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Examining the Impact of Sustainable Value and Economic Value on TPASS Usage Intention

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Abstract

As Taiwan faces the challenge of reducing per capita carbon emissions from 12 tons per year—twice the global average—to achieve the "net zero by 2050" goal, understanding the factors influencing the adoption of sustainable transportation becomes crucial. This study examines how sustainable value and economic value affect TPASS usage intention, using an integrated model based on the value-attitude-behavior theory and the theory of reasoned action. The model investigates how perceived economic value, perceived sustainable value, along with attitude and subjective norms, shape consumers' intentions to use TPASS commuter passes. Data are collected through online surveys, yielding 302 valid responses, and analyzed using structural equation modeling. Results show that both sustainable and economic values significantly influence TPASS attitude, with economic value having a stronger effect. Furthermore, attitude and subjective norms both positively affect usage intention, with subjective norms demonstrating a notably stronger impact, providing insights for sustainable transportation policies.

Keywords: TPASS, sustainable value, economic value, value-attitude-behavior, theory of reasoned action

1. Introduction

Faced with the global climate change crisis, the goal of "net zero carbon emissions by 2050" has become an international consensus. However, Taiwan's per capita carbon emissions are approximately 12 tons per year, more than twice the global average, and high private vehicle usage is a major source of emissions. This presents a significant transportation challenge. In Taiwan, private vehicles dominate transportation, accounting for 45.8% of daily trips, according to recent mobility statistics [1], exacerbating traffic congestion and raising significant environmental concerns. This transportation pattern has implications for Taiwan's ecological sustainability, as the transportation sector alone accounted for 12.7% of the country's total greenhouse gas emissions in 2024 [2], ranking fourth among six major sectors. The widespread use of motorcycles and cars in Taiwan sharply contrasts with the European Union's 28 member countries, where public transportation accounts for 56% of travel, highlighting a notable gap in adopting sustainable mobility.

The environmental urgency goes beyond local issues to encompass global sustainability goals. As Taiwan works to balance economic growth with environmental protection, sustainable transportation options have become more essential, requiring comprehensive policies to promote public shifts toward greener mobility choices. In response, the government launched TPASS on July 1, 2023. TPASS is Taiwan's nationwide monthly public transport pass, where T stands for both Taiwan and Transport, and it represents one of the most ambitious integrated transit projects in Taiwan's history. As a

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comprehensive 30-day unlimited pass, TPASS offers easy access to various transportation modes, including Taiwan Railways, metro systems, light rail, city buses, highway passenger transit, ferries, and YouBike bikes within designated zones (Fig. 1) [1]. TPASS also helps address first-mile and last-mile connectivity issues that often discourage people from using public transportation.

Fig. 1 The scope of TPASS applications

Despite growing interest in sustainable transportation policies, significant gaps still exist in current research. First, little focus has been given to comprehensive, integrated transportation passes like TPASS that combine multiple modes and innovative mobility options. This is a critical gap, especially considering the global move toward mobility-as-a-service solutions. Additionally, existing research on transportation behavior change often centers on initial adoption rather than long-term usage, despite the vital importance of maintaining behavior change for policy success. The difference between trying a service and becoming a long-term user is especially relevant for subscription-based services like TPASS, where customer retention over time is crucial to achieving policy objectives.

Second, most research has been conducted in Western contexts, with limited studies on sustainable transportation adoption in East Asian countries where cultural values, urban design, and transportation infrastructure can differ greatly. Taiwan's unique environment, marked by its high population density, widespread motorcycle culture, and recent democratization, offers valuable insights for similar developing economies. In transportation behavior research, the integration of value-attitude-behavior (VAB) and theory of reasoned action (TRA) models remains underexplored, despite the potential of this approach to clarify the links among values, attitudes, and behavior in environmental decision-making.

Recent research has examined sustainable mobility from different viewpoints, such as tourists' behavior involving AI [3] and the use of bike-sharing systems [4-5]. However, a specific research gap exists regarding integrated commuter passes (e.g., TPASS), especially in comparing the effects of economic value and sustainable value on daily commuters. Additionally, while Hauslbauer et al. [6] noted the limited impact of environmental concerns on ticket subscriptions, this study's novelty lies in expanding the discussion by combining the VAB theory with the TRA. This innovative approach allows for a thorough examination of how subjective norms and tangible economic benefits, rather than environmental altruism alone, influence behavioral intentions in an Asian context.

Considering the vital role of sustainable transportation in Taiwan's environmental goals and the substantial public investment in TPASS, this research tackles timely questions with immediate policy relevance. This study aims to deepen both academic understanding of sustainable transportation behavior and practical insights for improving public transportation policies. The two research questions are:

(1) To examine how perceived values (sustainable value and economic value) influence attitudes toward TPASS.
(2) To examine how attitude and subjective norm affect the intention to continue using TPASS.

2. Literature Review

This section reviews the theoretical foundations relevant to the study to establish a conceptual basis. First, the VAB and the TRA models are reviewed to understand the underlying mechanisms of user behavior. Next, the proposed research framework and the corresponding hypotheses are presented based on these theories.

2.1. The VAB model

The VAB model is a fundamental theory in social psychology that posits that individual values influence attitudes, which in turn shape behavior [7]. It highlights the connection between internal values and outward actions, mainly exploring how core personal values influence attitudes and, subsequently, behaviors [8]. Values are somewhat subjective and develop gradually as consumers grow socially and psychologically, leading to the formation of personal value systems that ultimately guide actions through attitudes [9]. Behavior results from a combination of knowledge and attitudes, but their relationship is not directly causal [10]. The VAB model proposes that individual core values influence attitudes and beliefs, which, in turn, affect behavior. It emphasizes that values impact attitudes, form behavioral intentions, and initiate actions, illustrating an inside-out process [11]. In this study, individuals who value environmental protection may develop pro-environmental attitudes and actively take actions such as conserving energy and sorting waste to protect the environment.

One of the core concepts of VAB is value, which refers to consumers' overall evaluation of a product or service's usefulness based on their perception of the trade-off between benefits and costs [12]. This means the difference between the advantages they receive and the fees they pay. Perceived value—conceptualized as a mental notion—influences many positive outcomes, such as customer satisfaction or brand loyalty [13]. Sweeney and Soutar [14] identified four categories for consumers' multi-dimensional value evaluation: emotional value (the feelings consumers experience from buying a product); social value (the social image consumers gain from buying a product); price value (the monetary amount spent on purchasing a product); and quality value (consumers' perception and expected usefulness of the quality of the purchased product).

This study investigates the factors that influence the intention to use the TPASS commuter monthly pass. It considers both economic value and sustainable value. Economic value is similar to monetary value, which, in its simplest form, is the cost paid for a product or service [12]. Meanwhile, sustainable value pertains to consumers' consideration of corporate social responsibility and the environmental impact of products on sustainable development when purchasing goods or services [15].

2.2. The TRA model

The TRA is a theoretical model in social psychology that has been widely used to predict and explain human voluntary behavior [16]. Ajzen and Fishbein [16] proposed the TRA in 1975, whose core idea is that behavioral intention can predict actual behavior, with intention being influenced by two factors: personal attitude and subjective norms. Behavioral intention shows how consumers intend to act in specific situations. Attitude reflects consumers' overall positive or negative feelings about acting on a target. In contrast, subjective norms refer to individuals' perceptions of the expectations from those around them regarding that behavior [17].

The core of the theory assumes that consumer behavior is rational and involves systematic thinking. In other words, consumer purchasing behavior results from the information they acquire, followed by careful and organized consideration before taking action. Most importantly, the theory suggests that behavior is determined by individual voluntary control of the will. It is mainly used to predict individual behavior. Two primary factors influence behavioral intention and behavior: one is attitude toward the behavior, which refers to an individual's values or views about specific behavior, representing internal factors that influence behavior; the other is subjective norms related to behavior, which pertain to others or groups that influence individuals to act, representing social values or norms, i.e., external factors affecting behavior.

2.3. The proposed framework and hypotheses development

The TPASS initially focuses on three main metropolitan areas: the Keelung-Taipei-Taoyuan corridor in northern Taiwan, the Miaoli-Central Changhua-Taichung corridor in central Taiwan, and the Kaohsiung-Pingtung corridor in southern Taiwan. TPASS expanded to include 20 counties and cities nationwide, demonstrating the government's commitment to comprehensive

and sustainable transportation coverage [1]. TPASS was established with three primary objectives aligned with sustainable urban development principles: easing traffic for residents, shifting from private to public transportation, and increasing public transit capacity while reducing traffic accidents.

These objectives reflect a multifaceted transportation policy that addresses economic, environmental, and safety concerns simultaneously. With an annual budget of NT$9 billion, TPASS is a significant public investment in sustainable transportation infrastructure and behavioral change programs. Current usage data shows both successes and ongoing challenges. The average monthly number of users has stabilized at around 600,000, indicating consistent use among a core group [1]. However, regional analysis reveals notable differences. Users in the Keelung-Taipei-Taoyuan metro area account for about 80% of the nation's total usage, highlighting potential barriers in other regions and the necessity for targeted efforts to improve access and promote more balanced use across Taiwan.

Understanding the factors that influence TPASS adoption and continued use requires a solid theoretical base that explains the complex interaction among individual values, attitudes, and behavioral intentions. This study employs an integrated framework combining the VAB and TRA models to identify the determinants of behavioral intentions to use TPASS. The research constructs in this study are sustainable value and economic value, reflecting TPASS's dual appeal. Sustainable value signifies individuals' environmental awareness and dedication to ecological preservation, which are directly linked to transportation's environmental impact.

Economic value considers financial aspects that greatly affect transportation choices, especially given TPASS's cost-benefit advantages over traditional options. Incorporating the TRA model improves this understanding by including social influences through subjective norms, recognizing that transportation decisions often happen in social settings where peer influences and social expectations play a crucial role. The proposed framework is illustrated in Fig. 2.

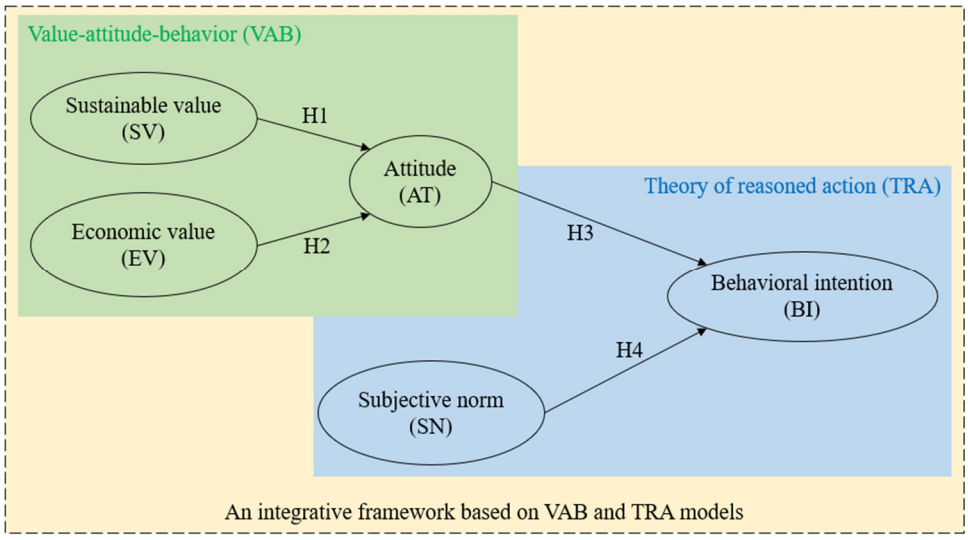

Fig. 2 Research framework

Sustainable value is an emerging concept in business management that aims to maximize profits while addressing environmental and social responsibilities to foster sustainable development for businesses, society, and the environment. Hartmann and Apaolaza Ibáñez [18] first clearly introduced the idea of sustainable value, emphasizing that consumers consider environmental features or ethical images of products when making purchasing decisions. Other research shows that environmental values influence attitudes and behaviors related to the environment. For instance, Tavitiyaman et al. [19] found that consumers with environmental values develop positive attitudes toward the environment and are more likely to buy green products. Mahmood et al. [20] demonstrated that consumers with these values tend to choose products with lower environmental impacts when faced with binary options, indicating that environmental values can predict preferences for environmentally friendly consumption.

Based on this review, the study suggests that values influence individuals' attitudes toward green transportation options, which in turn affect their likelihood of using them. In public transportation research, individuals' core environmental values shape their attitudes and behaviors regarding public transportation [21]. Therefore, this study proposes the following hypothesis:

H1: Sustainable value positively affects the attitude of TPASS.

Economic value is a key concept in economics, where the heart of economic activity is people's pursuit of utility maximization. Economic value mainly signifies the contribution of goods or services to individuals' well-being, as shown in the price they are willing to pay for these goods or services [22]. In marketing, monetary promotions often encourage consumers to see greater economic benefits [23]. When the price of products or services drops, consumers' perceived value increases, leading to higher purchase intentions. Regarding research on public transportation season tickets, Diab et al. [24] found that offering monthly ticket options increases bus ridership. Redman et al. [25] found that public transportation services can attract private car users by improving service quality—such as optimizing time, price, environmental, social, and emotional benefits, and lowering costs. Therefore, this study proposes the following hypothesis:

H2: Economic value positively affects the attitude of TPASS.

According to TRA, people's behavior depends on their attitudes toward those behaviors and subjective norms. Attitudes influence behavioral intention, but subjective norms can also significantly affect behavior [16]. TRA assumes that when a person has a positive attitude and believes that important people support this behavior, they are more likely to perform it. Additionally, individuals perceive significant others' views on the behavior, thereby forming normative beliefs. Subjective norms refer to people's perception of the level of expectation from those around them regarding that behavior [17]. When this perceived expectation is higher, the individual's intention to act increases. Therefore, this study proposes the following hypotheses:

H3: Attitude positively affects intention to use TPASS.

H4: Subjective norm positively affects intention to use TPASS.

3. Methodology

To ensure reliability and reproducibility, a thorough data collection and validation process was established. Data were collected through an anonymous online survey distributed via Google Forms from March 5 to April 9, 2024 (36 days). The study used a convenience sampling method to recruit potential and current users of public transport commuter passes in Taiwan. Details about data collection, configuration, and validation are provided below:

(1) Data acquisition and configuration. The survey link was distributed through a multi-channel digital approach to maximize outreach and diversity. Key channels included social media platforms targeting survey-exchange communities and academic research groups on Facebook. An additional physical distribution method using QR codes was also used to reach offline commuters. The online questionnaire was configured to prevent duplicate responses by restricting submissions to one per IP address.

(2) Validation of initial responses. To ensure data quality, strict screening criteria were applied to the initial response pool. Invalid responses were excluded based on the following criteria: incomplete questionnaires with missing data and straight-lining responses (i.e., selecting the same option across all items). As a result, 43 invalid responses were excluded, yielding 302 valid samples from 345 initial responses for the final analysis.

As shown in Table 1, the final sample (N = 302) consisted of males (74.2%). The age distribution revealed a younger group, with 80% of participants aged 30 or below (50.1% in the 21 to 30 age range and 29.9% under 20). The participants were highly educated, with 76.3% holding at least a college degree (43.5% with a college or university degree and 32.8% with

graduate or higher education). Occupationally, most were students (73.6%), followed by full-time employees (19.7%). Regarding usage experience, most (69.3%) had not yet purchased a TPASS, while 14.2% had made 1 to 2 purchases, 11.6% had made over five, and 4.9% had made 3 to 4 purchases. This suggests that, although the sample is well-educated and tech-savvy, overall engagement with the TPASS system remains at an early adoption stage.

Table 1 Summary of the demographic features of the research sample

	Characteristics	Number	Number percentage (%)
Gender	Female	89	25.8
	Male	256	74.2
Age	Under 20	103	29.9
	21 to 30	173	50.1
	31 to 40	23	6.7
	41 to 50	26	7.5
	51 to 60	16	4.6
	Over 61	4	1.2
Educational level	High school	82	23.8
	College/University	150	43.5
	Graduate school and above	113	32.8
Vocation	Full-time job	68	19.7
	Students	254	73.6
	Part-time job	12	3.5
	others	11	3.2
Number of TPASS purchases	0	239	69.3
	1 to 2	49	14.2
	3 to 4	17	4.9
	Over 5	40	11.6

The questionnaire used a 7-point Likert scale (1 = strongly disagree, 7 = strongly agree). All items were adapted from validated scales from existing literature and customized for the TPASS setting. Since the original instruments were in English, a standard back-translation process was conducted to ensure semantic equivalence between the English and Chinese versions. Three domain experts in information systems, tourism, and statistics reviewed the translated items to verify linguistic accuracy and contextual appropriateness.

Four items related to sustainable value were adapted from Izagirre-Olaizola et al. [26] and Haws et al. [27]; four items related to economic value were adapted from Rajh [28]. Concerning the antecedents of behavioral intention, four attitude items and three subjective norm items were adapted from Wang et al. [29] and Venkatesh et al. [30], respectively. Finally, three behavioral intention items were adapted from Venkatesh et al. [30].

4. Results

To test the research model, this study adopted a two-step structural equation modeling (SEM) approach using SmartPLS 4. In the first step, the measurement model was assessed through confirmatory factor analysis (CFA) with partial least squares (PLS), including descriptive statistics, reliability and validity testing, and correlation analysis. In the second step, PLS-SEM was employed to examine the structural relationships, given its established applicability in behavioral research involving prediction-oriented modeling.

4.1 Results of the measurement model

This study assesses the reliability and validity of the measures by analyzing factor loadings, composite reliability (CR), and average variance extracted (AVE). As shown in Table 2, the Cronbach's alpha and CR coefficients all surpass the accepted threshold of 0.7 (alpha ranging from 0.83 to 0.94; CR from 0.89 to 0.96), indicating that the items for each research construct

have internal consistency. Convergent validity is confirmed when all factor loadings of items within a construct exceed the threshold of 0.7 and are statistically significant. Additionally, all AVE values are above 0.5. As shown in Table 2, all items with high standardized factor loadings are statistically significant (factor loadings from 0.75 to 0.97, t values from 23.11 to 213.33). Furthermore, all AVE values are greater than 0.5 (ranging from 0.67 to 0.88).

Table 2 Results of reliability and validity assessments

Constructs	Items	Mean	S.D.	Factor loading	*t* value	Cronbach's α	CR	AVE
Sustainable value (SV)	SV1	5.22	1.36	0.81	29.41	0.83	0.89	0.67
	SV2	4.65	1.43	0.82	26.54			
	SV3	4.56	1.42	0.88	47.88			
	SV4	4.33	1.52	0.75	23.11			
Economic value (EV)	EV1	4.76	1.36	0.83	30.51	0.93	0.95	0.84
	EV2	5.20	1.28	0.95	131.99			
	EV3	5.25	1.27	0.95	134.26			
	EV4	5.08	1.31	0.93	92.26			
Attitude (AT)	AT1	5.43	1.21	0.92	77.23	0.94	0.96	0.86
	AT2	5.47	1.23	0.92	53.84			
	AT3	5.30	1.26	0.95	141.58			
	AT4	5.12	1.29	0.91	67.99			
Subjective norm (SN)	SN1	4.81	1.46	0.89	47.94	0.93	0.96	0.88
	SN2	4.51	1.48	0.97	213.33			
	SN3	4.47	1.52	0.96	169.91			
Behavioral intention (BI)	BI1	3.97	1.70	0.95	128.28	0.93	0.96	0.88
	BI2	4.57	1.64	0.92	67.86			
	BI3	4.11	1.71	0.95	141.97			

Note: S.D. = standard deviation; CR = composite reliability; AVE = average variance extracted

Discriminant validity is confirmed when the square root of AVE for each construct is greater than the off-diagonal elements in the same rows and columns. This standard, known as the Fornell-Larcker criterion, shows that each construct shares more variance with its own indicators than with those of other constructs, demonstrating that the constructs are empirically distinct.

As shown in Table 3, the square roots of AVE for all constructs ranged from 0.82 to 0.94, consistently higher than all corresponding off-diagonal correlation coefficients. Specifically, the diagonal values representing the square roots of AVE exceeded the highest inter-construct correlations in both the relevant rows and columns of the correlation matrix. This pattern was consistent across all constructs, indicating that each measure captures phenomena that are not better explained by any other construct.

Furthermore, the difference between the diagonal and off-diagonal values provides strong evidence of discriminant validity. The results show that, although the constructs may be theoretically related, they are empirically distinct and measure different underlying phenomena. This finding, along with the previously established convergent validity, confirms that the measurement instrument has proper psychometric properties and supports the reliability of subsequent analysis of the structural model.

Table 3 Results of the correlations between research constructs

Constructs	SV	EV	AT	SN	BI
Sustainable value (SV)	**0.82**	—	—	—	—
Economic value (EV)	0.57	**0.92**	—	—	—
Attitude (AT)	0.57	0.93	**0.93**	—	—
Subjective norm (SN)	0.53	0.70	0.70	**0.94**	—
Behavioral intention (BI)	0.42	0.59	0.55	0.75	**0.94**

Note: The diagonal value (bold) is the square root of AVE

4.2. Results of the structural model

With an appropriate measurement model in place, the study then tested the hypotheses. The coefficient of determination (R^2) values for attitude and behavioral intention were 78% and 50%, respectively. All four hypotheses were supported, confirming the validity of combining the VAB and TRA models. The results from the PLS analysis are shown in Fig. 3 and Table 4.

For the entire sample (N = 302), all hypotheses were supported. First, regarding sustainable value, it has a significant but weak effect on attitude ($\beta = 0.09$, $p < 0.05$), supporting H1. Economic value has a significant impact on attitude ($\beta = 0.83$, $p < 0.001$), supporting H2. When examining the effects of attitude and subjective norm on behavioral intention, attitude has a significant but weak effect ($\beta = 0.11$, $p < 0.05$; H3). In contrast, subjective norm has a significant impact on behavioral intention ($\beta = 0.63$, $p < 0.001$; H4). Both H3 and H4 are supported.

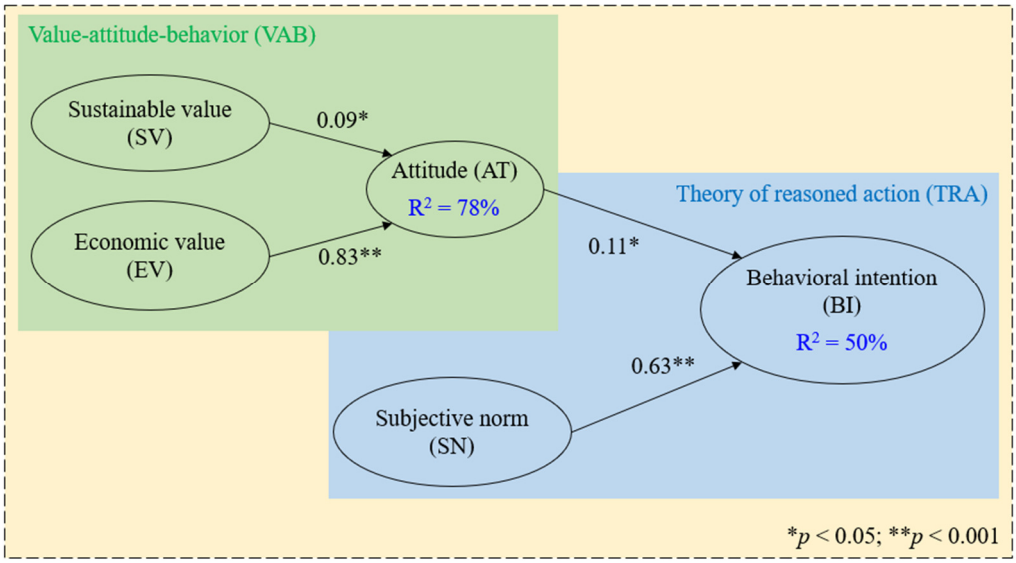

Fig. 3 Results of the proposed framework

Table 4 Results of hypothesis testing

Hypotheses	Path	Standardized coefficients	*t*-value	Results
H1	SV → AT	0.09*	2.46	Supported
H2	EV → AT	0.83**	32.05	Supported
H3	AT → BI	0.11*	2.00	Supported
H4	SN → BI	0.63**	11.78	Supported

Note: *$p < 0.05$; **$p < 0.001$

5. Discussion

This study combines the VAB and TRA models to examine factors influencing consumers' ongoing intention to use TPASS. The integrated model shows strong explanatory power, explaining 78% of the variance in attitude and 50% of the variance in behavioral intention. All four hypotheses are supported, confirming the validity of the integration and supporting the effects of sustainability and economic values on attitude, as well as the predictive roles of attitude and subjective norms in continuous usage intention.

Regarding attitude antecedents, sustainability values show a significant but weak positive impact, consistent with prior literature indicating that environmentally conscious consumers choose products with lower environmental impact [19-21]. Conversely, economic values have a significant positive effect on TPASS attitude, supporting the view that price promotions yield benefits [23-25]. Notably, economic values greatly exceed sustainability values, suggesting that economic considerations primarily influence TPASS usage attitudes, as practical financial benefits are more compelling.

For behavioral intention antecedents, attitude has a modest but positive effect, while subjective norms had a substantial, strong positive impact. These findings align with the core assumptions of the TRA [8, 17, 26], which state that positive attitudes and perceived social support boost behavioral intention. The effect of subjective norms greatly surpasses that of attitude, indicating that in TPASS decisions, social influence from significant others is a key factor, impacting intention more through group pressure than personal attitude.

This study find that economic value is the most important factor shaping attitudes toward TPASS usage. Policymakers should focus on highlighting economic benefits, comparing costs to private vehicle use, and providing clear data on long-term savings. Marketing efforts should underline key advantages such as cost savings and financial benefits. Improving pricing strategies or offering consumer incentives with TPASS could boost perceived value.

The results show that subjective norms significantly influence continuous usage intentions, far more than personal attitude. Policy promoters can harness social influence and peer effects by adopting strategies such as corporate group purchase discounts, community promotions, or group usage initiatives. Collaborating with large companies to promote collective TPASS use for commuting leverages workplace culture to boost usage rates.

Although the impact of sustainability values is relatively weak, the government should still recognize the importance of environmental education. A long-term strategy is advised, gradually increasing public awareness through school programs, media campaigns, and specific environmental benefit data. The government should implement segmented marketing tactics, highlighting economic benefits to price-sensitive groups while emphasizing sustainability values to those with higher environmental awareness.

6. Conclusions

This study examined how sustainable and economic values influence TPASS usage intention through an integrated framework based on the VAB and TRA models. The main findings are summarized as follows:

(1) Economic values have a much stronger impact on usage attitudes than sustainable values, while subjective norms significantly influence usage intention more than personal attitudes.

(2) The integration of VAB and TRA models provides a robust theoretical foundation, showing how individual values lead to sustainable transportation behaviors.

(3) From a practical perspective, understanding the relative importance of different values can guide more effective marketing and pricing strategies and improve TPASS policy implementation and user retention.

(4) This study contributes to global sustainable transportation policy by providing empirical evidence from a large-scale integrated transportation initiative in an East Asian context, which can inform similar urban settings worldwide.

Future studies could improve the generalizability of these findings by including benchmark experiments and comparative analyses across different contexts or populations. Experimental designs or longitudinal methods would aid researchers in establishing causal relationships and validating the predictive models developed in this study.

Conflicts of Interest

The authors declare no conflict of interest.

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