

Article

Research on MaaS Usage Intention and Influence Mechanism

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Abstract

To promote the sustainable development of urban smart transportation systems, this study constructs a structural equation model (SEM) based on the Technology Acceptance Model (TAM), incorporating extended variables including social influence, environmental awareness, privacy concerns, and service similarity to investigate users' behavioral intentions toward Mobility as a Service (MaaS). The research systematically examines key factors influencing user adoption behavior and their underlying mechanisms, providing theoretical foundations and practical guidance for optimizing MaaS system design and policy making. Using SEM as the core analytical framework, this study employs mediation analysis, moderation analysis, and multigroup comparison to empirically examine the direct and indirect effects among variables, as well as group heterogeneity. Data were collected through an online questionnaire survey, with Analysis of Variance (ANOVA) applied to identify the differential impacts of demographic and travel behavior characteristics on users' intentions and related psychological constructs, thereby supporting precise user segmentation and evidence-based policy interventions. Key findings include the following: (1) Social influence, ease of use, and environmental awareness boost MaaS adoption, while privacy concerns hinder it. (2) Freelancers/self-employed weaken the positive effects of usefulness, ease of use, and social influence on adoption. (3) Service similarity and ease of use effects vary significantly between single-mode and multimodal commuters. The findings extend the theoretical boundaries of TAM and provide both theoretical and practical support for the development of sustainable urban transportation systems.

Keywords: mobility as a service (MaaS); technology acceptance model; structural equation model; mediating effect; moderating effect



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1. Introduction

In recent years, the rapid development of socioeconomics and significant improvement in living standards have led to increasingly diversified public demand for urban mobility services. Coupled with the agglomeration effects resulting from accelerated urbanization, traffic congestion has extended from traditional megacities to regional central cities [1]. Concurrently, environmental externalities in the transportation sector have become increasingly prominent. As critical infrastructure supporting global economic activities, the movement of people and goods, while facilitating economic development, has also posed severe environmental challenges [2].

Against the backdrop of deep integration between mobile internet technologies and the digital economy, the urban transportation sector is undergoing profound paradigm shifts. The maturation of technologies such as the Internet of Things (IoT), big data,

and artificial intelligence (AI) has provided critical technological infrastructure for the development of intelligent transportation systems [3]. Innovative models such as new energy vehicles, car-sharing, and ride-pooling services have emerged continuously. The sharing economy has entered public discourse [4], demonstrating remarkable potential in optimizing idle resources and facilitating green, shared mobility—attributes that have earned it widespread acclaim. It is within this context that Mobility as a Service (MaaS) has emerged as a transformative solution.

Mobility as a Service (MaaS) seeks to enhance the overall efficiency of urban transportation systems by systematically integrating fragmented mobility resources and service components to develop comprehensive, user-oriented travel solutions. As an emerging smart mobility paradigm, MaaS faces multiple implementation challenges, including privacy security concerns, usage complexity, and service integration barriers, which necessitate in-depth investigation of its adoption mechanisms from user behavior theoretical perspectives [5,6].

Existing research demonstrates that psychological cognitive factors exert multidimensional and multilevel influences on MaaS adoption intentions. From a technology acceptance perspective, perceived usefulness and perceived ease of use constitute fundamental cognitive dimensions shaping users' evaluation of MaaS systems. Schikofsky et al. emphasize that understanding the underlying determinants and mechanisms of MaaS adoption is crucial for designing effective market strategies. Their findings reveal that perceived usefulness, perceived ease of use, and hedonic motivation significantly affect adoption intentions, with perceived ease of use additionally exerting indirect effects through hedonic motivation [7]. Lopez-Carreiro et al.'s comparative study in the Netherlands and Spain identified privacy concerns, environmental awareness, and technology affinity as critical antecedents of MaaS adoption. Notably, their Dutch subsample analysis further established service reliability as a significant influencing factor [8,9]. Complementing these findings, Matowicki et al.'s multinational investigation in England and Germany confirmed that environmentally conscious individuals exhibit more positive attitudes toward MaaS, while sharing willingness and positive social influences further enhance adoption likelihood [10].

Concurrently, empirical studies confirm that users' socioeconomic characteristics and travel attributes jointly constitute core determinants influencing mobility decision-making processes. These factors not only significantly affect conventional travel mode preferences but also systematically shape usage intentions and behavioral patterns toward MaaS. Willy Kriswardhana et al. employed Latent Class Cluster Analysis (LCCA) to examine preference segmentation in MaaS adoption. Their model revealed that females, high-income groups, and shared mobility users demonstrated higher MaaS adoption probabilities, while public transport users and occupational status showed negligible effects [11]. Complementing these findings, Nikiforiadis et al.'s Greek case study identified stronger MaaS adoption tendencies among younger demographics and higher-income cohorts. Notably, frequent taxi users exhibited particularly pronounced usage intentions [12]. These collective findings substantiate the significant impacts of users' socioeconomic profiles and travel characteristics on MaaS adoption dynamics.

Building upon this foundation, the present study focuses on investigating the influence mechanisms of six key variables—perceived ease of use, perceived usefulness, social influence, environmental awareness, privacy concerns, and service similarity—on MaaS adoption intention. Specifically, the research objectives encompass the following:

1. Constructing an integrated model to systematically examine both the direct effects and interaction effects among these variables;
2. Conducting in-depth analysis of the mediating roles between perceived usefulness/perceived ease of use and usage intention;

3. Investigating the moderating effects of demographic variables on core pathways.

2. Research Models and Hypothesis

This study establishes a structural equation model (SEM) of MaaS adoption intention among Shanghai residents, grounded in the Technology Acceptance Model (TAM) and augmented by the Theory of Planned Behavior (TPB) and the Unified Theory of Acceptance and Use of Technology (UTAUT). Building upon the core TAM constructs of perceived usefulness (PU) and perceived ease of use (PEU), the research framework incorporates four extended variables: social influence (SI), privacy concerns (PC), environmental awareness (EA), and service similarity (SS). This integrated model systematically examines their collective impact mechanisms on behavioral intention (BI) toward MaaS services in Shanghai.

2.1. Base Variables

Perceived ease of use (PEU), perceived usefulness (PU), and behavioral intention (BI) constitute the fundamental constructs of the Technology Acceptance Model (TAM). For MaaS systems in their nascent development stage, consumers' cognitive evaluations and usage experiences of the platform are particularly critical. Consequently, both users' attitudes toward MaaS and their perceived platform usability serve as viable predictors of adoption intention. Furthermore, social influence (SI), privacy concerns (PC), environmental awareness (EA), and service similarity (SS) emerge as significant additional determinants of usage intention. The research framework and corresponding hypotheses are presented in Figure 1 and Table 1, respectively.

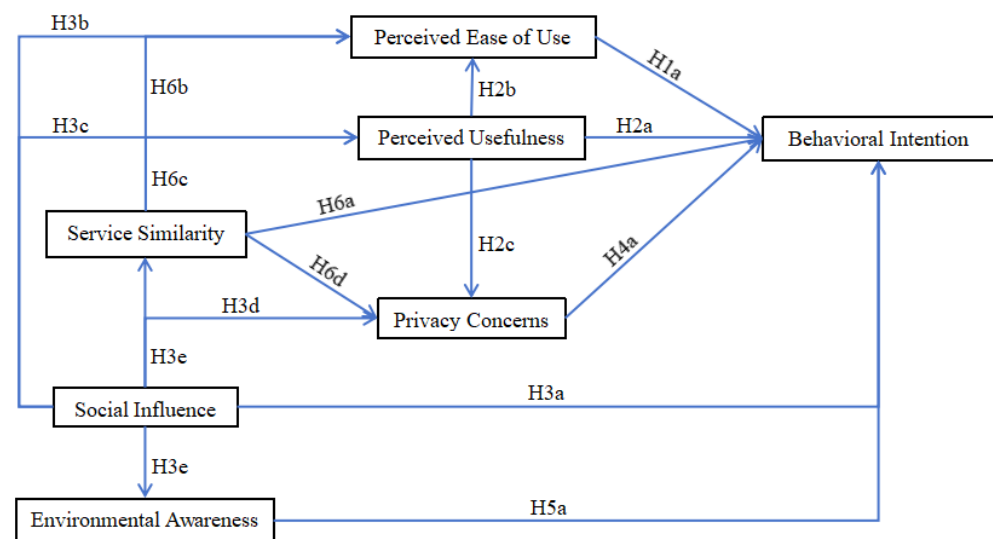


Figure 1. SEM model of MaaS usage intention based on TAM extension.

Perceived usefulness (PU): This construct refers to users' subjective evaluation of the benefits derived from adopting a specific technology or service. Within the mobility context, PU encompasses multidimensional advantages including time savings, cost reduction, and enhanced comfort and convenience [12,13].

Perceived ease of use (PEU): This construct refers to the degree of ease that a user expects when using a technology, that is, the user's subjective feeling of how difficult or effortless it will be to use the technology, such as the ease or difficulty of understanding and learning its concepts and operational techniques [14–16].

Table 1. Research hypotheses summary.

Hypothesis	Path
H1a	Perceived Ease of Use → Behavioral Intention (+)
H2a	Perceived Usefulness → Behavioral Intention (+)
H2b	Perceived Usefulness → Perceived Ease of Use (+)
H3a	Social Influence → Behavioral Intention (+)
H3b	Social Influence → Perceived Ease of Use (+)
H3c	Social Influence → Perceived Usefulness (+)
H2c	Perceived Usefulness → Privacy Concerns (+)
H3d	Social Influence → Privacy Concerns (−)
H4a	Privacy Concerns → Behavioral Intention (−)
H3e	Social Influence → Environmental Awareness (+)
H5a	Environmental Awareness → Behavioral Intention (+)
H6a	Service Similarity → Behavioral Intention (+)
H6b	Service Similarity → Perceived Ease of Use (+)
H6c	Service Similarity → Perceived Usefulness (+)
H6d	Service Similarity → Privacy Concerns (+)
H6e	Social Influence → Service Similarity (+)

2.2. Extended Variables

Social influence (SI): Refers to the extent to which an individual feels influenced by the surrounding group. In other words, when people develop needs and take actions, they often refer to the behavior of others and are affected by them. Psychology suggests that individuals exhibit conformity behavior within groups, and people may use MaaS due to recommendations from friends or the media [17,18].

Privacy concerns (PCs): According to privacy calculus theory, privacy concerns refer to users' subjective worries about the potential misuse of their personal data during its collection, utilization, and protection [19]. In the context of MaaS, such concerns are further amplified. Since MaaS requires the integration of highly sensitive data—such as users' real-time locations, travel history, and payment information—to deliver personalized mobility solutions, users may worry about the security of this data and whether it might be used for purposes beyond their expectations (e.g., being sold to third parties or used for user profiling). In this study, privacy concerns specifically refer to the extent of users' apprehension regarding security risks and potential misuse of their travel-related personal information by MaaS platforms [20–24].

Environmental awareness (EA): Environmental awareness refers to people's understanding and concern about environmental issues, as well as their willingness to take actions to reduce negative impacts on the environment. MaaS can reduce the use of private cars, promote the development of sustainable transportation, and positively impact transportation-related carbon emissions. Therefore, it tends to attract groups with strong environmental awareness [25,26].

Service similarity (SS): This study draws on analogical learning theory [27] and defines service similarity as the extent to which users perceive similarities between the MaaS platform and other digital services they have previously used (such as navigation software, ride-hailing apps, and e-commerce platforms) in terms of interface design, functional logic, and core concepts. For emerging services like MaaS, their conceptual and operational aspects may appear ambiguous to users. A high degree of service similarity can reduce users' learning costs and cognitive burden by activating their existing mental models, enabling them to more quickly understand the value of MaaS and develop usage intentions [28].

3. Questionnaire Design and Data Collection

This study conducted an online survey through a professional questionnaire platform (Wenjuanxing). The measurement scales used in the survey were primarily adapted from well-established and validated scales in existing domestic and international literature. Wording adjustments were made to fit the specific context of MaaS and the Chinese linguistic environment to ensure content validity. Prior to the large-scale formal distribution, a small-scale pilot test was carried out. Based on the results of the pilot test, minor revisions were made to the wording of certain items. A total of 266 valid questionnaires were ultimately collected in Shanghai. The questionnaire comprised four sections: (1) MaaS concept introduction (combining text, images, and videos); (2) usage intention (measured by 5-point Likert scale); (3) travel characteristics; and (4) socioeconomic characteristics. The scales were adapted from established studies with demonstrated content validity. The complete questionnaire items are provided in Appendix A.

3.1. Descriptive Statistical Analysis

Analysis of the sample's individual economic characteristics shows that the gender ratio is basically balanced. The majority of respondents are between 25 and 44 years old, accounting for 87.98%. Regarding education, most respondents hold a bachelor's or associate degree, making up 88.61%. In terms of occupation, employees of enterprises and public institutions constitute the vast majority, at 93.04%. Concerning economic status, most have a monthly income exceeding CNY 5000, accounting for 94.94%. Additionally, 84.81% of respondents have a driver's license, and 84.18% own a private car.

Analysis of sample travel characteristics shows that, in terms of travel purpose, commuting to and from work is the primary reason for travel, accounting for 91.77%. Regarding travel frequency, most people travel 2–3 times per day, making up 87.97%. In terms of travel distance, trips over 5 km are the most common, accounting for 70.89%, with 5–10 km trips at 30.38% and trips over 10 km at 40.51%. As for travel mode, respondents most frequently use public transportation, accounting for 70.89%. Regarding travel expenses, the majority fall within the range of CNY 300 to 1000, accounting for 58.86%. Additionally, compared to single-mode travel, multimodal travel combinations are more common, making up 67.72%. Commute durations are generally concentrated between 30 and 60 min, accounting for 50.63%. Looking at private car usage frequency, using a car up to twice a week is most common, at 60.13%. In terms of evaluations of transportation costs and transfer facilities, most respondents gave positive feedback: 56.33% consider transportation costs reasonable, and 63.92% find transfer facilities convenient, indicating a generally high level of satisfaction with current transportation costs and transfer facilities among respondents.

3.2. Reliability and Validity Analysis

Reliability refers to the consistency, stability, and dependability of measurement results. It is generally represented by internal consistency to indicate the level of reliability. Cronbach's alpha (Cronbach's α) is commonly used as the measurement index.

Validity refers to the effectiveness of a measurement tool or method, indicating the extent to which it can accurately measure the intended subject. Common methods for assessment include the KMO value and Bartlett's test of sphericity. Construct validity can be divided into convergent validity and discriminant validity. Convergent validity refers to whether different indicators or items of a measurement tool can cluster around the same underlying construct. In other words, it examines the internal consistency and reliability of the measurement tool. Common indicators of convergent validity include the Average Variance Extracted (AVE) and Composite Reliability (CR), with typical requirements being an AVE greater than 0.5 and a CR value greater than 0.7.

Discriminant validity (also known as divergent validity) refers to the ability of a measurement tool to distinguish between different latent traits or concepts. It ensures that the different dimensions or factors of the measurement tool have sufficient independence and are not confused with each other. Discriminant validity can be assessed by comparing the correlation coefficients between different latent variables, typically requiring that the square root of the Average Variance Extracted (AVE) for a latent variable be greater than its correlations with other variables.

As shown in Table 2, the AVE values for perceived ease of use (AVE = 0.501, CR = 0.751), perceived usefulness (AVE = 0.503, CR = 0.752), behavioral intention to use (AVE = 0.502, CR = 0.750), social influence (AVE = 0.506, CR = 0.754), privacy concerns (AVE = 0.832, CR = 0.937), environmental awareness (AVE = 0.504, CR = 0.751), and service similarity (AVE = 0.670, CR = 0.859) are all greater than 0.5, and their CR values are all above 0.7, indicating that the scales have good convergent validity.

Table 2. Results of reliability and validity analysis.

Variable	Measurement Items	Factor Loading	AVE	CR	Cronbach's α
PEU	PEU1	0.716	0.501	0.751	0.747
	PEU2	0.676			
	PEU3	0.731			
PU	PU1	0.741	0.503	0.752	0.751
	PU2	0.723			
	PU3	0.663			
BI	BI1	0.646	0.502	0.750	0.749
	BI2	0.688			
	BI3	0.785			
SI	SI1	0.698	0.506	0.754	0.754
	SI2	0.704			
	SI3	0.731			
PC	PC1	0.886	0.832	0.937	0.936
	PC2	0.930			
	PC3	0.920			
EA	EA1	0.653	0.504	0.751	0.746
	EA2	0.673			
	EA3	0.795			
SS	SS1	0.825	0.670	0.859	0.858
	SS2	0.854			
	SS3	0.776			

According to Table 3, the square roots of the AVE values for each factor are greater than the maximum absolute values of the inter-factor correlation coefficients, demonstrating good discriminant validity of the scales. Based on the above analyses, the scales used in this study have passed reliability and validity tests and can be used for modeling and analyzing the intention to use MaaS.

Table 3. Results of discriminant validity test.

	PEU	PU	BI	SI	PC	EA	SS
PEU	0.708						
PU	0.459	0.709					
BI	0.487	0.482	0.709				

Table 3. *Cont.*

	PEU	PU	BI	SI	PC	EA	SS
SI	0.353	0.476	0.561	0.711			
PC	−0.238	−0.247	−0.348	−0.254	0.912		
EA	0.367	0.288	0.478	0.391	−0.179	0.710	
SS	0.073	0.078	0.117	0.171	0.115	0.004	0.819

Note: The diagonal blue background is the square root value of AVE.

4. Results

4.1. Variance Analysis

Analysis of Variance (ANOVA) is a statistical method used to test differences in sample means. To explore differences in the acceptance of MaaS among different demographic groups and provide a foundation for subsequent moderation effects and multigroup analysis, this study conducted an Analysis of Variance (ANOVA). The selection of grouping variables was based on existing literature and potential application scenarios of MaaS; both demographic characteristics and travel attributes are important factors influencing residents' willingness to use MaaS. The research findings will provide empirical evidence for developing a user segmentation model for MaaS services, thereby supporting the formulation of differentiated service strategies [29–32].

4.1.1. MaaS Travel Service Usage Intention Variance Analysis

As shown in Table 4, among individual economic characteristics, there are differences in the willingness to use MaaS travel services based on education level, occupation, and whether the individual holds a driver's license.

Table 4. Results of one-way ANOVA of individual socioeconomic characteristics.

Variable	Item	Mean ± Standard Deviation	F Test	One-Way Analysis of Variance
Education	High school (including secondary school) and below	3.78 ± 0.50	0.832	0.009 **
	Bachelor's degree or junior degree	4.30 ± 0.50		
	Master or above	4.11 ± 0.46		
Occupation	Enterprise staff	4.29 ± 0.49	0.600	0.031 *
	Public institution	4.06 ± 0.63		
	Administrative body	3.44 ± 0.51		
	Student	4.22 ± 0.50		
Driver's license	Freelancers/self-employed individuals	4.28 ± 0.71	0.107	0.034 *
	Yes	4.24 ± 0.51		
	No	4.43 ± 0.44		

Note: * $p < 0.05$; ** $p < 0.01$.

The highest willingness was among university/college graduates (frequent commuters, high tech acceptance) and the lowest in high school or below groups. And corporate employees showed strongest preference (commute-sensitive), while government staff ranked lowest (possibly due to shuttle bus benefits). Non-license holders exhibited greater preference (reliant on public transit, favoring multimodal integration).

As shown in Table 5, within travel attributes, there are differences in the willingness to use MaaS travel services based on different travel purposes, travel distances, commonly used transportation modes, and commuting durations.

Table 5. Results of one-way ANOVA on travel attributes.

Variable	Item	Mean $\pm$ Standard Deviation	F Test	One-Way Analysis of Variance
Travel purpose	Commuting	4.30 $\pm$ 0.50	0.354	0.000 **
	Entertainment	3.67 $\pm$ 0.37		
	Shopping	4.27 $\pm$ 0.43		
Travel distance	<3 km	4.16 $\pm$ 0.52	0.632	0.000 **
	3–5 km	4.08 $\pm$ 0.46		
	5–10 km	4.24 $\pm$ 0.49		
	>10 km	4.45 $\pm$ 0.50		
Common traffic tools	Public transportation	4.32 $\pm$ 0.48	0.394	0.012 *
	Taxi/ride-hailing	3.94 $\pm$ 0.59		
	Private car	4.29 $\pm$ 0.55		
	Bikes/shared bikes	3.86 $\pm$ 0.38		
	Walk	4.00 $\pm$ 0.54		
	Shared electric bike	4.33 $\pm$ 0.47		
	Others	3.83 $\pm$ 0.71		
Commuting Time	<15 min	3.95 $\pm$ 0.47	0.218	0.024 *
	15–30 min	4.21 $\pm$ 0.54		
	30–60 min	4.31 $\pm$ 0.47		
	>60 min	4.42 $\pm$ 0.53		

Note: * $p < 0.05$; ** $p < 0.01$.

MaaS usage intention was significantly higher for commuting trips (rigid demand) than leisure trips. Long-distance travelers (>10 km requiring transfers) showed the strongest preference, while mid-range trips (3–5 km) ranked lowest. Public transport and e-scooter users exhibited greater acceptance than taxi/ride-hailing users, with willingness increasing proportionally to commute duration (driven by time-saving demands).

Research shows that the advantages of MaaS travel services in integrated services (such as multimodal transport and time optimization) are attractive for addressing rigid pain points (such as transfer hassles and low efficiency). The willingness to use is lowest among government agency groups, which is speculated to be because they enjoy fixed commuting benefits (such as shuttle buses) and need to be reached through customized services.

4.1.2. Environmental Awareness Variance Analysis

As shown in Table 6, differences in environmental willingness were observed across groups with different education levels and driving license ownership. Highly educated individuals showed weaker environmental willingness, while those without a driving license demonstrated stronger environmental consciousness. Among travel purposes, leisure and recreational travelers exhibited the lowest environmental awareness, whereas shopping travelers displayed the highest. Multimodal transport users demonstrated stronger environmental awareness compared to single-mode private car commuters.

Regarding the counterintuitive finding that highly educated groups exhibited lower environmental awareness, we posit that in the research sample, highly educated individuals were predominantly concentrated among enterprise and institutional employees. As the main demographic of commuters, they may prioritize pragmatic factors such as time reliability, convenience, and comfort in their daily travel decisions, rather than environmental attributes. This suggests that in high-pressure commuting scenarios, environmental motivations may be superseded by more immediate practical needs, rather than reflecting an inherently low level of environmental awareness. This phenomenon highlights that,

in promoting the development of MaaS, addressing users' practical travel pain points is equally crucial alongside enhancing environmental awareness.

Table 6. Results of one-way ANOVA of environmental awareness.

Variable	Item	Mean $\pm$ Standard Deviation	F Test	One-Way Analysis of Variance
Education	High school (including secondary school) and below	4.33 $\pm$ 0.70	0.140	0.040 *
	Bachelor's degree or junior degree	4.26 $\pm$ 0.50		
	Master or above	4.00 $\pm$ 0.63		
Driver's license	Yes	4.20 $\pm$ 0.53	0.174	0.004 **
	No	4.46 $\pm$ 0.45		
Travel purpose	Commuting	4.25 $\pm$ 0.51	0.264	0.043 *
	Entertainment	3.90 $\pm$ 0.68		
	Shopping	4.40 $\pm$ 0.43		
Commuting mode	Single mode	4.11 $\pm$ 0.57	0.071	0.004 **
	Multimode combination	4.30 $\pm$ 0.49		

Note: * $p < 0.05$; ** $p < 0.01$.

4.1.3. Social Influence Variance Analysis

As shown in Table 7, there are significant differences in the degree of social influence among different occupational groups and travel expense groups.

Table 7. Results of one-way ANOVA of social influence.

Variable	Item	Mean $\pm$ Standard Deviation	F Test	One-Way Analysis of Variance
Occupation	Enterprise staff	4.28 $\pm$ 0.51	0.147	0.013 *
	Public institution	3.94 $\pm$ 0.74		
	Administrative body	3.56 $\pm$ 0.51		
	Student	4.33 $\pm$ 0.63		
	Freelancers/self-employed individuals	3.89 $\pm$ 0.50		
Travel cost	CNY >1000	4.27 $\pm$ 0.60	0.078	0.021 *
	CNY 300–1000	4.31 $\pm$ 0.49		
	CNY <300	4.11 $\pm$ 0.58		

Note: * $p < 0.05$.

Occupational differences were significant: Government staff were least influenced by social factors, whereas corporate employees and students showed the highest susceptibility (workplace carpool culture/peer effects). The group with monthly transport expenditures of CNY 300–1000 exhibited the strongest social influence (commuting necessity, homogeneous decision-making patterns).

The analysis suggests that in promoting MaaS (Mobility as a Service), it is important to leverage the social network effects of students and corporate employees and to design differentiated social communication strategies based on consumer segmentation.

4.1.4. Privacy Concerns Variance Analysis

As shown in Table 8, there are highly significant differences in privacy concerns among groups with different numbers of private cars, travel distances, and commonly used transportation modes, indicating that these factors have a significant impact on users' levels of privacy concern.

Table 8. Results of one-way ANOVA on privacy concerns.

Variable	Item	Mean $\pm$ Standard Deviation	F Test	One-Way Analysis of Variance
Number of private cars	0	2.95 $\pm$ 1.17	0.383	0.004 **
	1	2.78 $\pm$ 1.24		
	≥ 2	3.57 $\pm$ 1.11		
Travel distance	<3 km	3.58 $\pm$ 0.99	0.240	0.000 **
	3–5 km	3.36 $\pm$ 1.17		
	5–10 km	2.71 $\pm$ 1.23		
	>10 km	2.58 $\pm$ 1.19		
Common traffic tools	Public transportation	2.66 $\pm$ 1.22	0.597	0.001 **
	Taxi/ride-hailing	3.12 $\pm$ 1.01		
	Private car	3.40 $\pm$ 1.21		
	Bikes/shared bikes	3.71 $\pm$ 1.04		
	Walk	3.50 $\pm$ 1.00		
	Shared electric bike	3.42 $\pm$ 1.20		
Travel cost	CNY >1000	2.45 $\pm$ 1.40	0.148	0.001 **
	CNY 300–1000	2.77 $\pm$ 1.21		
	CNY <300	3.28 $\pm$ 1.14		
Commuting mode	Single mode	3.22 $\pm$ 1.20	0.782	0.002 **
	Multimode combination	2.72 $\pm$ 1.22		
Commuting Time	<15 min	3.15 $\pm$ 1.17	0.576	0.002 **
	15–30 min	3.26 $\pm$ 1.18		
	30–60 min	2.63 $\pm$ 1.20		
	>60 min	2.80 $\pm$ 1.33		
Private Car Usage Frequency	Almost every day	3.45 $\pm$ 1.25	0.631	0.018 *
	2 times per week or less	2.73 $\pm$ 1.24		
	3–6 times a week	3.00 $\pm$ 1.19		

Note: * $p < 0.05$; ** $p < 0.01$.

Households with multiple vehicles (≥ 2) exhibited the strongest privacy concerns due to cross-platform data exposure risks, while single-vehicle owners showed the lowest concerns owing to fixed travel routines. Short-distance travelers (<3 km) demonstrated heightened privacy awareness from frequent visits to sensitive locations (e.g., homes/hospitals), with concerns diminishing as distance increased. Pedestrians/cyclists, unaccustomed to digital services, were most sensitive to data collection, whereas bus riders had minimal concerns given the anonymity of mass transit. Low-frequency users distrusted platforms more due to limited engagement, whereas multimodal users perceived lower risks through data fragmentation across platforms.

4.1.5. Service Similarity Variance Analysis

As shown in Table 9, there are significant differences in service similarity based on whether individuals hold a driver's license, their travel frequency, commuting time, and private car usage frequency.

Drivers (perceiving MaaS as “enhanced navigation”) reported significantly higher service similarity than non-drivers (reliant on public transit/walking). Frequent travelers exhibited reinforced similarity cognition through repeated use of core features (e.g., real-time navigation). Commuters with ≤ 15 min trips (using basic functions) showed the highest similarity perception, while those with 30–60 min trips (requiring complex inter-modal coordination) scored lowest. Moderate-frequency private car users (3–6 trips/week) demonstrated peak similarity recognition, whereas heavy users developed differentiation

perceptions due to specialized function dependence, and low-frequency users displayed insufficient feature exploration.

Table 9. Results of one-way ANOVA for service similarity.

Variable	Item	Mean $\pm$ Standard Deviation	F Test	One-Way Analysis of Variance
Driver's license	Yes	3.69 $\pm$ 0.78	0.071	0.000 **
	No	3.09 $\pm$ 0.91		
Travel frequency	>6	3.40 $\pm$ 0.92	0.163	0.000 **
	4–6	3.73 $\pm$ 0.97		
	2–3	3.66 $\pm$ 0.79		
	≤ 1	2.83 $\pm$ 0.83		
Commuting Time	<15 min	3.90 $\pm$ 0.58	0.094	0.044 *
	15–30 min	3.76 $\pm$ 0.78		
	30–60 min	3.48 $\pm$ 0.87		
	>60 min	3.58 $\pm$ 0.79		
Private Car Usage Frequency	Almost every day	3.45 $\pm$ 0.75	0.640	0.009 **
	2 times per week or less	3.49 $\pm$ 0.80		
	3–6 times a week	3.80 $\pm$ 0.85		

Note: * $p < 0.05$; ** $p < 0.01$.

4.2. Structural Equation Model Calculation Results

This paper constructs an extended TAM model based on research hypotheses, as shown in Table 10 and Figure 2. Except for hypotheses H2a, H2c, H3b, H6a, H6b, and H6c, all other hypotheses are supported. Perceived ease of use, social influence, and environmental awareness all have a significant positive impact on the intention to use MaaS travel services, while privacy concerns have a significant negative impact on the intention to use MaaS. Additionally, social influence significantly affects perceived usefulness, environmental awareness, privacy concerns, and service similarity. Service similarity indirectly affects the intention to use MaaS travel services by influencing privacy concerns. According to Table 11, seven fit statistics were selected: chi-square to degrees of freedom ratio, PGFI, RMSEA, RMR, CFI, and NNFI. All indicators meet the requirements, indicating good model fit.

Table 10. Path analysis results.

	Path	Nonstandard Coefficient	SE	Z (CR Value)	p	Standardization Coefficient	Result
H1a	PEU $\rightarrow$ BI	0.269	0.069	3.920	0.000	0.294	Yes
H2a	PU $\rightarrow$ BI	-	-	-	-	-	No
H2b	PU $\rightarrow$ PEU	0.594	0.084	7.047	0.000	0.627	Yes
H3a	SI $\rightarrow$ BI	0.463	0.098	4.719	0.000	0.481	Yes
H3b	SI $\rightarrow$ PEU	-	-	-	-	-	No
H3c	SI $\rightarrow$ PU	0.761	0.101	7.551	0.000	0.687	Yes
H2c	PU $\rightarrow$ PC	-	-	-	-	-	No
H3d	SI $\rightarrow$ PC	-0.987	0.196	-5.040	0.000	-0.377	Yes
H4a	PC $\rightarrow$ BI	-0.054	0.021	-2.516	0.012	-0.147	Yes
H3e	SI $\rightarrow$ EA	0.509	0.087	5.830	0.000	0.536	Yes
H5a	EA $\rightarrow$ BI	0.234	0.080	2.921	0.003	0.231	Yes
H6a	SS $\rightarrow$ BI	-	-	-	-	-	No

Table 10. Cont.

	Path	Nonstandard Coefficient	SE	Z (CR Value)	p	Standardization Coefficient	Result
H6b	SS → PEU	-	-	-	-	-	No
H6c	SS → PU	-	-	-	-	-	No
H6d	SS → PC	0.304	0.099	3.076	0.002	0.206	Yes
H6e	SI → SS	0.351	0.132	2.658	0.008	0.197	Yes

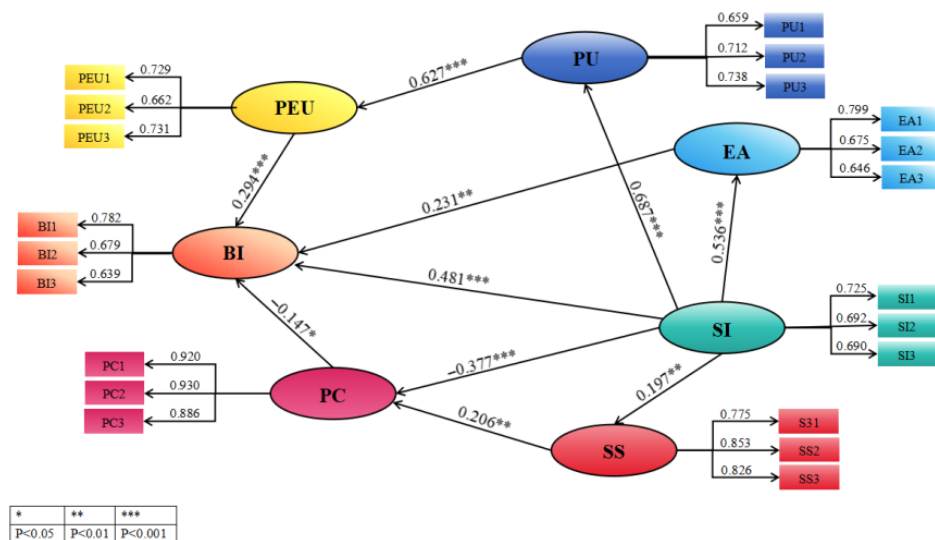


Figure 2. Path analysis results.

Table 11. Model fitting index.

Common Index	χ^2/df	GFI	RMSEA	RMR	CFI	NFI	NNFI
Judgment criteria	<3	>0.9	<0.10	<0.05	>0.9	>0.9	>0.9
Value	1.080	0.936	0.017	0.030	0.994	0.926	0.993

4.3. Mediation Effect Analysis Results

To explore the complex intrinsic mechanisms in users' adoption decisions regarding MaaS, we propose the following research question: Do variables such as perceived usefulness and service similarity indirectly influence users' behavioral intention through mediating variables like perceived ease of use and privacy concerns? Investigating this question will help reveal the deeper psychological pathways affecting MaaS adoption and provide a more nuanced understanding of the underlying dynamics. In this study, the Bootstrap sampling method was used to test the indirect effects of independent variables on the willingness to use MaaS. The number of resampling iterations was set to 5000, and both Bias-corrected and Percentile confidence intervals were set at 95%. The analysis results are as follows.

4.3.1. Mediating Effect Test of Service Similarity

As shown in Table 12, with perceived usefulness, perceived ease of use, environmental awareness, and social influence set as control variables, the mediation effect test results indicate that paths a and b are significant, while path c' is not significant, demonstrating a full mediation effect.

Table 12. Results of mediating effect test (1).

Item	c	a	b	a*b	a*b (Boot SE)	a*b (z Value)	a*b (p Value)	a*b (95% BootCI)	c'	Result
SS $\Rightarrow$ PC $\Rightarrow$ BI	0.018	0.271 **	−0.052 **	−0.014	0.012	−1.140	0.254	−0.054–−0.006	0.032	Full mediation

* $p < 0.05$; ** $p < 0.01$.

4.3.2. Mediating Effect Test of Social Influence

As shown in Table 13, the 95% confidence interval (BootCI) for the indirect effect values does not include zero, indicating that the mediation effect is significant. The results reveal the following:

1. Social influence affects the intention to use through privacy concerns and environmental awareness, with effects in the same direction. This indicates that social influence has a significant positive impact on usage intention (by reducing privacy concerns and enhancing environmental awareness).
2. Social influence forms a chain mediation through the cognitive variables of the Technology Acceptance Model: social influence $\rightarrow$ perceived usefulness $\rightarrow$ perceived ease of use $\rightarrow$ usage intention. This pathway shows that social influence first strengthens perceived usefulness, which then enhances perceived ease of use, ultimately promoting the intention to use MaaS travel services. This finding confirms the applicability of the Technology Acceptance Model in the MaaS context and reveals the role of social norms in shaping technology perceptions.
3. A complex pathway involving service similarity was identified: social influence $\rightarrow$ service similarity $\rightarrow$ privacy concerns $\rightarrow$ usage intention. This chain mediation indicates that social influence increases the perception of service similarity, which in turn heightens privacy concerns, thereby inhibiting the intention to use MaaS travel services.

Table 13. Results of mediating effect test (2).

Item	Effect	Boot SE	BootLLCI	BootULCI	z	p
SI $\Rightarrow$ EA $\Rightarrow$ BI	0.081	0.024	0.041	0.136	3.362	0.001
SI $\Rightarrow$ PC $\Rightarrow$ BI	0.031	0.013	0.010	0.063	2.297	0.022
SI $\Rightarrow$ SS $\Rightarrow$ PC $\Rightarrow$ BI	−0.006	0.004	−0.015	−0.001	−1.693	0.090
SI $\Rightarrow$ PU $\Rightarrow$ PEU $\Rightarrow$ BI	0.047	0.014	0.025	0.080	3.362	0.001

4.3.3. Mediating Effect Test of Perceived Usefulness

As shown in Table 14, with social influence, environmental awareness, privacy concerns, and service similarity set as control variables, when perceived ease of use is not included as a mediating variable in the model, the regression coefficient of perceived usefulness on usage intention (i.e., the total effect) is 0.233. When the mediating variable is present, the direct effect c' is 0.162, and the mediating effect values are 0.072, indicating a partial mediation effect. There are discrepancies in this part of the analysis between the SEM model and the mediation effect test. After subsequent moderation analysis and multi-group analysis, it was found that group heterogeneity (commuting mode) is the reason for these differences.

Table 14. Results of mediating effect test (3).

Item	c	a	b	a*b	a*b (Boot SE)	a*b (z Value)	a*b (p Value)	a*b (95% BootCI)	c'	Result
PU $\Rightarrow$ PEU $\Rightarrow$ BI	0.233 **	0.348 **	0.206 **	0.072	0.031	2.342	0.019	0.014–0.134	0.162 *	Partial mediation

* $p < 0.05$ ** $p < 0.01$.

4.4. Results of Moderating Effect Analysis

Based on the Diffusion of Innovations Theory, distinct groups with different characteristics exhibit significant variations in their acceptance of new technologies. Preliminary ANOVA results (Table 4) in the early stage of this study also initially confirmed that occupation is a key demographic factor contributing to differences in MaaS usage intention. Accordingly, we propose the core research question of this section: how does users' occupational background moderate the effects of psychological cognitive factors and social influence on their intention to use MaaS?

Theoretically, the work patterns of freelancers/self-employed individuals (e.g., lack of fixed workplace, flexible schedules) may lead them to value the immediacy and flexibility of MaaS more highly, rather than the planned and regularity features designed for commuters. Therefore, we hypothesize that, for this group, the driving effects of core variables in the traditional TAM (perceived ease of use and perceived usefulness) and social influence on their usage intention may be weakened. The moderation analysis in this section aims to empirically test this hypothesis.

4.4.1. Moderating Effect of Occupation on Perceived Ease of Use and Willingness to Use

As shown in Table 15, when no moderating variables are added to the model, perceived ease of use has a significant effect on the willingness to use MaaS travel services ($B = 0.192$, $p = 0.000$ ***). This indicates that without considering the moderating variable (occupation), perceived ease of use has a significant positive impact on usage intention. In Model 3, only the interaction term (perceived ease of use * occupation—freelancer/self-employed) is significant ($B = -0.774$, $p = 0.002$ **), indicating that for freelancers/self-employed individuals, for every one-unit increase in perceived ease of use, the increase in willingness to use MaaS is 0.774 units lower than that of the reference group. The research results confirmed our research hypothesis, indicating that freelancers/self-employed individuals are less sensitive to improvements in ease of use. Targeted optimizations can be made by simplifying the registration process (reducing qualification requirements) and enhancing service flexibility (such as flexible payment plans).

4.4.2. Moderating Effects of Occupation on Perceived Usefulness and Intention to Use

As shown in Table 16, when no moderating variables are added to the model, the effect of perceived usefulness on the willingness to use MaaS travel services is significant ($B = 0.140$, $p = 0.008$ **), indicating that without considering the moderating variable (occupation), perceived usefulness has a significant positive impact on usage intention. In Model 3, only the interaction term (perceived usefulness * occupation—freelancer/self-employed) is significant ($B = -1.895$, $p = 0.000$ ***), indicating that for freelancers/self-employed individuals, for every one-unit increase in perceived usefulness, the increase in usage intention is 1.895 units lower than that of the reference group. The research results show that freelancers are significantly less sensitive to functional practicality.

Table 15. Results of moderating effect analysis (1).

	Model 1					Model 3				
	<i>B</i>	<i>se</i>	<i>t</i>	<i>p</i>	β	<i>B</i>	<i>se</i>	<i>t</i>	<i>p</i>	β
Constant	3.508	0.643	5.454	0.000 ***	-	3.639	0.714	5.097	0.000 ***	-
PC	−0.052	0.015	−3.450	0.001 ***	−0.162	−0.050	0.015	−3.421	0.001 ***	−0.158
PU	0.140	0.052	2.692	0.008 **	0.145	0.152	0.051	2.969	0.003 **	0.157
SI	0.271	0.051	5.318	0.000 ***	0.287	0.269	0.050	5.429	0.000 ***	0.285
EA	0.214	0.048	4.489	0.000 ***	0.223	0.202	0.047	4.279	0.000 ***	0.211
SS	0.032	0.024	1.324	0.187	0.060	0.023	0.023	0.973	0.332	0.043
PEU	0.192	0.051	3.808	0.000 ***	0.198	0.141	0.150	0.945	0.346	0.145
Occupation— Public institution [reference item]	-	-	-	-	-	-	-	-	-	-
PEU * Occupation— Freelancer/self- employed						−0.774	0.246	−3.144	0.002 **	−0.174
R^2			0.500					0.550		
Adjust R^2			0.488					0.525		
F			$F(6259) = 43.158, p = 0.000$					$F(14,251) = 21.919, p = 0.000$		
ΔR^2			0.500					0.038		
ΔF			$F(6259) = 43.158, p = 0.000$					$F(4251) = 5.281, p = 0.000$		

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.**Table 16.** Results of moderating effect analysis (2).

	Model 1					Model 3				
	<i>B</i>	<i>se</i>	<i>t</i>	<i>p</i>	β	<i>B</i>	<i>se</i>	<i>t</i>	<i>p</i>	β
Constant	3.032	0.657	4.611	0.000 ***	-	2.775	0.674	4.120	0.000 ***	-
PEU	0.192	0.051	3.808	0.000 ***	0.198	0.247	0.051	4.817	0.000 ***	0.254
EA	0.214	0.048	4.489	0.000 ***	0.223	0.207	0.047	4.416	0.000 ***	0.216
PC	−0.052	0.015	−3.450	0.001 ***	−0.162	−0.050	0.015	−3.400	0.001 ***	−0.157
SI	0.271	0.051	5.318	0.000 ***	0.287	0.274	0.049	5.575	0.000 ***	0.290
SS	0.032	0.024	1.324	0.187	0.060	0.023	0.023	0.998	0.319	0.043
PU	0.140	0.052	2.692	0.008 **	0.145	0.075	0.174	0.432	0.666	0.078
Occupation— Public institution [reference item]	-	-	-	-	-	-	-	-	-	-
PU * Occupation— Freelancer/self- employed						−1.895	0.433	−4.374	0.000 ***	−0.281
R^2			0.500					0.557		
Adjust R^2			0.488					0.532		
F			$F(6259) = 43.158, p = 0.000$					$F(14,251) = 22.532, p = 0.000$		
ΔR^2			0.500					0.045		
ΔF			$F(6259) = 43.158, p = 0.000$					$F(4251) = 6.328, p = 0.000$		

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

4.4.3. Moderating Effect of Occupation on Social Influence and Willingness to Use

As shown in Table 17, when no moderating variables are added to the model, social influence has a significant effect on the willingness to use MaaS travel services ($B = 0.271$, $p = 0.000$ ***). This indicates that without considering the moderating variable (occupation), social influence has a significant positive impact on usage intention. In Model 3, only the interaction term (social influence * occupation—freelancer/self-employed) is significant ($B = -1.174$, $p = 0.001$ **), indicating that for freelancers/self-employed individuals, each one-unit increase in social influence results in a 1.174-unit smaller increase in usage intention compared to the reference group. The results show that freelancers/self-employed

individuals are significantly less sensitive to social recommendations than other groups. For this group, it is recommended to optimize strategies by strengthening practical value (highlighting actual benefits such as flexible time and income sharing) and customized communication (promoting through personal media rather than familiar social networks).

Table 17. Results of moderating effect analysis (3).

	Model 1					Model 3				
	<i>B</i>	<i>se</i>	<i>t</i>	<i>p</i>	β	<i>B</i>	<i>se</i>	<i>t</i>	<i>p</i>	β
Constant	4.211	0.673	6.254	0.000 ***	-	4.410	0.700	6.301	0.000 ***	-
PEU	0.192	0.051	3.808	0.000 ***	0.198	0.186	0.051	3.655	0.000 ***	0.191
PU	0.140	0.052	2.692	0.008 **	0.145	0.137	0.052	2.654	0.008 **	0.141
PC	-0.052	0.015	-3.450	0.001 ***	-0.162	-0.053	0.015	-3.567	0.000 ***	-0.167
EA	0.214	0.048	4.489	0.000 ***	0.223	0.226	0.047	4.796	0.000 ***	0.235
SS	0.032	0.024	1.324	0.187	0.060	0.027	0.024	1.159	0.248	0.052
SI	0.271	0.051	5.318	0.000 ***	0.287	0.369	0.151	2.454	0.015 *	0.391
Occupation— Public institution [reference item]	-	-	-	-	-	-	-	-	-	-
SI * Occupation— Freelancer/self- employed						-1.174	0.346	-3.392	0.001 ***	-0.203
R^2			0.500					0.539		
Adjust R^2			0.488					0.513		
F		$F(6259) = 43.158, p = 0.000$						$F(14,251) = 20.975, p = 0.000$		
ΔR^2			0.500					0.027		
ΔF		$F(6259) = 43.158, p = 0.000$						$F(4251) = 3.671, p = 0.006$		

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

4.5. Results of Multigroup Analysis

4.5.1. Multigroup Analysis of Perceived Usefulness and Perceived Ease of Use

The sample was divided into two groups based on commuting mode: single-mode travel and multimodal combined travel. Mediation effect tests were conducted separately for each group. As shown in Tables 18 and 19, under the low-level condition (single-mode travel), the path “perceived usefulness → perceived ease of use → intention to use” exhibited a full mediation effect. In contrast, under the high-level condition (multimodal combined travel), a partial mediation effect was observed. This indicates that heterogeneity in commuting modes is the reason for the differences in the structural equation model and mediation effect tests along the “perceived usefulness → perceived ease of use → intention to use” pathway. It also suggests that single-mode travelers place greater emphasis on the difficulty of using MaaS travel services, and targeted strategies should be proposed when promoting MaaS.

Table 18. Mediation effect test results (single travel mode).

Item	<i>c</i>	<i>a</i>	<i>b</i>	<i>a*b</i>	<i>a*b</i> (Boot SE)	<i>a*b</i> (<i>z</i> Value)	<i>a*b</i> (<i>p</i> Value)	<i>a*b</i> (95% BootCI)	<i>c'</i>	Result
PU ⇒ PEU ⇒ BI	0.294 **	0.379 ***	0.335 ***	0.127	0.054	2.359	0.018	0.035–0.246	0.167	Full mediation

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

4.5.2. Multigroup Analysis of Service Similarity

As shown in Table 20, when the sample is divided according to commuting mode, under the low-level condition (single travel mode), service similarity has a significant positive effect on the willingness to use MaaS. However, under the high-level condition

(multimodal travel combination), service similarity has a negative but not significant effect on the willingness to use MaaS.

Table 19. Mediation effect test results (multimode combined travel).

Item	c	a	b	a*b	a*b (Boot SE)	a*b (z Value)	a*b (p Value)	a*b (95% BootCI)	c'	Result
PU $\Rightarrow$ PEU $\Rightarrow$ BI	0.185 **	0.311 ***	0.138 *	0.043	0.025	1.696	0.090	−0.004–0.097	0.142 *	Partial mediation

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Table 20. Model regression results.

X	$\rightarrow$	Y	Nonstandard Coefficient	SE	z (CR Value)	p	Standardization Coefficient
SS (Low level)	$\rightarrow$	BI	0.226	0.075	3.035	0.002	0.417
SS (High level)	$\rightarrow$	BI	−0.016	0.053	−0.299	0.765	−0.028

5. Discussion and Suggestion

5.1. Key Findings and Theoretical Contributions

Social influence emerged as the strongest predictor driving MaaS usage intention. Perceived ease of use and environmental awareness directly and positively influenced usage intention, while privacy concerns exerted a direct negative impact. Perceived usefulness enhanced usage intention primarily by improving perceived ease of use, whereas service similarity indirectly suppressed usage intention by exacerbating privacy concerns. Occupation (self-employed/freelancers) consistently demonstrated a negative moderating effect across core influence pathways, while differences in commuting patterns (single-mode vs. multimodal) significantly altered the mechanisms through which service similarity and perceived usefulness operate.

5.2. Theoretical Insights and Practical Implications from a Cross-City Comparative Perspective

Through comparisons with global studies, this research reveals that the adoption of MaaS follows both universal patterns and is profoundly shaped by local urban contexts.

Commonalities: The Shanghai case validates findings from international studies: social influence is the primary driver of user adoption [9], while privacy concerns represent a universal barrier [7,8]. This suggests that establishing trustworthy data privacy protection and leveraging social networks for promotion are globally applicable strategies for MaaS success.

Distinctive aspects: This study highlights the uniqueness of Shanghai as a high-density megacity in Asia. Unlike some European studies, highly educated groups in Shanghai prioritize travel efficiency and reliability over environmental attributes—a reflection of the “pragmatism-first” commuting culture fostered by its well-developed public transportation system. Additionally, Shanghai’s vibrant gig economy has given rise to a large number of freelancers, whose unique travel needs make them less responsive to traditional MaaS services. This finding diverges from the conclusions of Willy Kriswardhana et al. [10].

Therefore, the global promotion of MaaS must emphasize localization strategies: In cities dominated by private car use, efforts should focus on overcoming car dependency. In public transportation-rich metropolises like Shanghai, environmental appeals should be translated into extremely convenient and reliable services, while tailored flexible solutions should be designed for the flexible workforce.

5.3. Research on User Group Differences Based on Market Segmentation Theory

This study employed Analysis of Variance (ANOVA) and multigroup analysis to identify key user segments and their differentiated needs, providing a foundation for the precise operation of MaaS services.

(1) Deep Operation Strategies for High-Potential User Segments. Target groups such as enterprise employees, individuals without a driver's license, long-distance commuters (>10 km), and multimodal transport users exhibit strong commuting demands, high sensitivity to travel efficiency, cost, and convenience, and are already accustomed to using multiple transport modes. These characteristics make them ideal target users for MaaS.

For enterprise employees, emphasize combinations of “public transport + bike-sharing” in recommendations, highlighting the seamless transfer advantages of MaaS. Introduce “low-carbon travel points” that can be redeemed for free bike-sharing coupons or metro tickets.

(2) Conversion Strategies for Low-Intention User Segments. Groups such as government employees (who may enjoy fixed commuting benefits), frequent private car users (with high loyalty to their current mode), short-distance travelers (with weaker demand), and freelancers (with highly nonstandardized travel patterns) are less responsive to traditional promotional approaches.

For government employees, offer customized “government commuter shuttle” services aligned with official bus schedules. Promote the convenience of MaaS for streamlining official travel reimbursements. For frequent private car users, promote the “Park and Ride (P + R)” model, providing discounted parking fees and emphasizing MaaS's real-time traffic updates for congestion avoidance. For freelancers, move away from fixed subscription plans and offer pay-as-you-go flexible services alongside multi-destination route planning features. Marketing efforts should focus on value propositions like “enhancing work efficiency” and target these users through knowledge-sharing platforms (e.g., Zhihu, LinkedIn) rather than traditional social networks.

5.4. Optimization Strategies and Managerial Implications Based on Influence Mechanisms

- (1) Mitigating Privacy Concerns to Build a Foundation of Trust. Privacy concerns are a key barrier directly inhibiting user adoption. Thus, data security and privacy protection should not merely be backend technical issues but must become core frontend product selling points. Operators should adopt “data sandbox technologies” to ensure sensitive information (e.g., home addresses) is stored locally. Provide users with a “Privacy Protection Mode” feature, allowing them to enable blurred location sharing (e.g., within a 500 m radius). Enhance in-app “Data Usage Transparency” explanations to clearly demonstrate how personal information is protected and utilized.
- (2) Leveraging Social Influence to Activate Network Effects. Social influence is the strongest driving factor, indicating that MaaS promotion possesses strong social attributes. Launch “real user experience” short videos on platforms like Douyin and Xiaohongshu to enhance credibility. Introduce “refer-a-friend rewards” mechanisms to encourage social sharing. For enterprise users, establish “departmental green travel rankings” to leverage workplace social influence.
- (3) Balancing the Double-Edged Sword of “Similarity” to Optimize User Experience. The study finds that service similarity indirectly negatively impacts intention through privacy concerns. This suggests that while interface familiarity reduces learning costs, it may also trigger associations with data misuse. Adopt interaction logic from mature apps (e.g., ordering and payment processes) to ensure usability. Establish unique visual and brand identity to differentiate from data-abusive platforms. At critical user touchpoints (e.g., first registration), use clear privacy statements and

data-friendly designs to proactively distinguish MaaS as a privacy-conscious service, making “privacy protection” a core brand asset.

- (4) **Strengthening Environmental Awareness to Shape Brand Value.** Environmental awareness directly positively influences usage intention, but motivations vary across groups. For highly educated, high-stress commuters, avoid simplistic environmental messaging. Instead, translate environmental values into convenient actions (e.g., optimizing commute reliability and transfer efficiency) to make green travel the “smartest and most reliable” choice, not just the “greenest.” For less educated groups, implement instant reward mechanisms (e.g., red envelopes for bike-sharing usage). For enterprises, incorporate employee MaaS usage into ESG (Environmental, Social, and Governance) scoring systems and offer tax incentives to promote participation.

6. Conclusions

This study builds upon the traditional Technology Acceptance Model by introducing four extended variables—social influence, environmental awareness, privacy concerns, and service similarity—to establish a MaaS usage intention analysis model. Using data obtained from Shanghai, we analyzed the main factors influencing MaaS usage intention and their mechanisms. The research results show that perceived ease of use, social influence, environmental awareness, and privacy concerns can all directly affect residents’ intention to use MaaS services, while perceived usefulness and service similarity indirectly influence MaaS usage intention through perceived ease of use and privacy concerns, respectively. Moderating effect analysis reveals that for freelancers/self-employed individuals, the positive effects of perceived ease of use, perceived usefulness and social influence on MaaS usage intention are all suppressed. Meanwhile, multigroup analysis demonstrates that service similarity has a significantly positive effect on MaaS usage intention in single-mode travel scenarios, while perceived usefulness exerts greater influence on MaaS usage intention in multimodal travel scenarios.

This study has certain limitations in terms of data collection and analysis. While the number of questionnaires has met the minimum sample size requirements for academic analysis, the overall sample size remains relatively small. Future research should aim to collect more extensive sample data and incorporate additional influencing factors to enhance the model’s accuracy.

Supplementary Materials: The following supporting information can be downloaded at <https://www.mdpi.com/article/10.3390/app15179453/s1>; Table S1: Raw experimental data.

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Appendix A

Table A1. Questionnaire item summary.

Latent Variable	Symbol	Measurement Items	Reference
Perceived Ease of Use (PEU)	PEU1	I think it's very simple to learn to use MaaS software	Schikofsky et al.
	PEU2	I think the operation steps of MaaS software are clear and easy to understand, and it's not difficult to comprehend and use	
	PEU3	I don't think using MaaS is difficult	
Perceived Usefulness (PU)	PU1	I think MaaS can enrich my travel options	Schikofsky et al.
	PU2	I think using MaaS can improve my travel efficiency	
	PU3	I think using MaaS can make travel more convenient	
Behavior intention (BI)	BI1	If there is a chance, I will consider choosing MaaS as my mode of transportation	Schikofsky et al.
	BI2	If I have the chance to use MaaS, I will try to use it	
	BI3	If a mature MaaS software emerges, I will use it	
Social Influence (SI)	SI1	If the social media reviews are good, I am willing to use MaaS	Wen et al.
	SI2	If everyone around me uses MaaS, then I will use it too	
	SI3	If my relatives and friends support and praise MaaS, I am willing to use it	
Environmental Awareness (EA)	EA1	I am very concerned about the environmental situation and think that environmental problems have become increasingly serious in recent years	Lopez-Carreiro et al.
	EA1	Considering environmental pollution, I usually try to choose green means of transportation such as buses, subways and bicycles	
	EA1	If it is beneficial to the environment, I am willing to change my mode of transportation or my travel pattern	
Privacy Concerns (PC)	PC1	I'm worried that MaaS will collect too much personal information	Zhang et al.
	PC2	I'm worried that MaaS might use my personal information for other purposes without my authorization	
	PC3	I'm worried that MaaS might share my personal information with other applications without my authorization	
Service Similarity (SS)	SS1	MaaS reminds me of other products or services I have used	Schikofsky et al.
	SS2	I find that MaaS has similarities in usage with other products or services	
	SS3	MaaS is similar to the travel services I am accustomed to using	

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