sustainability

MDPI

Article

Public Acceptance of Last-Mile Shuttle Bus Services with Automation and Electrification in Cold-Climate Environments

Naihui Wang [1], Yulong Pei [1,*] and Hao Fu [2]

[1] School of Traffic and Transportation, Northeast Forestry University, Harbin 150040, China
[2] Department of Civil and Environmental Engineering, The Hong Kong Polytechnic University, Hung Hom, Hong Kong, China
* Correspondence: peiyulong@nefu.edu.cn

Abstract: The last-mile shuttle bus service with automation and electrification has emerged to fill gaps in on-demand transportation systems and its goals are to satisfy the door-to-door mobility needs of residents. It could help to enhance the happiness of public travel in cold-climate environments, which is also considered a pro-social public transportation service. Although it has the potential to promote sustainable and environmentally friendly mobility systems, the successful implementation of last-mile shuttle bus services with automation and electrification highly depends on individuals' willingness to accept. In this paper, a theoretical acceptance model for last-mile shuttle bus services with automation and electrification is proposed. Partial least squares structural equation modeling is employed to examine research model in accordance with 986 valid questionnaires answered by public in snow and ice environments. The outcomes show that the proposed model accounts for 73.4% of the variance in behavioral intention to utilize last-mile shuttle bus services with automation and electrification. The strongest determinants of behavior intention are attitude and perceived usefulness. In addition, perceived risk negatively affects behavioral intention. We also provide theoretical findings and practical suggestions for developing last-mile shuttle bus services with automation and electrification based on the results and our analysis.

Keywords: shuttle bus; last-mile transportation service; cold-climate environments; automated vehicle; electric vehicle; acceptance model

check for updates

Citation: Wang, N.; Pei, Y.; Fu, H. Public Acceptance of Last-Mile Shuttle Bus Services with Automation and Electrification in Cold-Climate Environments. *Sustainability* **2022**, *14*, 14383. https://doi.org/10.3390/su142114383

Academic Editors: Ciyun Lin, Bowen Gong and Dayong (Jason) Wu

Received: 13 October 2022
Accepted: 31 October 2022
Published: 3 November 2022

1. Introduction

The cold-climate environments are areas that have a long and cold winter accompanied by frequent snowfall [1]. Many problems arise due to weather conditions in cold-climate areas, such as difficulties in vehicle travel and frequent road accidents. Urban residents suffer from the pain of last-mile travel and thereby expect to more efficient travel in cold-climate environments. The last-mile shuttle bus service (LMSBS) with automation and electrification has the potential to alleviate these issues. It has emerged as a new mode of public transportation, providing residents with travel services from public transportation nodes to their final destinations, such as office buildings, commercial areas, residential houses, etc. The LMSBS with automation and electrification could meet the residents' demand for door-to-door travel services and improve their travel efficiency in cold-climate environments, with the characteristics of the short route, high frequency, and convenience. Automation and electrification are popular trends in urban transportation [2]. Last-mile shuttle buses will be more environmentally friendly and marketable than traditional ones due to the synergies between automation and electrification [3]. The LMSBS with automation and electrification is also a pro-social transportation mode, with the advantages of alleviating traffic congestions, increasing energy efficiency and safety, and enhancing travel well-being in cold-climate environments [4].

Many countries have conducted road trials of automated shuttle buses, including Baidu "Apollo" in China, Navya "Arma" and EasyMile "EZ10" in France, Ohmio "Lift" in

New Zealand, and Local Motors "Olli" in the United States. Overall, autonomous shuttle services still have potential safety risks in the trial operation. For instance, the Navya automated bus collided with a large truck in road trials in 2017 [5]. Besides inherent technical factors, the widespread adoption of the LMSBS with automation and electrification also depends on higher public acceptance. Public acceptance is directly related to the ridership of shuttle buses, thereby affecting the successful operation of LMSBS with automation and electrification. Transportation administrators and governments could make operational management policies (e.g., pricing and subsidy mechanism design) by the evaluation of public acceptance. The LMSBS with automation and electrification could be developed and refined according to public preferences and attitudes. Rojas-Rueda et al. [6] indicate that autonomous electric vehicles are more environmentally friendly than fossil fuel ones, promoting public adoption of the LMSBS with automation and electrification. Moreover, extreme weather conditions place higher technical requirements on the operation of LMSBS with automation and electrification in cold-climate environments. People may worry about the general safety of LMSBS with automation and electrification in cold-climate environments, which may affect the public's willingness to use this service. Accordingly, it is significant to study public acceptance of last-mile shuttle bus services with automation and electrification in cold-climate environments.

The problem of last-mile services has been widely studied. In the existing research, researchers explore the last-mile services from different perspectives, including routing and scheduling of last-mile transportation [4,7,8], bus stop location planning of shuttle buses [9,10], and the pricing problem [11,12]. In summary, the existing studies concentrate on the design and operational management problem of last-mile services. In addition, based on a case study, Soe and Müür [13] explored the mobility acceptance factors of an automated shuttle bus for last-mile transportation services. They found that passengers with the experience of riding automated shuttle bus perceived higher security and safety feelings of this transport mode than passengers without the riding experience. Chee et al. [14] conducted a 3-factor theory analysis for determining the criteria for potential users to evaluate the last-mile automated bus service and make a decision about whether to use the service accordingly. The results revealed that frequency and ride comfort were important determinants of adopting this service. The existing studies have preliminarily explored the influencing factors of last-mile services with automated buses. However, the influencing factors of last-mile services with autonomous electric buses have not been fully elucidated. In addition, to our best knowledge, limited studies have focused on the acceptance of LMSBS with automation and electrification by public in cold-climate environments.

This study attempts to fill the research gap by exploring public acceptance of LMSBS with automation and electrification in cold-climate environments. In this study, we first established a theoretical research model by utilizing the technology acceptance model (TAM), norm activation model (NAM), and the theory of planned behavior (TPB), on the basis of the consideration of automation and electrification features of last-mile shuttle bus services. Second, data were gathered by conducting a cross-sectional survey of Chinese residents in cold-climate environments via an anonymous online questionnaire. The survey questionnaire was developed in line with our proposed theoretical model. Third, to analyze the reliability and validity of the measurement scales, we employed partial least squares structural equation modeling. We compared the proposed model with basic models and performed the evaluation of the proposed model. Finally, valuable managerial insights were offered based on the results and our analysis.

The main contributions of this paper include the following. First, this research focuses on an emerging public transportation issue. To our best knowledge, this paper is among the first to investigate the determinants of public intention to adopt LMSBS with automation and electrification in cold-climate environments. Second, we present a theoretical acceptance model for LMSBS with automation and electrification based on its convenience, safety, and pro-social characteristics. Third, the empirical results indicate that behavioral intention is most significantly impacted by attitude and perceived usefulness, whereas perceived risk exerts an adverse effect on behavioral intention. The findings contribute to providing insights into the development of last-mile shuttle bus services with automation and electrification from the perspective of the government, operating businesses, and manufacturers.

The theoretical background on public acceptance of last-mile shuttle bus services with automation and electrification and a description of the data gathering procedure are presented in Section 2. Section 3 expounds on the findings of the current research analysis. The key findings, significance, limitations, and future directions are covered in Section 4. A summary of this research serves to wrap up the paper in Section 5.

2. Methods

2.1. Model Development

We attempt to develop a theoretical model for public acceptance of LMSBS with automation and electrification in cold-climate environments according to pertinent theories. TAM is a typical model to explain the usage behaviors of emerging technologies and services. As the LMSBS with automation and electrification is an emerging public transportation service, we apply TAM as the base model to construct a theoretical framework. NAM, an altruistic theory, is developed and applied to describe altruistic and pro-social behaviors that are advantageous to society or others. TPB, a self-interest theory, is extensively applied to capture rational motivations of relevant behaviors. As explained in Section 1, LMSBS with automation and electrification is a pro-social behavior. Empirical evidence reveals that combined consideration of individual moral preference and self-interest concerns contributes to examining the motivation for pro-social behaviors comprehensively [15]. Therefore, we integrated TAM, NAM, and TPB to construct a theoretical framework for this research. In addition, to enhance the explanatory capacity of the theoretical framework, we included perceived risk.

TAM has been effectively adopted to interpret and predict behavioral intentions in the transportation areas, such as smart transportation services [16], autonomous electric vehicles [17], shared parking modes [18], and shipping blockchain [19]. Given its broad utility in the transportation domain, we believe that TAM could also be applied to understand the public acceptance of last-mile shuttle bus services with automation and electrification. In our research, the public's acceptance of the LMSBS with automation and electrification is referred to as behavioral intention (BI). A person's perception of how free of effort it would be to embrace LMSBS with automation and electrification is referred to as perceived ease of use (PEOU). The extent to which a person thinks that implementing LMSBS with automation and electrification will enhance the effectiveness of travel is termed perceived usefulness (PU). Research emerging in transportation has indicated a positive association of individuals' behavioral intention with perceived ease of use and perceived usefulness, as stated by Ning et al. [20]. In addition, it has been found that the perceived ease of use has an impact on perceived usefulness. As a result, the following hypotheses were put forth:

H1: *PU has a positive influence on individuals' BI for last-mile shuttle bus services with automation and electrification.*

H2: *PEOU has a positive influence on individuals' BI for last-mile shuttle bus services with automation and electrification.*

H3: *PEOU has a positive influence on individuals' PU of last-mile shuttle bus services with automation and electrification.*

The NAM model posits that altruistic and pro-social behaviors are relevant to individual morality, which is driven by three components. In existing studies, the NAM model has been extensively employed in transportation fields to explain different green transportation behaviors [21,22]. Therefore, in this research, we applied the NAM to describe the pro-social characteristics of LMSBS with automation and electrification.

In this research, personal norms (PN) refer to individual feelings of moral obligation to use LMSBS with automation and electrification. Existing literature on transportation research has demonstrated that personal norms positively affect behavioral intention [23]. It indicates that when an individual's moral obligation feelings are higher, he/she is more able to accept LMSBS with automation and electrification. Thereby, we proposed that:

H4: *PN positively influence individuals' BI for last-mile shuttle bus services with automation and electrification.*

The ascription of responsibility (AR) in this research refers to the feelings of responsibility for the positive consequences of LMSBS with automation and electrification. Previous studies in the transportation domain have indicated that the responsibility ascription may activate personal norms, as stated by Mehdizadeh et al. [22]. In our research, it means that people will be more likely to feel a sense of responsibility if they have the responsibility for using LMSBS with automation and electrification. Thereby, the following hypothesis is proposed:

H5: *AR positively influences individuals' PN of last-mile shuttle bus services with automation and electrification.*

In this research, awareness of consequences (AC) indicates individuals' perception or valuations of the positive effects of using LMSBS with automation and electrification on society. Existing literature has also reported that consequence awareness positively influences responsibility ascription [22,23]. It shows that if people realize the positive effects of the action on society, they will have a stronger sense of moral obligation and responsibility. Thereby, it was hypothesized that:

H6: *AC positively influences individuals' AR of last-mile shuttle bus services with automation and electrification.*

TPB theory proposes that attitude, subjective norm, and perceived behavior control determine an individual's behavioral intention. The TPB has been successfully used in numerous areas, including the transportation research domain, to explain and predict behaviors [24–26]. Therefore, in this research, we applied the TPB to explore further beliefs and attitudes about public acceptance of LMSBS with automation and electrification.

In this research, subjective norm (SN) refers to individuals' perception of the extent to which important others feel that they should utilize the LMSBS with automation and electrification. Existing research emerging in transportation has revealed that subjective norm has a significant impact on individuals' behavioral intention [24,25], and the subjective norm is an antecedent of personal norms [25]. Hence, we proposed that:

H7: *SN positively influences individuals' BI for last-mile shuttle bus services with automation and electrification.*

H8: *SN positively influences individuals' PN of last-mile shuttle bus services with automation and electrification.*

The extent to which a person perceives the difficulty of using LMSBS with automation and electrification is referred to as perceived behavioral control (PBC) in this study. Studies in the transportation research area have demonstrated that perceived behavioral control positively affects individuals' behavioral intention [24,25]. Hence, we proposed that:

H9: *PBC positively influences individuals' BI for last-mile shuttle bus services with automation and electrification.*

The extent to which people feel they should employ LMSBS with automation and electrification is referred to as attitude (AT) in this study. Studies in the field of transportation have pointed out that individuals' behavioral intentions are positively impacted by attitude [24,25]. The perception of ease of use and usefulness has been reported to be direct determinants of users' attitudes toward emerging transportation technologies [27]. As a result, the following hypotheses were put forth:

H10: *AT positively influences individuals' BI for last-mile shuttle bus services with automation and electrification.*

H11: *AT is positively affected by individuals' PU of last-mile shuttle bus services with automation and electrification.*

H12: *AT is positively affected by individuals' PEOU of last-mile shuttle bus services with automation and electrification.*

According to this research, perceived risk (PR) is the degree of an individual's subjective evaluation of uncertainty and adverse consequences of adopting LMSBS with automation and electrification. Prior studies have indicated that autonomous driving is an emerging technology that has great potential to be more efficient and safer than human driving [28]. However, users are still concerned about personal safety and functional failure [29]. Hence, perceived risk is primarily the perception of safety issues, including road safety and vehicle safety. Pigeon et al. [30] pointed out that safety issues are one of the main factors affecting public acceptance of autonomous public transportation. Thereby, we hypothesized that:

H13: *PR negatively affects individuals' BI for last-mile shuttle bus services with automation and electrification.*

In accordance with the above hypotheses, we developed the theoretical research model depicted in Figure 1 to investigate the public acceptance of LMSBS with automation and electrification in cold-climate environments.

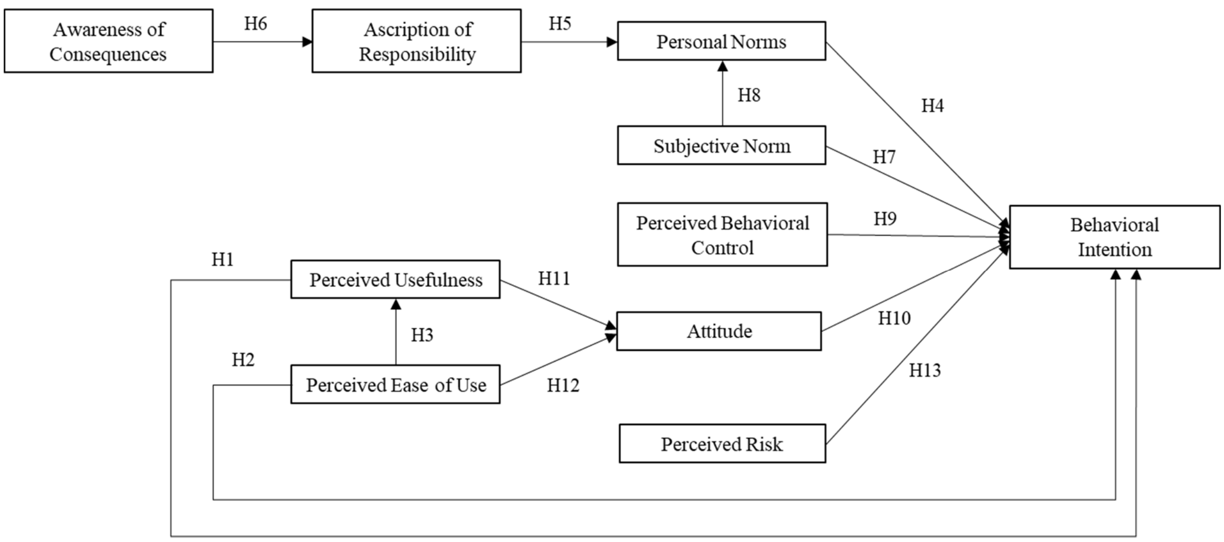

Figure 1. The proposed theoretical model.

2.2. Measurement Instrument

We developed the questionnaire to measure the constructs in the proposed theoretical model and the demographic information of the participants. We carried out an exhaustive literature review on technology acceptance research that applied TAM, TPB, and NAM to identify appropriate measurement items for each construct in the acceptance model. Measurement items were contextualized to fit the current study's context. Measurement scales for public acceptance of LMSBS with automation and electrification were designed based on previously validated scales. Participants scored each construct's items on the 7-point Likert scale, from "strongly disagree" to "strongly agree".

Measurement scales were reviewed by three bus company employees, two researchers engaged in technology acceptance research, and three regular individuals in cold-climate environments. We replaced esoteric technical terms with easy-to-understand colloquialisms based on their comments to make questionnaire items more suitable and understandable. Notably, 3 out of the 33 measurement items were revised as reversed questions (i.e., PR4, PEOU1, and AT2) to detect nonserious responses and guarantee the validity of the collected data. A correction of reversed items was made during data analysis. In addition, the questionnaire was pre-tested with a sample of 137 individuals prior to a large-scale survey. We conducted further revisions on measurement items following feedback from the pre-testing group. One item of PN was deleted since its outer loading was lower than cross-loadings on other constructs.

Measurement items for each construct of the final version were provided in Appendix A. Measurement items for BI were modified from scales applied by Wu et al. [31] and Venkatesh et al. [32], namely, try to employ, plan to employ, and future choice. The items of measuring PN were derived from research on pro-environmental behavior acceptance applying the NAM model [33]. Measurement items for AC and AR were developed by integrating pro-environmental consequences of this service and scales applied in existing NAM model [4,33]. Measurement items for SN was modified from "social influence" in the unified theory of acceptance and use of technology [32]. The items of measuring AT were modified from scales applied by Wu et al. [31], namely, positivity, wisdom of choice, and the important role in the public transportation system. Measurement items for PBC were adapted from previous scales on the acceptance of sustainable transport behavior [25]. Measurement items for PEOU and PU were derived from "effort expectancy" and "performance expectancy" in the unified theory of acceptance and use of technology [32]. The items of measuring PR were modified from scales applied by Wu et al. [31] and Zhang et al. [34], which mainly included bad weather conditions, ability to handle emergencies, failure or malfunctions, and general safety.

2.3. Data Collection

We employed a web-based questionnaire to investigate this research, which was shown to be an effective way to collect research data in empirical studies [20,35,36]. In December 2021, we utilized social networks to invite residents of cold-climate regions to answer the questionnaire. Public acceptance of last-mile shuttle bus services with automation and electrification in cold-climate environments is an exploratory study. We hoped to collect as much data as possible to explore elements affecting public acceptance in cold-climate environments. Therefore, questionnaires were completed by the Chinese public in cold-climate environments with no special requirements for participants' demographic information. Prior to participating in the formal investigation, respondents were required to read an informed consent form. They were specifically informed that the information collected would only be used for research purposes and that their participation was anonymous and confidential. None of the survey data could be viewed without the project manager's permission. During the investigation, respondents had the option of terminating at any time without adverse effects. The contact information of our research assistant was also provided to participants in case of any queries.

During the period from December 25 to 31, 2021, a total of 1115 questionnaires from different cities in China were submitted. Questionnaires were distributed by the online survey platform (www.wjx.cn), which could automatically collect the Internet Protocol address of submitted questionnaires, including corresponding attribution city information. We deleted questionnaires from non-cold climate regions based on the attribution city information of the submitted questionnaires. Additionally, questionnaires with abnormal answer times (i.e., answer time over one hour) and nonserious responses based on reversed questions were considered invalid. The effective sample size was 986 (effective response rate: 88.4%). Males made up more than half of the participants (53.3%). In addition, 65.3% of participants were young people, according to 2015 WHO published standard for aging [37]. In light of statistics, 45.7% of the participants had College's degree or above. Demographic information for the participants in our investigation sample and Chinese Census (2020) were summarized in Table 1. The distribution of gender and age was in good agreement between our investigation sample and China population. The proportion of participants with College's degree or above in our investigation sample was higher than the higher educated proportion in China population. Overall, we tried to reduce sampling bias of online survey to ensure representativeness of the results. Moreover, we conducted data analysis by Smart PLS 3.0 for evaluating the effectiveness of the theoretical research model. Additionally, the investigation's ethical approval was gained on 10 December 2021 from School of Traffic and Transportation, Northeast Forestry University, China.

Table 1. Demographic information for participants in our investigation sample and Chinese Census (2020).

Characteristics	Frequency and Proportion in Our Sample	China Population (2020 Census)
Gender		
Male	526 (53.3%)	51.2%
Female	460 (46.7%)	48.8%
Age		
<45	644 (65.3%)	62.0%
>=45	342 (34.7%)	38.0%
Education level		
Completed high school or below	535 (54.3%)	85.4%
College's degree or above	451 (45.7%)	14.6%

3. Results

3.1. Reliability and Validity Assessment

The internal consistency, the extent to which related items are designed to measure the same factor, was examined by Cronbach's alpha (i.e., Cronbach's alpha > 0.7), and composite reliability (i.e., composite reliability > 0.7). As depicted in Table 2, Cronbach's alpha and composite reliability both had values greater than 0.70. Therefore, we considered that the questionnaire passed the reliability test. The average variance extracted (AVE) for each construct was larger than 0.5, and factor loadings for each item were all greater than 0.70. Therefore, we considered that the questionnaire had a satisfactory convergent validity. From Table 3, we could observe that the outer loading on the associated construct was higher than cross-loadings on any other construct. From Table 4, it could be seen that the square root of the AVE for each construct was greater than its correlations with any other construct. Thus, we considered that the questionnaire had an acceptable discriminant validity. Collectively, the measurement model employed in this study possessed reasonable reliability and validity, which was suited for structural model analysis.

3.2. Model Evaluation

The path coefficient (β) is a standardized regression coefficient that indicates the direct effect of one variable on another variable. Path coefficients and their significance were calculated using a bootstrapping approach with 5000 subsamples. The coefficient of determination (R^2) is applied for estimating the explaining power of the acceptance models. Evaluation results of the proposed model were presented in Figure 2. The theoretical research model accounted for 73.4% of the variance in acceptance of LMSBS with automation and electrification in cold-climate environments.

Table 2. Outcomes of reliability and convergent validity tests.

Constructs	Items	Mean (SD)	Factor Loadings	Cronbach's Alpha	Composite Reliability	AVE
AC	AC1	5.631 (1.333)	0.944	0.926	0.953	0.871
	AC2	5.648 (1.336)	0.943			
	AC3	5.789 (1.259)	0.912			
AR	AR1	6.208 (1.010)	0.983	0.984	0.989	0.968
	AR2	6.176 (1.047)	0.986			
	AR3	6.176 (1.047)	0.983			
PN	PN1	6.100 (1.069)	0.958	0.967	0.978	0.938
	PN2	6.146 (1.000)	0.974			
	PN3	6.128 (1.019)	0.975			
SN	SN1	5.331 (1.366)	0.974	0.973	0.982	0.949
	SN2	5.252 (1.364)	0.980			
	SN3	5.290 (1.363)	0.968			
AT	AT1	5.795 (1.104)	0.944	0.950	0.968	0.909
	AT2	5.710 (1.174)	0.962			
	AT3	5.827 (1.137)	0.954			
PBC	PBC1	2.882 (1.774)	0.925	0.930	0.955	0.877
	PBC2	3.065 (1.748)	0.959			
	PBC3	3.236 (1.788)	0.925			
PU	PU1	5.555 (1.395)	0.921	0.961	0.972	0.895
	PU2	5.703 (1.294)	0.955			
	PU3	5.705 (1.300)	0.952			
	PU4	5.740 (1.289)	0.956			
PEOU	PEOU1	5.219 (1.608)	0.883	0.931	0.951	0.829
	PEOU2	5.419 (1.429)	0.926			
	PEOU3	5.274 (1.515)	0.930			
	PEOU4	5.426 (1.466)	0.902			
PR	PR1	2.599 (1.367)	0.913	0.943	0.959	0.854
	PR2	2.601 (1.389)	0.933			
	PR3	2.603 (1.427)	0.931			
	PR4	2.682 (1.387)	0.920			
BI	BI1	5.993 (1.036)	0.953	0.963	0.976	0.932
	BI2	5.885 (1.083)	0.982			
	BI3	5.856 (1.113)	0.961			

Table 3. Cross-loadings and outer loadings on the associated construct.

	BI	PEOU	PU	PN	AC	AR	SN	AT	PBC	PR
BI1	0.953	0.504	0.634	0.663	0.634	0.663	0.522	0.781	−0.161	−0.327
BI2	0.982	0.496	0.641	0.653	0.660	0.658	0.580	0.809	−0.159	−0.307
BI3	0.961	0.482	0.616	0.630	0.663	0.639	0.586	0.792	−0.153	−0.278
PEOU1	0.423	0.883	0.610	0.317	0.368	0.332	0.348	0.468	−0.142	−0.155
PEOU2	0.500	0.926	0.682	0.369	0.430	0.365	0.416	0.511	−0.144	−0.171
PEOU3	0.457	0.930	0.682	0.358	0.438	0.343	0.433	0.503	−0.180	−0.146
PEOU4	0.481	0.902	0.669	0.371	0.433	0.380	0.413	0.490	−0.177	−0.177
PU1	0.600	0.695	0.921	0.415	0.558	0.399	0.501	0.632	−0.154	−0.240
PU2	0.598	0.665	0.955	0.435	0.544	0.433	0.435	0.634	−0.145	−0.277
PU3	0.619	0.692	0.952	0.416	0.536	0.421	0.457	0.633	−0.154	−0.257
PU4	0.653	0.698	0.956	0.468	0.577	0.470	0.465	0.663	−0.164	−0.268
PN1	0.629	0.364	0.443	0.958	0.490	0.835	0.481	0.588	−0.172	−0.273
PN2	0.664	0.382	0.448	0.974	0.526	0.857	0.467	0.627	−0.176	−0.308
PN3	0.658	0.385	0.442	0.975	0.545	0.853	0.487	0.633	−0.185	−0.298
AC1	0.594	0.403	0.504	0.476	0.944	0.494	0.530	0.622	−0.155	−0.233
AC2	0.632	0.443	0.577	0.504	0.943	0.522	0.545	0.657	−0.176	−0.251
AC3	0.664	0.437	0.557	0.524	0.912	0.508	0.564	0.683	−0.190	−0.294

Table 3. *Cont.*

	BI	PEOU	PU	PN	AC	AR	SN	AT	PBC	PR
AR1	0.670	0.390	0.459	0.865	0.521	0.983	0.409	0.616	−0.169	−0.316
AR2	0.658	0.381	0.440	0.860	0.533	0.986	0.415	0.599	−0.177	−0.297
AR3	0.670	0.382	0.446	0.860	0.555	0.983	0.444	0.616	−0.171	−0.300
SN1	0.585	0.451	0.492	0.498	0.582	0.439	0.974	0.630	−0.169	−0.159
SN2	0.561	0.428	0.464	0.475	0.564	0.411	0.980	0.608	−0.151	−0.164
SN3	0.556	0.415	0.479	0.469	0.565	0.405	0.968	0.608	−0.153	−0.163
AT1	0.769	0.527	0.615	0.608	0.651	0.602	0.584	0.944	−0.232	−0.270
AT2	0.785	0.530	0.658	0.596	0.668	0.580	0.646	0.962	−0.222	−0.245
AT3	0.798	0.493	0.663	0.616	0.686	0.594	0.577	0.954	−0.209	−0.267
PBC1	−0.136	−0.091	−0.110	−0.184	−0.124	−0.192	−0.082	−0.166	0.925	0.083
PBC2	−0.154	−0.178	−0.152	−0.182	−0.160	−0.187	−0.146	−0.218	0.959	0.069
PBC3	−0.165	−0.215	−0.189	−0.151	−0.230	−0.120	−0.215	−0.258	0.925	0.028
PR1	−0.304	−0.184	−0.274	−0.306	−0.250	−0.309	−0.163	−0.250	0.022	0.913
PR2	−0.290	−0.151	−0.245	−0.283	−0.264	−0.291	−0.142	−0.244	0.083	0.933
PR3	−0.277	−0.159	−0.249	−0.251	−0.257	−0.271	−0.143	−0.260	0.078	0.931
PR4	−0.291	−0.163	−0.249	−0.277	−0.258	−0.271	−0.165	−0.258	0.049	0.920

Table 4. The square roots of AVEs and associations among the constructs.

	AC	AR	AT	BI	PBC	PEOU	PN	PR	PU	SN
AC	0.933									
AR	0.545	0.984								
AT	0.701	0.621	0.953							
BI	0.675	0.677	0.822	0.965						
PBC	−0.186	−0.175	−0.232	−0.163	0.937					
PEOU	0.459	0.390	0.542	0.512	−0.177	0.911				
PN	0.538	0.876	0.636	0.672	−0.183	0.389	0.969			
PR	−0.278	−0.309	−0.274	−0.315	0.062	−0.178	−0.303	0.924		
PU	0.586	0.456	0.677	0.653	−0.163	0.727	0.458	−0.276	0.946	
SN	0.586	0.430	0.632	0.583	−0.162	0.443	0.494	−0.166	0.491	0.974

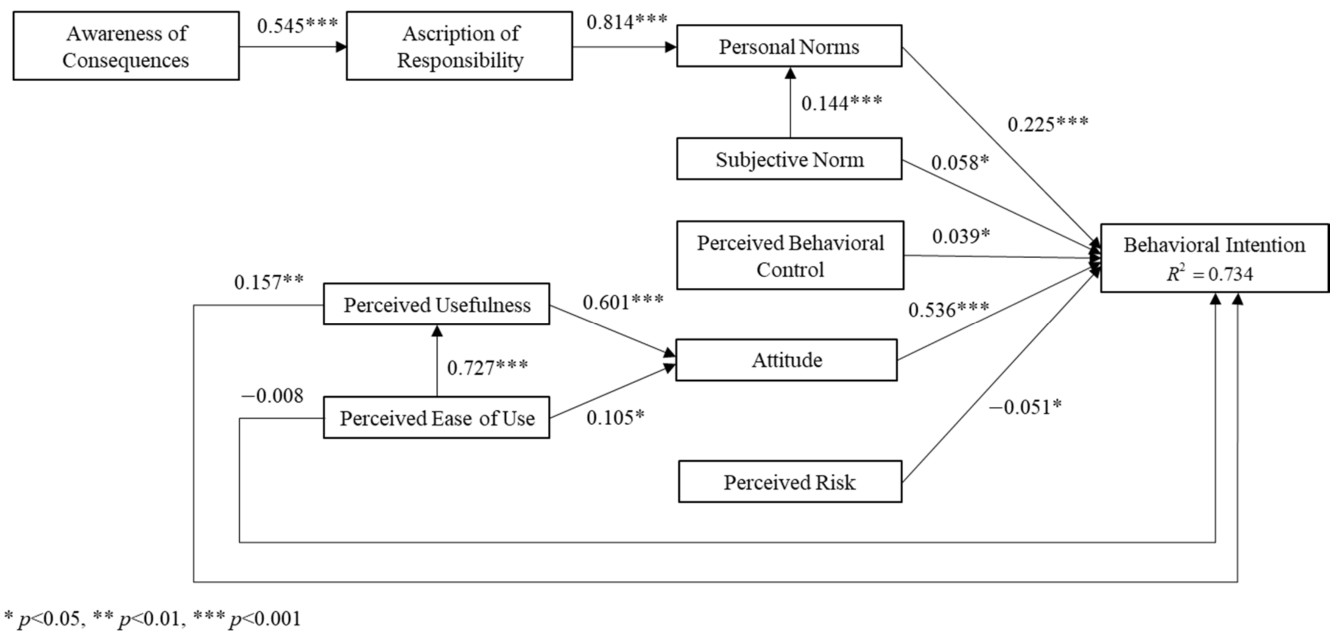

Figure 2. Evaluation results of the proposed model.

Table 5 illustrated the hypothesis testing results and path coefficients of the proposed research model. The behavior intention for last-mile shuttle bus services with automation and electrification in cold-climate environments was directly and positively affected by perceived usefulness, personal norms, subjective norm, perceived behavioral control, and attitude, but not by perceived ease of use. Thus, H1, H4, H7, H9, and H10 were supported, while H2 was not supported. Perceived usefulness was positively impacted by perceived ease of use, which supported H3. Personal norms were positively influenced by the ascription of responsibility and subjective norm, which supported H5 and H8. H6 was supported as awareness of consequences positively affected ascription of responsibility. Attitude was positively impacted by perceived usefulness and perceived ease of use, which supported H11 and H12. H13 was supported as perceived risk negatively affected behavioral intention.

Table 5. The hypothesis testing outcomes and path coefficients.

Hypothesis	Path Coefficients (β)	*p*-Value	Supported? (Yes/No)
H1: PU→BI	0.157	<0.01	Yes
H2: PEOU→BI	−0.008	0.810	No
H3: PEOU→PU	0.727	<0.001	Yes
H4: PN→BI	0.225	<0.001	Yes
H5: AR→PN	0.814	<0.001	Yes
H6: AC→AR	0.545	<0.001	Yes
H7: SN→BI	0.058	<0.05	Yes
H8: SN→PN	0.144	<0.001	Yes
H9: PBC→BI	0.039	<0.05	Yes
H10: AT→BI	0.536	<0.001	Yes
H11: PU→AT	0.601	<0.001	Yes
H12: PEOU→AT	0.105	<0.05	Yes
H13: PR→BI	−0.051	<0.05	Yes

We calculated the indirect, direct, and total effects using a bootstrapping approach with 5000 subsamples by Smart PLS 3.0. Table 6 shows the direct, indirect, and total impacts of the predictors on public acceptance of LMSBS with automation and electrification in cold-climate environments. Results highlighted that attitude and perceived usefulness yielded the largest total effects on the intention for LMSBS with automation and electrification, followed by perceived ease of use, personal norms, ascription of responsibility, awareness of consequences, subjective norm, and perceived behavioral control. Although the direct effect of perceived ease of use on BI was not significant, perceived ease of use significantly affected BI indirectly through the mediating roles of perceived usefulness and attitude. Moreover, perceived risk negatively impacted intention for LMSBS with automation and electrification in cold-climate environments.

Table 6. The effects of predictors on behavioral intention.

	Indirect Effect	*p*-Value	Direct Effect	*p*-Value	Total Effect	*p*-Value
AC→BI	0.100	<0.001	-	-	0.100	<0.001
AR→BI	0.183	<0.001	-	-	0.183	<0.001
PN→BI	-	-	0.225	<0.001	0.225	<0.001
PEOU→BI	0.404	<0.001	−0.008	0.810	0.396	<0.001
PU→BI	0.322	<0.001	0.157	<0.01	0.479	<0.001
AT→BI	-	-	0.536	<0.001	0.536	<0.001
PBC→BI	-	-	0.039	<0.05	0.039	<0.05
SN→BI	0.032	<0.001	0.058	<0.05	0.090	<0.01
PR→BI	-	-	−0.051	<0.05	−0.051	<0.05

4. Discussion

4.1. Main Findings and Theoretical Implications

This study proposed an effective theoretical model that integrated TAM, NAM, and TPB with additional variable perceived risk to examine user acceptance in cold-climate environments. The model explained 73.4% of the variance in acceptance of LMSBS with automation and electrification in cold-climate environments. We identified the direct factors and the indirect factors that affected behavioral intention for LMSBS with automation and electrification.

The research provided clarification on the roles of attitude on public acceptance of LMSBS with automation and electrification in cold-climate environments. Attitude was found to be the strongest predictor of public acceptance of LMSBS with automation and electrification. This observation was in line with findings by Ajzen [38], which indicated that users relied on their thoughts and feelings. To be more specific, the more positive attitudes individuals had toward the particular behavior, the stronger the individual's intention to perform the behavior. In this research, the attitude was measured by one's positivity in using the LMSBS with automation and electrification and the expected importance of the public transport system through this service. We also revealed two antecedents of attitude, namely perceived usefulness and perceived ease of use. Both of them had a considerable association with attitude and, thereby, indirectly impacted intention for the LMSBS with automation and electrification.

Perceived usefulness played a key role in affecting users' acceptance of the LMSBS with automation and electrification in cold-climate environments. Perceived usefulness, following attitude, was the second most significant predictor for public acceptance of LMSBS with automation and electrification. Such a result mirrored the evidence reported in existing research [17,39], indicating that people would prefer to adopt this service if they find the LMSBS with automation and electrification is useful and convenient in their daily life. The LMSBS with automation and electrification has the characteristics of convenience and high resource utilization. Therefore, individuals' perception of its usefulness was strong, which, in turn, increased their intention. Moreover, perceived ease of use was hypothesized to directly impact behavioral intention, but we found no significant evidence in support of the hypothesis. A possible explanation is that emerging automation and electrification technologies are employed in the last-mile shuttle bus services, and there is still a lack of comprehensive understanding of emerging technologies. Most participants in our study had no experience of using LMSBS with automation and electrification yet. Therefore, they could not accurately perceive the effort expectancy to use this service, which made the direct influence of PEOU on behavioral intention non-significant.

NAM, an altruistic theory, captured individual moral preference of adopting the LMSBS with automation and electrification. The LMSBS with automation and electrification is a form of pro-social behavior in alleviating traffic congestions and enhancing travel well-being in cold-climate environments, and NAM was firstly proposed to explain pro-social behaviors [40]. Therefore, integrating NAM in the acceptance model enables a comprehensive understanding of individuals' intention to choose the LMSBS with automation and electrification. The results revealed that variables from NAM played important roles in affecting users' acceptance of LMSBS with automation and electrification. The empirical results revealed that awareness of consequences was significantly associated with the ascription of responsibility that had a positive influence on personal norms. Such a mediating framework was in line with previous results by Mehdizadeh et al. [22]. It implied that ascription of responsibility was activated when people noticed the positive consequences of adopting the LMSBS with automation and electrification. Consistent with previous acceptance research, personal norms were found to positively impact pro-social behavioral intention [23,41], suggesting that people are more prone to adopt the LMSBS with automation and electrification if their moral obligation is strong. We also found that personal norms mediated the association between subjective norm and behavioral intention. This finding mirrored the evidence reported in the current literature [25].

TPB, a self-interest theory, captured rational motivations of intention for LMSBS with automation and electrification in cold-climate environments. It was found that perceived behavioral control from TPB was positively related to individuals' intention to accept LMSBS with automation and electrification. However, this result should be regarded with caution. PBC reflected the extent to which a person had control over the performance of specific behaviors [38]. Notably, Sok et al. [42] pointed out that it is not an easy task to determine the degree to which a person's own volition governs behaviors in empirical research. Thus, perceived behavioral control is usually regarded as an approximation of actual control. Subjective norm from TPB was also found to have a significantly positive influence on adopting LMSBS with automation and electrification among the public in cold-climate areas. This observation was consistent with previous findings within the transportation service domain [24,25]. As shown by Furnham et al. [43], collectivism was relatively more dominant in the context of daily life in China. This may have led to the significant impact of social pressure on behavioral intention among the public. In addition, the LMSBS with automation and electrification has not been extensively popular with the general public, and individuals' understanding may not be comprehensive. Thus, social media could be an approach to promote the adoption of this service among the public.

The negative impact of perceived risk on transportation technology acceptance has been confirmed [44], and the empirical results also proved this relationship. Perceived risk was found to negatively affect behavioral intention, which was consistent with prior findings within the transportation domain [44,45]. It is possible that the LMSBS with automation and electrification has not been widely popular in the market. Thus, users still have a concern about personal safety and functional failure. The perception of safety issues might decrease their intention to use LMSBS with automation and electrification in cold-climate environments.

4.2. Practical Implications

The results contribute to offering practical implications for the development, promotion, and implementation of the LMSBS with automation and electrification in cold-climate environments. In view of the study findings, three streams (i.e., government, operating businesses, and manufacturers) are suggested based on analysis results.

The governments are suggested to propose corresponding policies and increase users' enthusiasm through positive advocacy, thus resulting in intention to use. The governments should emphasize the pro-social value of the LMSBS with automation and electrification regarding environmental benefits and anticipated contributions to congestion mitigation, which could improve personal norms. Furthermore, the governments should actively promote the benefits for which individuals adopt this service for personal travel convenience and well-being, which could improve individuals' perceived usefulness and intention to use. The promotion channels could be newspapers, the internet, and other social media to vividly introduce the LMSBS with automation and electrification.

The shuttle bus operating companies should improve the operational efficiency of LMSBS with automation and electrification by optimizing departure intervals, which could improve individuals' perceived usefulness of adopting LMSBS with automation and electrification. Additionally, the shuttle bus operating companies could conduct a free trial operation to directly allow users to experience the LMSBS with automation and electrification. It could enrich users' knowledge about this service effectively and enhance their intention to travel by this mode. The companies could also provide subsidies for experienced users to publicize the service to their friends and family as the subjective norm is a significant determinant of behavioral intention. Moreover, it is also necessary for companies to issue statements explaining how the last-mile shuttle buses with automation and electrification protect passengers in special events, which could reduce individuals' perceived risk to enhance their acceptance of this service.

Manufacturers should promote the research of automation and electrification technologies to ensure the safe operation of the LMSBS with automation and electrification in different scenarios. Particularly, it is essential to pay attention to decreasing the potential perceived risk of LMSBS with automation and electrification.

4.3. Limitations and Future Directions

First, sampling bias might exist in our research sample regarding different education level among the public. The age of participants was divided into only two groups in our study sample (i.e., <45 and >=45) without more detailed division, and the survey sample only comprised China survey data and may not be fully representative of the general attitude around the world. Different cultural backgrounds and conditions may affect individuals' willingness to accept. Second, most participants did not have usage experience with LMSBS with automation and electrification. The behavioral intention discussed in this research depends on the initial intention of the individuals' recognition gained from social media. With the popularity of automation and electrification technologies in the market, individuals' behavioral intentions toward LMSBS with automation and electrification will be changed in the future.

There could be more studies on the acceptance of LMSBS with automation and electrification to be conducted in the future. First, future studies could conduct stratified sampling of different education levels according to Chinese Census (2020) data to make the results more representative. Future studies could target older people above 60 more strongly, who are considered digitally excluded social groups. It is also necessary to generalize and compare our results for exploring choice intentions in different countries. Second, future studies can aim to identify the evolution of public willingness after interaction between passengers and LMSBS with automation and electrification. Third, a longitudinal study might be carried out to further explore relationships between behavioral intentions and usage behaviors.

5. Conclusions

A theoretical model for public acceptance of last-mile shuttle bus services with automation and electrification in cold-climate environments that integrated TAM, NAM, and TPB with the considerations of perceived risk has been developed in this paper. Attitude and perceived usefulness were found to contribute most to predicting public acceptance of last-mile shuttle bus services with automation and electrification in cold-climate environments. Perceived ease of use indirectly affected the willingness to use through the mediating roles of attitude and perceived usefulness. Predictors from NAM were found to play important roles in determining intention for public acceptance of last-mile shuttle bus services with automation and electrification. Personal norms had a significant association with the intention for last-mile shuttle bus services with automation and electrification. Moreover, awareness of consequences and ascription of responsibility were identified to have indirect impacts on behavioral intention. Perceived behavioral control and subjective norm were found to positively affect behavioral intention based on the research data. Subjective norm also affected behavioral intention indirectly through the mediating effect of personal norms. Additionally, perceived risk was revealed to be negatively associated with the behavioral intention for last-mile shuttle bus services with automation and electrification in cold-climate environments. In general, the proposed acceptance model matched well with the data collected in China. The results provide significant implications for designing and implementing last-mile shuttle bus services with automation and electrification to support better individuals' acceptance.

Author Contributions: Conceptualization, N.W.; Data curation, N.W.; Formal analysis, Y.P. and H.F.; Funding acquisition, Y.P.; Investigation, N.W.; Methodology, N.W. and H.F.; Resources, Y.P.; Software, N.W.; Supervision, Y.P.; Validation, H.F.; Writing–original draft, N.W.; Writing–review and editing, Y.P. and H.F. All authors have read and agreed to the published version of the manuscript.

Funding: The research was funded by the Key Project of National Natural Science Foundation of China (Grant No. 51638004).

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the School of Traffic and Transportation, Northeast Forestry University, China (approval date: 10 December 2021).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Not applicable.

Acknowledgments: The authors thank the Transportation Research Center, Northeast Forestry University, China, for providing the survey data.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Measurement items.

Constructs	Items	Origin
Behavioral Intention	BI1: If the last-mile shuttle bus service with automation and electrification is put into use, I will try to employ it. BI2: If the last-mile shuttle bus service with automation and electrification is put into use, I will plan to employ it. BI3: If the last-mile shuttle bus service with automation and electrification is put into use, I will employ it.	[31,32]
Awareness of Consequences	AC1: Using the last-mile shuttle bus service with automation and electrification can reduce environmental pollution. AC2: Using the last-mile shuttle bus service with automation and electrification can enhance travel well-being in cold-climate environments. AC3: Using the last-mile shuttle bus service with automation and electrification can alleviate traffic congestion due to the use of private cars.	[4,33]
Ascription of Responsibility	AR1: I have the responsibility to reduce environmental pollution. AR2: I have the responsibility to enhance travel well-being. AR3: I have the responsibility to alleviate traffic congestion.	[4,33]
Personal Norms	PN1: I feel a moral obligation to use this service to reduce energy consumption and alleviate traffic congestion. PN2: I consider it crucial to use this service to reduce energy consumption and alleviate traffic congestion. PN3: I feel that I should use this service to reduce energy consumption and alleviate traffic congestion.	[33,46]
Subjective Norm	SN1: People who are important to me think that I should use the last-mile shuttle bus service with automation and electrification. SN2: People who influence my behavior think that I should use the last-mile shuttle bus service with automation and electrification. SN3: People whose opinion I value think that I should use the last-mile shuttle bus service with automation and electrification.	[32]
Attitude	AT1: My attitude towards using the last-mile shuttle bus service with automation and electrification is positive. AT2 *: Using the last-mile shuttle bus service with automation and electrification is not a wise choice. AT3: The last-mile shuttle bus service with automation and electrification will play an important role in the public transportation system.	[31]
Perceived Behavioral Control	PBC1: Whether I use the last-mile shuttle bus service with automation and electrification or not is completely up to me. PBC2: Using the last-mile shuttle bus service with automation and electrification is entirely within my control. PBC3: I am confident that if I want, I can use the last-mile shuttle bus service with automation and electrification.	[25]

Table A1. *Cont.*

Constructs	Items	Origin
Perceived Usefulness	PU1: I find the last-mile shuttle bus service with automation and electrification useful in my daily life. PU2: Using the last-mile shuttle bus service with automation and electrification helps me reach destinations more quickly. PU3: Using the last-mile shuttle bus service with automation and electrification improves travel efficiency. PU4: Overall, using the last-mile shuttle bus service with automation and electrification makes my life convenient.	[32]
Perceived Ease of Use	PEOU1 *: Using the last-mile shuttle bus service with automation and electrification will be difficult for me. PEOU2: Using the last-mile shuttle bus service with automation and electrification is understandable. PEOU3: The last-mile shuttle bus service with automation and electrification is easy to use. PEOU4: It is easy for me to become skillful at using the last-mile shuttle bus service with automation and electrification.	[32]
Perceived Risk	PR1: In bad weather (e.g., rain, fog, snow, etc.) I will worry about its safety. PR2: I am worried that autonomous electric buses cannot handle emergencies well. PR3: I am worried that the failure or malfunctions of autonomous electric buses may cause accidents. PR4 *: I am not worried about the general safety of last-mile shuttle bus services with automation and electrification.	[31,34]

* Notably, 3 out of the 33 measurement items were reversed questions (i.e., PR4, PEOU1, and AT2) to detect nonserious responses and guarantee the validity of the collected data. A correction of reversed items was made during data analysis.

References

1. Stout, M.; Collins, D.; Stadler, S.L.; Soans, R.; Sanborn, E.; Summers, R.J. Celebrated, not just endured: Rethinking Winter Cities. *Geogr. Compass* **2018**, *12*, e12379. [CrossRef]
2. Jansuwan, S.; Liu, Z.; Song, Z.; Chen, A. An evaluation framework of automated electric transportation system. *Transp. Res. Part E Logist. Transp. Rev.* **2021**, *148*, 102265. [CrossRef]
3. Zhuge, C.; Wei, B.; Shao, C.; Dong, C.; Meng, M.; Zhang, J. The potential influence of cost-related factors on the adoption of electric vehicle: An integrated micro-simulation approach. *J. Clean. Prod.* **2019**, *250*, 119479. [CrossRef]
4. Kong, X.; Li, M.; Tang, T.; Tian, K.; Moreira-Matias, L.; Xia, F. Shared Subway Shuttle Bus Route Planning Based on Transport Data Analytics. *IEEE Trans. Autom. Sci. Eng.* **2018**, *15*, 1507–1520. [CrossRef]
5. Chen, J.; Li, R.; Gan, M.; Fu, Z.; Yuan, F. Public Acceptance of Driverless Buses in China: An Empirical Analysis Based on an Extended UTAUT Model. *Discret. Dyn. Nat. Soc.* **2020**, *2020*, 1–13. [CrossRef]
6. Rojas-Rueda, D.; Nieuwenhuijsen, M.; Khreis, H. Autonomous Vehicles and Public Health: Literature Review. *J. Transp. Health* **2017**, *5*, S13. [CrossRef]
7. Wang, H. Routing and Scheduling for a Last-Mile Transportation System. *Transp. Sci.* **2019**, *53*, 131–147. [CrossRef]
8. Alcaraz, J.J.; Caballero-Arnaldos, L.; Vales-Alonso, J. Rich vehicle routing problem with last-mile outsourcing decisions. *Transp. Res. Part E Logist. Transp. Rev.* **2019**, *129*, 263–286. [CrossRef]
9. Taplin, J.H.; Sun, Y. Optimizing bus stop locations for walking access: Stops-first design of a feeder route to enhance a residential plan. *Environ. Plan. B Urban Anal. City Sci.* **2019**, *47*, 1237–1259. [CrossRef]
10. Jie, Z.; Zhiwei, W.; Meng, M. Optimization of bus stop locations for on-demand public bus service. *Transp. Lett.* **2019**, *12*, 329–339. [CrossRef]
11. Chen, Y.; Wang, H. Pricing for a Last-Mile Transportation System. *Transp. Res. Part B Methodol.* **2018**, *107*, 57–69. [CrossRef]
12. Migliore, M.; Burgio, A.L.; Di Giovanna, M. Parking Pricing for a Sustainable Transport System. *Transp. Res. Procedia* **2014**, *3*, 403–412. [CrossRef]
13. Soe, R.-M.; Müür, J. Mobility Acceptance Factors of an Automated Shuttle Bus Last-Mile Service. *Sustainability* **2020**, *12*, 5469. [CrossRef]
14. Chee, P.N.E.; Susilo, Y.O.; Wong, Y.D. Determinants of intention-to-use first-/last-mile automated bus service. *Transp. Res. Part A Policy Pract.* **2020**, *139*, 350–375. [CrossRef]
15. Bamberg, S.; Hunecke, M.; Blöbaum, A. Social context, personal norms and the use of public transportation: Two field studies. *J. Environ. Psychol.* **2007**, *27*, 190–203. [CrossRef]
16. Wang, J.; Zhao, S.; Zhang, W.; Evans, R. Why people adopt smart transportation services: An integrated model of TAM, trust and perceived risk. *Transp. Plan. Technol.* **2021**, *44*, 629–646. [CrossRef]

17. Wu, J.; Liao, H.; Wang, J.-W.; Chen, T. The role of environmental concern in the public acceptance of autonomous electric vehicles: A survey from China. *Transp. Res. Part F Traffic Psychol. Behav.* **2018**, *60*, 37–46. [CrossRef]
18. Niu, Z.; Hu, X.; Qi, S.; Yang, H.; Wang, S.; An, S. Determinants to parking mode alternatives: A model integrating technology acceptance model and satisfaction–loyalty model. *Transp. Res. Part A Policy Pract.* **2021**, *152*, 216–234. [CrossRef]
19. Yang, C.-S. Maritime shipping digitalization: Blockchain-based technology applications, future improvements, and intention to use. *Transp. Res. Part E Logist. Transp. Rev.* **2019**, *131*, 108–117. [CrossRef]
20. Ning, Y.; Yan, M.; Xu, S.X.; Li, Y.; Li, L. Shared parking acceptance under perceived network externality and risks: Theory and evidence. *Transp. Res. Part A Policy Pract.* **2021**, *150*, 1–15. [CrossRef]
21. Nordlund, A.; Jansson, J.; Westin, K. Acceptability of electric vehicle aimed measures: Effects of norm activation, perceived justice and effectiveness. *Transp. Res. Part A Policy Pract.* **2018**, *117*, 205–213. [CrossRef]
22. Mehdizadeh, M.; Zavareh, M.F.; Nordfjaern, T. Mono- and multimodal green transport use on university trips during winter and summer: Hybrid choice models on the norm-activation theory. *Transp. Res. Part A Policy Pr.* **2019**, *130*, 317–332. [CrossRef]
23. Kim, J.J.; Hwang, J. Merging the norm activation model and the theory of planned behavior in the context of drone food delivery services: Does the level of product knowledge really matter? *J. Hosp. Tour. Manag.* **2020**, *42*, 1–11. [CrossRef]
24. Chen, C.-F.; Chao, W.-H. Habitual or reasoned? Using the theory of planned behavior, technology acceptance model, and habit to examine switching intentions toward public transit. *Transp. Res. Part F Traffic Psychol. Behav.* **2011**, *14*, 128–137. [CrossRef]
25. Liu, Y.; Sheng, H.; Mundorf, N.; Redding, C.; Ye, Y. Integrating Norm Activation Model and Theory of Planned Behavior to Understand Sustainable Transport Behavior: Evidence from China. *Int. J. Environ. Res. Public Health* **2017**, *14*, 1593. [CrossRef] [PubMed]
26. Yuen, K.F.; Wang, X.; Wong, Y.D.; Zhou, Q. Antecedents and outcomes of sustainable shipping practices: The integration of stakeholder and behavioural theories. *Transp. Res. Part E Logist. Transp. Rev.* **2017**, *108*, 18–35. [CrossRef]
27. Chen, C.-F. Factors affecting the decision to use autonomous shuttle services: Evidence from a scooter-dominant urban context. *Transp. Res. Part F Traffic Psychol. Behav.* **2019**, *67*, 195–204. [CrossRef]
28. Liu, P.; Yang, R.; Xu, Z. How Safe Is Safe Enough for Self-Driving Vehicles? *Risk Anal.* **2019**, *39*, 315–325. [CrossRef]
29. Bigman, Y.E.; Gray, K. Life and death decisions of autonomous vehicles. *Nature* **2020**, *579*, E1–E2. [CrossRef]
30. Pigeon, C.; Alauzet, A.; Paire-Ficout, L. Factors of acceptability, acceptance and usage for non-rail autonomous public transport vehicles: A systematic literature review. *Transp. Res. Part F Traffic Psychol. Behav.* **2021**, *81*, 251–270. [CrossRef]
31. Wu, Z.; Zhou, H.; Xi, H.; Wu, N. Analysing public acceptance of autonomous buses based on an extended TAM model. *IET Intell. Transp. Syst.* **2021**, *15*, 1318–1330. [CrossRef]
32. Venkatesh, V.; Thong, J.Y.; Xu, X. Consumer acceptance and use of information technology: Extending the unified theory of acceptance and use of technology. *MIS Q.* **2012**, *36*, 157–178. [CrossRef]
33. Onwezen, M.C.; Antonides, G.; Bartels, J. The Norm Activation Model: An exploration of the functions of anticipated pride and guilt in pro-environmental behaviour. *J. Econ. Psychol.* **2013**, *39*, 141–153. [CrossRef]
34. Zhang, T.; Tao, D.; Qu, X.; Zhang, X.; Lin, R.; Zhang, W. The roles of initial trust and perceived risk in public's acceptance of automated vehicles. *Transp. Res. Part C Emerg. Technol.* **2019**, *98*, 207–220. [CrossRef]
35. Zhang, T.; Tao, D.; Qu, X.; Zhang, X.; Zeng, J.; Zhu, H.; Zhu, H. Automated vehicle acceptance in China: Social influence and initial trust are key determinants. *Transp. Res. Part C Emerg. Technol.* **2020**, *112*, 220–233. [CrossRef]
36. Herrenkind, B.; Brendel, A.B.; Nastjuk, I.; Greve, M.; Kolbe, L.M. Investigating end-user acceptance of autonomous electric buses to accelerate diffusion. *Transp. Res. Part D Transp. Environ.* **2019**, *74*, 255–276. [CrossRef]
37. Dyussenbayev, A. Age Periods of Human Life. *Adv. Soc. Sci. Res. J.* **2017**, 4. [CrossRef]
38. Ajzen, I. The theory of planned behavior. *Organ. Behav. Hum. Decis. Process.* **1991**, *50*, 179–211. [CrossRef]
39. Wang, Y.; Wang, S.; Wang, J.; Wei, J.; Wang, C. An empirical study of consumers' intention to use ride-sharing services: Using an extended technology acceptance model. *Transportation* **2020**, *47*, 397–415. [CrossRef]
40. Li, D.; Xu, X.; Chen, C.-F.; Menassa, C. Understanding energy-saving behaviors in the American workplace: A unified theory of motivation, opportunity, and ability. *Energy Res. Soc. Sci.* **2019**, *51*, 198–209. [CrossRef]
41. Han, H.; Meng, B.; Kim, W. Emerging bicycle tourism and the theory of planned behavior. *J. Sustain. Tour.* **2016**, *25*, 292–309. [CrossRef]
42. Sok, J.; Borges, J.R.; Schmidt, P.; Ajzen, I. Farmer Behaviour as Reasoned Action: A Critical Review of Research with the Theory of Planned Behaviour. *J. Agric. Econ.* **2020**, *72*, 388–412. [CrossRef]
43. Furnham, A.; Tu, B.-L.; Swami, V. Cross-cultural differences in self-assessed intelligence: A comparison of british and chinese undergraduates. *Psychologia* **2012**, *55*, 21–27. [CrossRef]
44. Jing, P.; Du, L.; Chen, Y.; Shi, Y.; Zhan, F.; Xie, J. Factors that influence parents' intentions of using autonomous vehicles to transport children to and from school. *Accid. Anal. Prev.* **2021**, *152*, 105991. [CrossRef] [PubMed]
45. Jing, P.; Huang, H.; Ran, B.; Zhan, F.; Shi, Y. Exploring the Factors Affecting Mode Choice Intention of Autonomous Vehicle Based on an Extended Theory of Planned Behavior—A Case Study in China. *Sustainability* **2019**, *11*, 1155. [CrossRef]
46. Wang, N.; Pei, Y.; Wang, Y.-J. Antecedents in Determining Users' Acceptance of Electric Shuttle Bus Services. *Mathematics* **2022**, *10*, 2896. [CrossRef]