a regular vehicle. The service time is from 8:00 to noon and 13:00 to 17:00 daily, with a fleet of three EVs driven by hired Thai drivers. Through the reservation system on the LINE application, residents can reserve the service in advance or choose to ride from now. In the user interface of the reservation page, it is flexible to appoint the locations for pick-up and drop-off within the service area. As a pilot service, the fee to reserve and use the service is free. This study conducted an online survey on enrolled SSVS users from November 21 to November 30, 2022, after the pilot service had been in operation for about one year. This timing enabled us to capture users' intention following a prolonged trial period, providing insights into their sustained interest and commitment to the behavior under investigation. The questionnaire was created on the online platform, and the link was reached to all registered pilot service users through the LINE application.

3.1.2. Characteristics of participants and travel patterns

The number of registered individuals who have used the pilot service at least once was 250. From this group, a sample size with 101 valid responses was collected, resulting in a response rate of 40.4 %. Table 1 lists the sample characteristics. Among the respondents, about 60 % of them were female, and more than 87 % were married. As mentioned earlier, the target respondents were local residents with limited transport options. Out of the 101 respondents, 34.7 % did not own private means of transport, while 65.3 % reported

Table 1
Sample profile.

Characteristics	Sample size (n = 101)	Percentage (%)
Gender		
Male	28	27.7
Female	60	59.4
Prefer not to answer	13	12.9
Marriage		
Married	88	87.1
Single	1	1.0
Prefer not to answer	12	11.9
Number of members in family		
Live alone	12	11.9
2 persons	15	14.9
3–4 persons	59	58.4
More than 5 persons	4	4.0
Prefer not to answer	11	10.9
Available private transport (multiple-choice question)		
Car driven by myself	2	2.0
Car with a driver (e.g., private hire vehicle)	66	65.3
Motorcycle	6	5.9
Private mobility is not available	35	34.7
Primary modes for first and last-mile transport (select up to three answers)		
Walk	68	67.3
Private cars	14	13.9
Smart Small Vehicle Service (SSVS)	61	60.4
Shuttle services provided by the condominium	69	68.3
Ride-hailing cars (e.g., taxi, Grab car)	19	18.8
Motorcycle taxi	10	9.9
Three-wheeled taxi (i.e., Tuk-Tuks)	21	20.8

having private mobility within their households by relying on hired drivers. This finding highlight concerns regarding the dynamics within these households, suggesting that the household head tends to monopolize the car for commuting or social activities after work, thereby limiting the access of other household members to the vehicle during the daytime. The survey further revealed that the majority of participants belonged to households with three or more family members (62.4 %). This implies that even if a household has a private car, individual family members face constraints in terms of their mobility choices and options.

A question was used to investigate respondents' transport mode preferences: "What is the mode you frequently choose for traveling a short distance from home? For example, to the nearby supermarket or a public transport station?" A maximum of three answers was possible. Except for walking (67.3 %), the shuttle service offered by the condominium (68.3 %) was the primary transport mode for most of the sample, followed by the SSVS (60.4 %). Besides, the three-wheeled taxis (20.8 %), ride-hailing cars (18.8 %), and motorcycle taxis (9.9 %) still served as primary options for some users during the pilot project. A shuttle service offered by the condominium was usually served with a 10-passenger van. According to the interview results with the condominium manager, the shuttle van usually carried a few passengers except for the peak hours in the morning and evening. Owing to the fixed-route and fixed-time scheduling, an additional issue of the current shuttle service lay in its inflexibility in catering to residents' travel needs.

The pilot service usage increased as time went by despite an increased waiting time and cancellation rate. During the last week of May, the service took 40.1 trips and served 57.1 passengers daily, while it took 52.1 trips and served 80.9 passengers daily on average for the last week of November 2022. The data showed about a 30 % increase in trips and a 41.7 % increase in passengers. However, at the same time, the average waiting time increased from 5.4 min in May to 7.0 min in November. The service offer rate decreased from 90 % to 79 %, which indicated that 79 % of all reservations were successfully served. The data offers important evidence that the users still keep using the service despite its decreased level of service.

Looking into the travel characteristics of the users, 97.9 % of Origin-Destination (OD) pairs were home-based trips. The most traveled OD was from the condominium (i.e., home) to the BTS Phrom Phong station with an about 2.5 km travel distance, accounting for 19.8 % of all served trips. Overall, the popular ODs included transit (accounting for 43.8 % among all served trips), supermarkets (19.5 %), educational facilities (6.9 %), and hospitals (7.1 %). Besides, the data showed that users tended to travel to the transit in the morning peak (8:00 to 10:00) while from the transit in the evening (16:00 to 17:00). The summarized travel patterns confirmed the role of the promoted community-based electric ride-sharing as first and last-mile mobility.

3.2. Measures

This study modified the measurement scales for all constructs from the existing literature to fit the research context. Each construct in the questionnaire comprised a set of items presented in a five-point Likert format to capture the extent to which respondents agree or disagree (1 = "strongly disagree" and 5 = "strongly agree") with the item statements. Precisely, both perceived ease of use and trust was measured by two items adapted from Chen (2019) and another item recommended by the authors in consideration of the research context. Instrumental and hedonic attitudes were measured by three items adapted from Zhu et al. (2022). Social norm measured by

Table 2
Descriptive statistics of survey items.

Constructs and items		Mean	S.D.
Perceived ease of use (PE)			
PE1	The way to use SSVS is clear and understandable.	4.18	0.91
PE2	The LINE reservation interface is easy to use for me.	4.42	0.97
PE3	The reservation function of SSVS is useful.	3.76	1.12
Trust (TR)			
TR1	I believe that SSVS provides a robust and safe environment in which I can use the service.	3.86	0.93
TR2	I trust that the SSVS provider has enough safeguards to protect me from liability or damage.	3.81	0.91
TR3	I think SSVS is punctual and reliable	3.08	1.12
Social norm (SN)			
SN1	Mass media shared information regarding the benefits of electric vehicles, influencing me that I should use SSVS.	1.95	1.20
SN2	The promotion that conveyed SSVS is eco-friendly mobility attracted me to use it.	2.76	1.58
SN3	Seeing the electric SSVS cars running on the streets would attract me to use it.	2.99	1.59
Instrumental attitude (IA)			
IA1	SSVS enables me to reach my destinations more quickly.	4.46	0.66
IA2	SSVS helps me save my effort on travel.	4.60	0.60
IA3	SSVS improves my safety compared to other travel modes.	4.26	0.82
Hedonic attitude (HA)			
HA1	Traveling using SSVS would be pleasant overall.	3.82	0.85
HA2	I am satisfied with the ride comfort of SSVS.	3.79	0.96
HA3	I enjoy my journey with SSVS.	4.00	0.79
Travel-related self-efficacy (TS)			
TS1	I feel less worried when going out because SSVS serves me as a reliable option.	4.45	0.81
TS2	SSVS makes me feel secure by ensuring my daily mobility.	4.50	0.77
TS3	I feel freer in daily transport and movement with SSVS.	4.42	0.75
TS4	I become able to move around on my own without relying on others if SSVS is available.	4.43	0.82
Eudaimonic value (EV)			
EV1	I think it is meaningful to prioritize the use of SSVS even if I have other alternative mobility.	4.33	0.69
EV2	I enjoy using SSVS no matter how other people are impressed by it.	4.42	0.71
EV3	I have been more willing to try new services or technologies.	4.59	0.60
Normative value (NV)			
NV1	I believe that everyone has a responsibility to use eco-friendly transport.	4.17	0.83
NV2	I believe using eco-friendly transport would benefit the environment in the long term.	4.23	0.79
NV3	I believe that shared mobility service would be a solution to solve traffic congestion.	4.19	0.87
Behavioral intention (BI)			
BI1	I prefer SSVS rather than hailing a taxi, Tuk-Tuk, or Grab car.	4.67	0.67
BI2	I intend to use SSVS to substitute private car or motorcycle trips.	4.40	0.93
BI3	If the free service becomes available permanently, I intend to use it.	4.91	0.43
BI4	If the SSVS starts to charge users, I will still consider using it.	3.66	1.06

three items was adapted according to Dutta and Hwang (2021). Travel-related self-efficacy (four items) was suggested by Chou et al. (2022) and the authors. Normative value was measured by three items, with two adapted from Kim and Choi (2005) and the other one suggested by the authors. Referring to the questionnaire of Waterman et al. (2010), item design for eudaimonic value (three items) was suggested by the authors. The items describe users' (1) senses of purpose and meanings toward using the service, perceiving (2) enjoyment of the activity as personally expressive, and (3) self-discovery while using an innovative service and becoming more willing to take on new challenges. Behavioral intention (four items) was proposed by the authors in light of the research context. Demographic questions included gender, marital and family status, and travel characteristics such as available private transport to use and transport mode preferences.

3.3. Data analysis

This study applied structural equation modeling (SEM) with the maximum likelihood estimates to address a series of interrelated dependence relationships among latent variables and between latent constructs. The data analysis followed a two-stage approach. Before proceeding with the hypotheses verification, the scale validation was examined by conducting a confirmatory factor analysis (CFA). Both the convergent reliability and discriminant validity were tested for the construct validity of the measurement model in the first stage. The hypothesized structural model was empirically tested in the second stage.

The SEM fit indices used in this study included the normed X^2 (chi-square value divided by the degrees of freedom, X^2/df), the comparative fit index (CFI), the Tucker-Lewis index (TLI), the goodness-of-fit index (GFI), and the root mean square of approximation (RMSEA). A value of normed X^2 less than 2.0 is considered good, and less than 5.0 is acceptable (Marsh & Hocevar, 1985). The other indices except RMSEA are greater than 0.9, indicating a good model fit (Hair, 2009). A value of RMSEA up to 0.08 is considered reasonable (MacCallum, Browne, & Sugawara, 1996). The multi-group SEM analysis was further conducted to explore the differences in estimated results by respondents' transport mode preferences. Acknowledging sample division limitations in multi-group analysis, this study applied moderating effect analysis in PLS-SEM to complement multi-group findings. Results are detailed in the Appendices.

Table 3
CFA results of the measurement model.

Construct	Item	Standard factor loading	Standard error	Cronbach's α	CR	AVE
Perceived ease of use	PE1	0.873	0.085	0.779	0.781	0.641
	PE2	0.732	0.093			
Trust	TR1	0.858	0.081	0.848	0.848	0.736
	TR2	0.857	0.080			
Social norm	SN1	0.661	0.128	0.743	0.815	0.706
	SN2	0.928	0.180			
Instrumental attitude	IA1	0.711	0.058	0.817	0.833	0.630
	IA2	0.860	0.049			
	IA3	0.807	0.069			
Hedonic attitude	HA1	0.747	0.079	0.732	0.757	0.520
	HA2	0.784	0.087			
	HA3	0.576	0.078			
Travel-related self-efficacy	TS1	0.885	0.063	0.948	0.949	0.861
	TS2	0.969	0.056			
	TS3	0.933	0.056			
Eudaimonic value	EV1	0.827	0.059	0.807	0.827	0.623
	EV2	0.857	0.059			
	EV3	0.622	0.056			
Normative value	NV1	0.693	0.077	0.798	0.813	0.690
	NV2	0.959	0.069			
Behavioral intention	BI1	0.823	0.062	0.737	0.748	0.600
	BI2	0.749	0.088			

Table 4
Results of discriminant validity.

Construct	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Perceived ease of use	**0.801**								
(2) Trust	0.116	**0.858**							
(3) Social norm	0.006	0.187	**0.840**						
(4) Instrumental attitude	0.405	0.235	0.035	**0.794**					
(5) Hedonic attitude	0.310	0.467	0.225	0.352	**0.721**				
(6) Travel-related self-efficacy	0.209	0.111	0.000	0.755	0.150	**0.928**			
(7) Eudaimonic value	0.264	0.378	0.056	0.456	0.269	0.284	**0.789**		
(8) Normative value	0.305	0.134	0.128	0.167	0.355	0.039	0.362	**0.830**	
(9) Behavioral intention	0.153	0.253	0.074	0.169	0.229	0.091	0.566	0.344	**0.775**

Note: Values on the diagonal of correlation matrices represent the square root of the AVEs.

Moderating effect analysis examines relationships across varying third construct levels, enhancing precision without sample division, while multi-group analysis robustly compares parameter estimates among groups.

4. Results

4.1. Descriptive statistics

Table 2 shows the descriptive statistics, including item means and standard deviation of each construct in the hypothesized model.

4.2. Measurement model

A preliminary CFA was then conducted. Seven items were eliminated to increase reliability and decrease measurement error because their standardized factor loadings did not meet the minimum criterion of 0.5 (Hair, 2009), including one of perceived ease of use (PE3), one of trust (TR3), one of social norm (SN3), one of travel-related self-efficacy (TS4), one of normative value (NV3), and two of behavioral intention (BI3, BI4). After removing these items, the CFA was carried out again. According to Hair (2009), the convergent validity of CFA results should be supported by the item reliability (i.e., standardized factor loadings, Cronbach's α), composite reliability (CR), and average variance extracted (AVE).

The estimated model showed good fit indices according to $X^2(173) = 274.358$, X^2/df=1.59, CFI = 0.93, TLI = 0.90, and RMSEA = 0.076, despite a lower GFI value of 0.83. The model complexity (in terms of the number of observed variables, number of observed variables per factor, number of parameters estimated, degrees of freedom, Etc.) was indicated to have sizable negative effects on the value of GFI and AGFI (Baumgartner & Homburg, 1996). In contrast, X^2/df, RMSEA, and TLI are considered effective in controlling model complexity by assessing fit per degree of freedom. Accordingly, some researchers interpret GFI range from 0.80 to 0.89 as representing reasonable fit (Doll, Xia, & Torkzadeh, 1994; Hoyle, 1995).

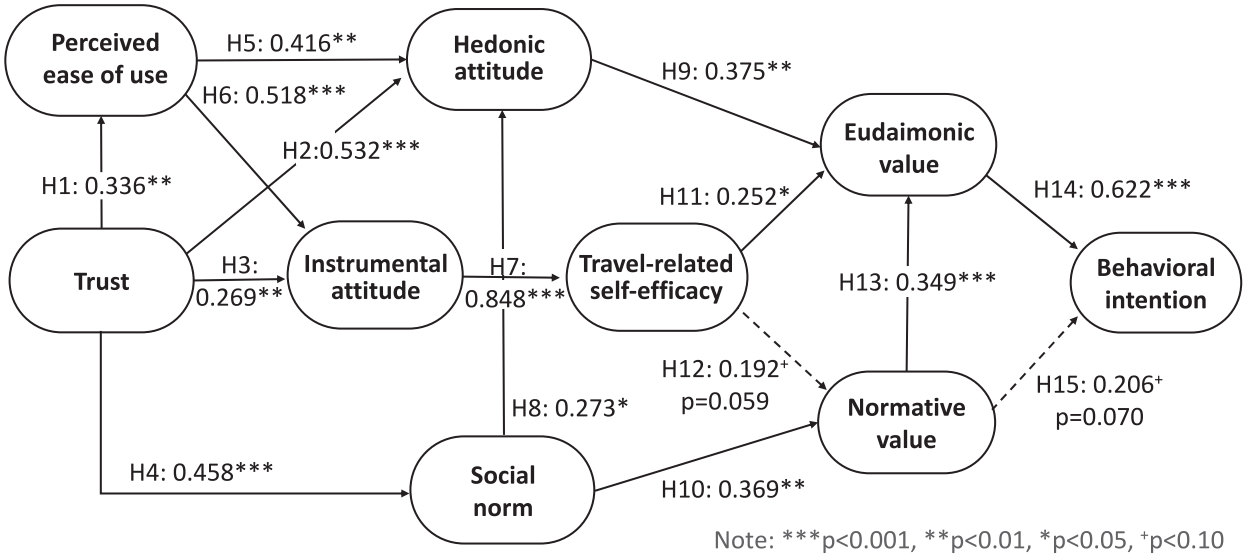

Fig. 3. The estimated model.

As shown in Table 3, the standardized factor loadings ranged from 0.576 to 0.969, supporting the required level of 0.50. Both Cronbach's α and CR estimates of all constructs achieved the recommended level of 0.70. In addition, all AVE values were higher than the suggested value of 0.50, providing additional evidence of convergent validity. The discriminant validity was confirmed by Fornell and Larcker (1981)'s criterion. As shown in Table 4, the square root of each construct' AVE was greater than the inter-construct correlation of that same construct and all other measured constructs in the structural model.

In the final factor structure, we employed nine variables, with five featuring two items each. Importantly, the measurement model assessment found no Heywood cases, indicating no negative variance. Appendix A supplements the CB-SEM evaluation with PLS-SEM results (Hair et al., 2012), demonstrating robust construct and discriminant validity across both methods.

4.3. Structural model and hypotheses test

The hypothesized structural model was subsequently estimated to examine the relationships between constructs. The hypothesized model showed an acceptable fit on the sample data according to the goodness-of-fit indices (X^2 (173) = 280.55, X^2/df=1.62, CFI = 0.92, TLI = 0.90, GFI = 0.81, RMSEA = 0.078). Fig. 3 shows the estimated model with the standardized path coefficients and significant levels. Thirteen out of fifteen hypotheses in the model were empirically supported, except for H12: the positive effects of travel-related self-efficacy on normative value (β = 0.192, p = 0.059) and H15: the positive effects of normative on behavioral intention (β = 0.206, p = 0.070). However, both paths showed a trend toward statistical significance.

Trust had significant positive effects on users' perceived ease of use (H1: β = 0.336, p < 0.01), both hedonic (H2: β = 0.532, p < 0.001) and instrumental attitudes (H3: β = 0.269, p < 0.01), and social norm (H4: β = 0.458, p < 0.001). Perceived ease of use had significant positive effects on the attitudes toward behavior, including hedonic attitude (H5: β = 0.416, p < 0.01) and instrumental attitudes (H6: β = 0.518, p < 0.001). Instrumental attitude significantly and strongly positively affected travel-related self-efficacy (H7: β = 0.848, p < 0.001). Social norm had significant positive effects on hedonic attitude (H8: β = 0.273, p < 0.05) and normative value (*H*10: β = 0.369, p < 0.01), which further caused a significant positive effect on eudaimonic value (H13: β = 0.349, p < 0.001) and showed a tendency to enhance behavioral intention. In addition to normative value, both hedonic attitude (H9: β = 0.375, p < 0.01) and travel-related self-efficacy (*H*11: β = 0.252, p < 0.05) had significant positive effects on eudaimonic value in using the community-based electric ride-sharing. The results highlight a crucial role of eudaimonic as a mediating variable that directly contributes to behavior intention. A significant strong correlation was found between eudaimonic value and behavioral intention (H14: β = 0.622, p < 0.001).

4.4. Multi-group analysis

The SSVS served the target residents as a free transport choice. Among 101 respondents, 61 stated that they frequently used SSVS when traveling to nearby public transits or facilities (i.e., frequent users). The other 40 respondents tended to choose private cars, ride-hailing, or taxis more as first and last-mile transport (i.e., infrequent SSVS users). This study set using SSVS frequently or not as a moderator. A multi-group analysis was conducted to measure the moderating effects on the hypothesized structural model. The unconstrained models were compared with their structural weight model, which set equal regression coefficients between the latent variables. If such moderating effects exist, they should cause statistically significant differences in the empirical relationship of the same two models within the subgroups (Bamberg, 2003; Li & Zhang, 2021). The chi-square difference tests conducted between the

Table 5
Multi-group analysis results for the moderating effects of frequent use of SSVS.

Path	Fully constrained model		Unconstrained model				Test results for each constrained path	
			Frequent user		Infrequent user			
	Estimate	P	Estimate	P	Estimate	P	Chi-square	P
H1: TR → PE	0.365	**	0.295	*	0.499	*	$\Delta X^2(1) = 0.58$	ns
H2: TR → HA	0.483	***	0.446	***	0.546	**	$\Delta X^2(1) = 0.17$	ns
H3: TR → IA	0.202	***	0.115	ns	0.400	**	$\Delta X^2(1) = 4.88$	*
H4: TR → SN	0.452	***	0.556	**	0.091	ns	$\Delta X^2(1) = 3.30$	ns
H5: PE → HA	0.267	**	0.272	*	0.116	ns	$\Delta X^2(1) = 0.83$	ns
H6: PE → IA	0.265	***	0.242	**	0.185	*	$\Delta X^2(1) = 0.18$	ns
H7: IA → TS	1.266	***	1.050	***	1.731	***	$\Delta X^2(1) = 2.59$	ns
H8: SN → HA	0.197	*	0.164	ns	1.587	ns	$\Delta X^2(1) = 8.91$	**
H9: HA → EV	0.417	***	0.519	**	0.442	*	$\Delta X^2(1) = 0.05$	ns
*H*10: SN → NV	0.237	**	0.150	ns	2.034	ns	$\Delta X^2(1) = 9.70$	**
*H*11: TS → EV	0.153	*	−0.030	ns	0.351	**	$\Delta X^2(1) = 1.63$	ns
H12: TS → NV	0.141	ns	0.156	ns	0.119	ns	$\Delta X^2(1) = 0.03$	ns
H13: NV → EV	0.349	***	0.544	***	−0.103	ns	$\Delta X^2(1) = 8.27$	**
H14: EV → BI	0.771	***	1.077	***	0.597	*	$\Delta X^2(1) = 1.44$	ns
H15: NV → BI	0.233	ns	0.003	ns	0.298	ns	$\Delta X^2(1) = 1.23$	ns

Note: ns: non-significant; *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.

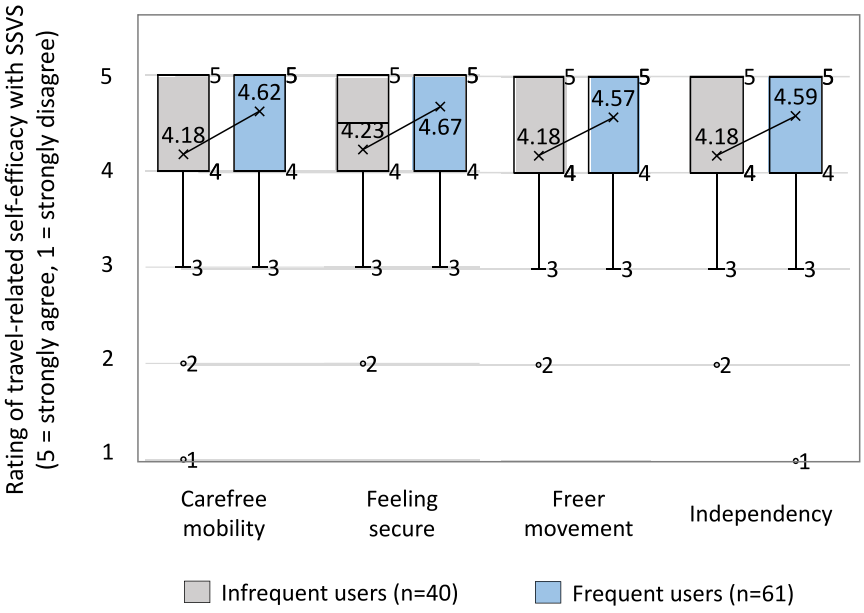

Fig. 4. Group comparison between frequent and infrequent users on stated self-efficacy in daily transport with using the community-based electric ride-sharing.

unconstrained model ($X^2 = 551.96$, df = 346) and structural weight model ($X^2 = 625.97$, df = 373) showed $\Delta X^2(27) = 74.009$, p-value < 0.001, indicating apparent differences existed between the subgroups. More detailed chi-squared tests were performed on the regression coefficients to assess the group differences in each path. Each path was constrained at each time; the chi-square difference test was performed to evaluate the difference between the model fits. Table 5 reports the results.

Significant differences existed in four paths. Except for the paths which were insignificant in both unconstrained models of subgroups (H8: social norm → hedonic attitude and *H*10: social norm → normative value), significant moderating effects in two paths were found between SSVS frequent users and infrequent users, i.e., H3: trust → instrumental attitudes (p-value < 0.05), and H13: normative value → eudaimonic value (p-value < 0.01). Appendix B presents the moderating effect analysis. The findings align with the multi-group results, confirming significant moderating effects of mode preference for choosing SSVS on H3 and H13. T-test results comparing frequent users and infrequent users are available in Appendix C.

4.5. Affordable mobility to secure transport self-efficacy

The respondents stated high levels of travel-related self-efficacy, with SSVS serving as a daily transport option. The mean of overall travel-related self-efficacy was 4.45 on the rating scale from 1 (strongly disagree) to 5 (strongly agree). The four designed items described how the promoted mobility satisfied residents' self-efficacy in daily transport, including acting as carefree mobility (TS1, mean = 4.45), making users feel secure (TS2, mean = 4.50), freer (TS3, mean = 4.42) and more independent (TS4, mean = 4.43). T-tests were further conducted to compare item means between frequent and infrequent users of SSVS. As shown in Fig. 4, the frequent users responded with a higher score than infrequent users at a significant p-value < 0.01 for each item. Furthermore, spearman correlations were conducted between overall travel-related self-efficacy and each item of behavioral intention. Significant and positive correlations were found for all items, including the intentions to keep using the free service (BI3: $r_s = 0.377$, $p < 0.001$), substitute taxi trips by SSVS (BI1: $r_s = 0.268$, $p < 0.001$), substitute private cars by SSVS (BI2: $r_s = 0.232$, $p < 0.05$), and to keep using even though the service start to charge its users (BI4: $r_s = 0.200$, $p < 0.05$). These significant correlations indicated that intentions to use community-based electric ride-sharing could be enhanced by securing users' self-efficacy in daily transport.

As reported earlier (Table 2), users showed high intention to use the service to substitute taxis (BI1, mean = 4.67) and private cars (BI2, mean = 4.40). Another two items addressed more generally were used to investigate users' intention to pay for the service. If the free service became available permanently, 97.1 % of respondents agreed that they intend to use it, with 94.2 % "strongly agree" and 2.9 % "agree" responses. In contrast, if the SSVS started to charge users, only 62.6 % stated that they would still consider using it, with 21.2 % "strongly agree" and 41.4 % "agree" responses. The willingness to use decreased by 35.5 %, indicating the importance of promoting affordable mobility to sustain transport self-efficacy in a community context.

5. Discussion and conclusions

This study targeted a pilot project introducing community-based electric ride-sharing in Thailand. The research findings show a pivotal role of travel-related self-efficacy in encouraging users to use the pilot service to substitute their existing travel modes by finding goals during the intervention. The specific results are summarized as follows.

First, trust as an additional factor had positive effects on perceived use of use, attitudinal variables, and social norm. This finding implies that trust acts as a control belief in using innovative services that may facilitate or impede behavior performance. The finding is consistent with Chen (2019); the study suggested trust has an indirect effect through the mediation of attitudes affecting the decision to use an innovative autonomous shuttle service. Second, this study tried dividing attitudes toward behavior into instrumental and hedonic attitudes to capture different aspects of consumer values. In line with TAM, perceived ease of use significantly affects both attitudinal variables. The findings show that instrument and hedonic attitudes have different indirect effects on behavior intention by mediating eudaimonic value and travel-related self-efficacy to encourage a sustained behavior change. The results confirm the usefulness of adapted attitudinal variables and enhance explanatory power by capturing the various aspects of user values. Third, social norm leads to hedonic attitudes toward using the service, which confirms the results of (Flores & Jansson, 2022) that environmental motivations would positively affect positive emotions in using emerging electric mobility. Forth, eudaimonic value strongly affects users' intention to substitute present mode choices (i.e., private cars and taxis) with community-based electric ride-sharing. In addition to strong direct effects, the indirect positive effects from hedonic value, self-efficacy, and normative value highlight that eudaimonic value is a critical mediating variable to sustain behavioral intention. This finding is consistent with a previous study that eudaimonic behaviors would lead to more experiences (i.e., keep using the service) through searching for greater meaning in activities (Henderson, Knight, & Richardson, 2013).

The multi-group analysis results provide additional implications. This study set mediator by choosing community-based electric ride-sharing as a primary mode for traveling first and last-mile (i.e., frequent users). The infrequent users were those who preferred using private cars, taxis, or ride-hailing services for short-distance travel. At first, the effect of trust on instrumental attitude is only significantly positive for infrequent users, implying it is more important to establish a trustworthy service to enhance the perceived usefulness of community-based ride-sharing for those with other mobility options. In addition, the normative value can only lead frequent users to find a sense of purpose and meaning during the interventions. Other findings show that frequent users had higher self-efficacy in daily transport during the intervention. Significant and positive correlations between self-efficacy and intention confirmed the role of self-efficacy in sustaining behavior change. However, a notable decrease in intention was found when asking the users to pay for the service. According to Steg and Vlek (2009), moral obligations to behave pro-environmentally appear successful in low-cost environmental behavior; Nevertheless, they appear to have far less explanatory power in situations of high behavioral costs or strong constraints, such as reducing car use.

The present study contributes to the literature by extending the understanding of the underlying mechanisms driving individuals' sustained intention to adopt sustainable mobility options. By integrating the Theory of Planned Behavior (TPB) and goal-framing theory, this research enhances existing theoretical frameworks in the field of travel behavior intervention. The integrated theory identifies key psychological factors that determine a given behavior while also providing insights into how behaviors can be changed over time by pursuing different goals. Moreover, this study reveals the vital mediating role of self-efficacy in integrating these two existing theories. Consistent with Bandura's (1986) Social Cognitive Theory, high self-efficacy is shown to provide motivation during the goal-striving process and influence individuals' progression in the decision-making process. This study demonstrates that external influences, such as beliefs about the consequences of specific actions (as captured by the instrumental attitude in the model), impact behavior through their effect on self-efficacy rather than acting directly (Bandura, 1986). By integrating TPB and goal-framing theory while highlighting the mediating role of self-efficacy, this study contributes to a deeper understanding of the psychological factors

influencing individuals' sustained intention to adopt sustainable mobility services. The findings not only advance theoretical frameworks in the field but also provide practical implications for designing effective interventions and strategies to promote sustainable travel behavior.

5.1. Practical implications

The research findings provide empirical evidence for practical applications. Overall, community-based electric ride-sharing could be promoted in built environment supporting areas that increase transit access and connectivity by linkage destinations (e.g., commercial facilities and services) and transport. Since trust and perceived ease of use are the fundamental conditions for users to adopt a new service, it is essential to provide trustworthy service and understandable service design from the initial stage of introducing a new service. These can be attained by offering the service with well-trained and reliable drivers that keep safe driving on roads, safeguards to protect users from damage during travel, and applications (e.g., a reservation system) that are easy to learn and use. In the pilot project, a decreased level of service (i.e., waiting time) has shown as demand increased. Service providers can encourage a sustained intention by satisfying users' hedonic value. In addition to providing the service with good riding comfort, the perceived enjoyment and pleasure of using the service can be encouraged by social norms. Concretely, conveying the environmental benefits of community-based electric ride-sharing could affect how users see the service, leading to positive experiential emotions and encouraging them to perform pro-environmental behavior. As a final point, this study highlights the significance of affordable transport services in enhancing travel-related self-efficacy, thereby sustaining behavioral intention. Reinvesting development benefits led by developers across different sectors emerges as a potential solution for funding affordable community-based transport initiatives that return the benefits derived from development projects back to the community. This concept underscores the utilization of gains and advantages obtained from development activities to promote overall growth and generate positive societal impact. The findings of this study have important implications for policymakers, emphasizing the importance of accessible and affordable transport services in supporting travel-related self-efficacy and promoting sustainable behavioral intentions.

5.2. Limitations and future research

This study has limitations and offers directions for future research. The use of survey data instead of panel data restricts the ability to capture changes in actual travel patterns over time. However, the long-term pilot service survey provides credible evidence of users' experiences and developmental changes. The small sample size is another limitation, although acceptable fit indices were obtained. A larger sample size would have allowed for more robust statistical analysis and generalizability. The exclusive focus on foreign residents in Bangkok may limit the applicability to native residents and different values. Future research can expand the scope to include native residents and investigate variations in moral obligation and travel mode preferences. Additionally, exploring the role of eudaimonic well-being in sustained change, despite its limited discussion in behavior model literature, offers a promising direction for future studies in the pro-environmental behavior field.

CRediT authorship contribution statement

Chun-Chen Chou: Conceptualization, Methodology, Formal analysis, Investigation, Writing – original draft, Writing – review & editing, Visualization. **Pawinee Iamtrakul:** Investigation, Writing – review & editing, Visualization, Supervision. **Kento Yoh:** Investigation, Writing – review & editing, Supervision. **Masato Miyata:** Investigation, Data curation, Project administration. **Kenji Doi:** Conceptualization, Writing – review & editing, Supervision, Project administration.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A. Model estimation in PLS-SEM

See Tables A1, A2 and A3).

Table A1
Hypothesis verification.

Path	Path coefficients	Standard deviation	T statistics	*P*
H1: TR → PE	0.286	0.082	3.475	***
H2: TR → HA	0.363	0.101	3.610	***
H3: TR → IA	0.291	0.094	3.114	**
H4: TR → SN	0.374	0.080	4.659	***
H5: PE → HA	0.312	0.075	4.145	***
H6: PE → IA	0.449	0.101	4.433	***
H7: IA → TS	0.780	0.049	15.790	***
H8: SN → HA	0.250	0.091	2.737	**
H9: HA → EV	0.145	0.094	1.540	ns ($p = 0.124$)
*H*10: SN → NV	0.207	0.088	2.356	*
*H*11: TS → EV	0.328	0.088	3.751	***
H12: TS → NV	0.310	0.077	4.005	***
H13: NV → EV	0.364	0.098	3.711	***
H14: EV → BI	0.505	0.104	4.840	***
H15: NV → BI	0.205	0.089	2.289	*

Note: ns: non-significant; *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.

Table A2
Construct reliability and validity.

Construct	Item	Standard factor loading	Standard error	Cronbach's α	CR	AVE
Perceived ease of use	PE1	0.922	0.023	0.780	0.900	0.818
	PE2	0.887	0.053			
Trust	TR1	0.940	0.015	0.848	0.929	0.868
	TR2	0.923	0.021			
Social norm	SN1	0.878	0.045	0.761	0.892	0.806
	SN2	0.917	0.023			
Instrumental attitude	IA1	0.824	0.047	0.832	0.899	0.749
	IA2	0.915	0.020			
	IA3	0.855	0.027			
Hedonic attitude	HA1	0.862	0.028	0.728	0.847	0.650
	HA2	0.712	0.075			
	HA3	0.837	0.039			
Travel-related self-efficacy	TS1	0.932	0.018	0.949	0.967	0.907
	TS2	0.970	0.009			
	TS3	0.954	0.010			
Eudaimonic value	EV1	0.871	0.023	0.805	0.886	0.722
	EV2	0.905	0.024			
	EV3	0.767	0.068			
Normative value	NV1	0.875	0.059	0.799	0.906	0.828
	NV2	0.944	0.015			
Behavioral intention	BI1	0.914	0.023	0.763	0.894	0.808
	BI2	0.883	0.043			

Table A3
Discriminant validity.

Construct	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Perceived ease of use	**0.905**								
(2) Trust	0.286	**0.931**							
(3) Social norm	0.095	0.374	**0.898**						
(4) Instrumental attitude	0.533	0.420	0.175	**0.866**					
(5) Hedonic attitude	0.440	0.546	0.416	0.521	**0.806**				
(6) Travel-related self-efficacy	0.397	0.298	0.003	0.780	0.372	**0.952**			
(7) Eudaimonic value	0.423	0.518	0.197	0.544	0.466	0.458	**0.850**		
(8) Normative value	0.443	0.288	0.311	0.366	0.544	0.208	0.512	**0.910**	
(9) Behavioral intention	0.293	0.409	0.204	0.340	0.380	0.247	0.610	0.463	**0.899**

Appendix B. Results of moderating effect analysis

In both figures of Fig. B2, green represents the mode preference for choosing SSVS (i.e., frequent users), while red corresponds to the group of infrequent users. The upward-sloping lines from left to right indicate positive effects of trust (normative value) on instrumental attitude (eudaimonic value). Regarding the trust-instrumental attitude relationship, the positive effect exhibits a steeper slope among infrequent users, implying that increased trust yields amplified positive effects on enhancing instrumental attitudes. As for the normative value-eudaimonic value relationship, the positive effect displays a steeper slope among frequent users, suggesting that an enhancement in normative value results in a greater boost in eudaimonic values for frequent users. The results of the moderating effects analysis in PLS-SEM align with those of the multi-group analysis.

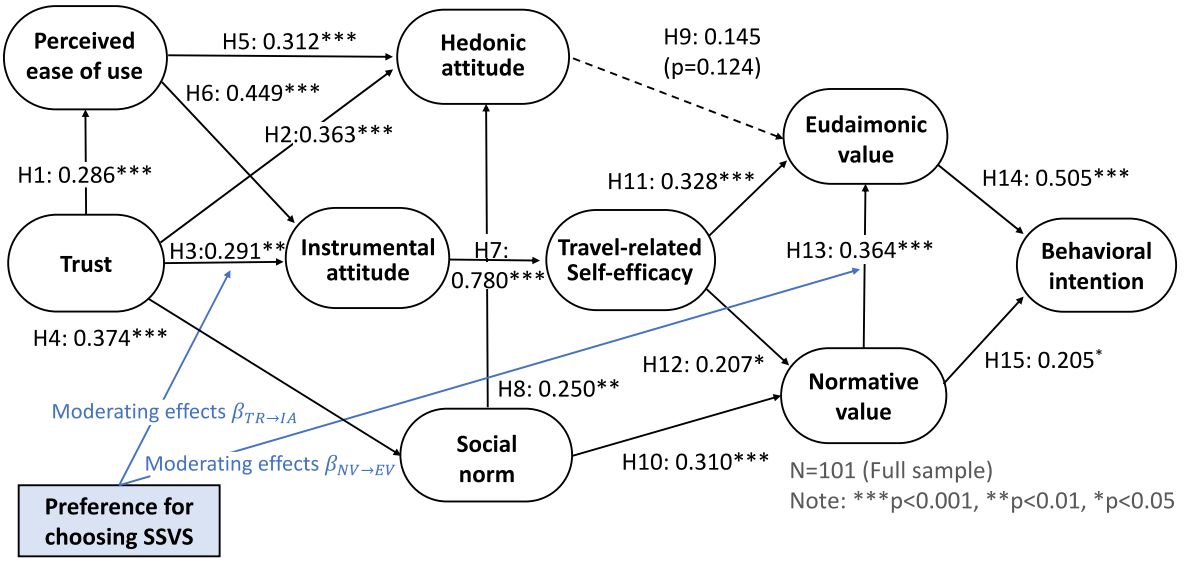

Fig. B1. Estimated model in PLS-SEM – Mode preference as moderator.

Table B1
Moderating effect of mode preference for choosing SSVS on each path.

Moderating effects on each path	Estimate	Standard deviation	T statistics	*P*
H1: TR → PE	−0.131	0.199	0.657	ns
H2: TR → HA	−0.150	0.180	0.835	ns
H3: TR → IA	−0.362	0.177	2.049	$p < 0.05$
H4: TR → SN	0.337	0.205	1.644	ns
H5: PE → HA	0.017	0.154	0.112	ns
H6: PE → IA	−0.113	0.164	0.690	ns
H7: IA → TS	−0.158	0.127	1.243	ns
H8: SN → HA	−0.054	0.199	0.272	ns
H9: HA → EV	−0.175	0.187	0.937	ns
*H*10: SN → NV	0.010	0.213	0.047	ns
*H*11: TS → EV	−0.203	0.191	1.059	ns
H12: TS → NV	0.010	0.213	0.047	ns
H13: NV → EV	0.395	0.197	2.009	$p < 0.05$
H14: EV → BI	0.229	0.248	0.925	ns
H15: NV → BI	−0.223	0.173	1.287	ns

Note: The moderator is a dummy variable indicating a mode preference for selecting SSVS as 1.

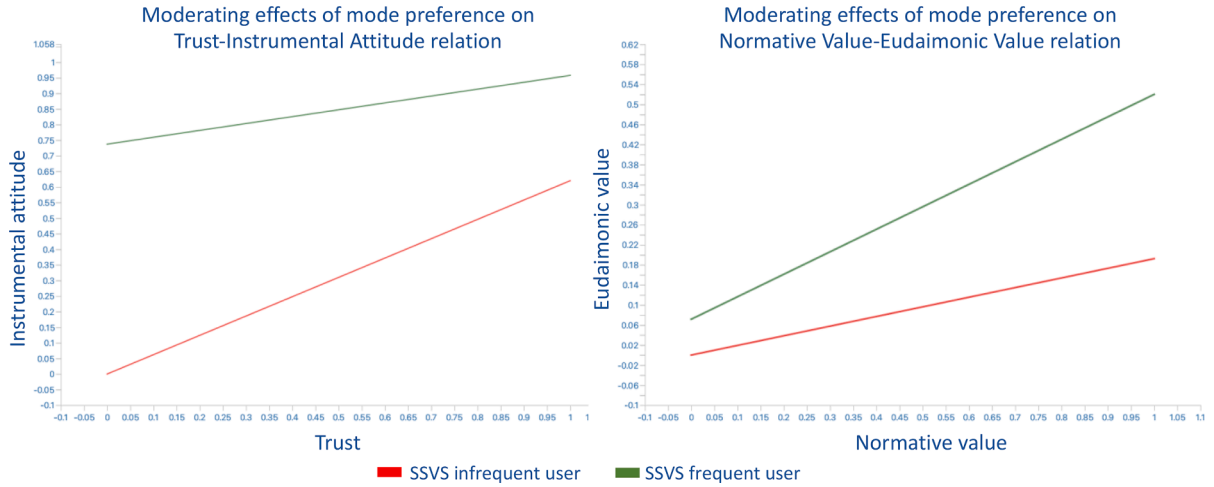

Fig. B2. Moderating effects of the mode preference on user attitudes. Simple slope analysis by SmartPLS4.

Appendix C. Group comparison

See Table C1.

Table C1
T-test results between frequent users and infrequent user of SSVS.

Construct	Item	Frequent user (n = 61)		Infrequent user (n = 40)		T statistics
		Mean	S.D.	Mean	S.D.	
Perceived ease of use	PE1	4.26	0.874	4.05	0.959	1.149
	PE2	4.52	0.887	4.25	1.08	1.395
Trust	TR1	3.84	0.986	3.90	0.841	−0.337
	TR2	3.70	0.989	3.98	0.768	−1.540
	TR3	3.16	1.083	2.90	1.194	1.150
Social norm	SN1	1.84	1.227	2.13	1.159	−1.183
	SN2	2.52	1.689	3.13	1.343	−1.981*
	SN3	2.84	1.614	3.33	1.542	−1.515
Instrumental attitude	IA1	4.67	0.507	4.13	0.723	4.471***
	IA2	4.79	0.413	4.33	0.73	3.639***
	IA3	4.38	0.799	4.08	0.829	1.831
Hedonic attitude	HA1	3.93	0.834	3.65	0.864	1.653
	HA2	3.87	0.991	3.68	0.917	0.990
	HA3	4.08	0.802	3.88	0.757	1.296
Travel-related self-efficacy	TS1	4.62	0.582	4.18	1.01	2.542**
	TS2	4.67	0.569	4.22	0.947	2.685**
	TS3	4.57	0.644	4.18	0.844	2.687**
	TS4	4.59	0.761	4.18	0.844	2.568**
Eudaimonic value	EV1	4.41	0.739	4.20	0.608	1.556
	EV2	4.56	0.719	4.20	0.648	2.537**
	EV3	4.61	0.613	4.58	0.594	0.256
Normative value	NV1	4.26	0.772	4.03	0.891	1.420
	NV2	4.23	0.864	4.22	0.66	0.030
	NV3	4.23	0.824	4.13	0.939	0.590
Behavioral intention	BI1	4.75	0.623	4.55	0.714	1.518
	BI2	4.39	1.005	4.40	0.81	−0.035
	BI3	4.93	0.403	4.88	0.463	0.683
	BI4	3.64	1.184	3.70	0.853	−0.299

Note: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.

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