Hindawi
Journal of Advanced Transportation
Volume 2019, Article ID 9095279, 12 pages
https://doi.org/10.1155/2019/9095279

Research Article

Exploring Passengers' Travel Behaviors Based on Elaboration Likelihood Model under the Impact of Intelligent Bus Information

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Received 17 November 2018; Revised 30 January 2019; Accepted 17 February 2019; Published 4 March 2019

Academic Editor: Nicolas Chiabaut

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The ubiquitous intelligent transportation infrastructure in metropolitan cities has enabled bus passengers to access comprehensive (even real-time) bus information. However, the impact of different types of information on passenger behavior is still insufficiently understood. Combining with the theory of information processing path, this study partially fills this gap by adopting an elaboration likelihood model (ELM) suitable for explaining how the various types of intelligent bus information influence passengers' choice behavior. Six types of intelligent bus information (information of bus lines, estimated travel time, estimated time of arrival, congestion inside bus, road congestion, and bus fare) are used as six independent variables, and passengers' departure time, travel routes, and travel modes as dependent variables. Valid questionnaire assessments were collected from 285 participants at 4 bus stops equipped with intelligent bus system in Harbin, providing quantitative data to verify each hypothesis. The results show that six types of intelligent bus information to different degrees (significant influence, slight influence, and no significant influence) affect three types of passengers' choice behaviors; the information of estimated travel time and that of road congestion are both significantly effective in all three types of choice behavior while bus fare has no significant influence. Meanwhile, other types of information have a significant or slight effect on certain behavior. The results of this study can be used to design more reasonable intelligent bus information provision strategies to meet passengers' requirements.

1. Introduction

Buses are important components of public transportation system, which play a crucial role in alleviating urban congestion. Many efforts have been devoted to enhancing bus service, including providing as much bus information as possible to passengers. The intelligent bus information referred to in this paper includes both stationary information (e.g., bus route, schedule, and fare) and dynamic (real-time) information (e.g., estimated bus arrival time, estimated travel time, congestion on road, and congestion inside bus); passengers can plan their trips according to the information available.

Previous studies concentrated more on real-time bus information which refers to the tracking of transit vehicle locations and predicted arrival times for vehicles at stops or stations. So far, a number of researchers have attempted to reveal the procedures of intelligent bus information collection and distribution or concentrate only on travelers' choice behavior modes; however, there has been little discussion about the changes of passenger travel choice behavior influenced by different types of information. At the same time, few studies have been conducted to determine whether all kinds of information have a certain effect.

According to ELM and the relative importance of bus-related information [1–3], this paper categorizes the information of bus line, estimated travel time, and estimated time of arrival into the central route and groups the information of congestion inside bus, road congestion, and bus fare into the peripheral route. Based on the data of a survey, we test the significance of these information to three kinds of travel behavior (departure time, travel route, and travel mode). Finally, we summarized the effects of different kinds of information on the three types of behavior.

This study will enrich the research field and has some theoretical contribution. The traditional bus scheduling scheme and strategy based on static data of passengers will deviate from the actual situation in the case that the passengers' travel plan may change. Therefore, information, passengers' behavior, and vehicle scheduling are combined to guide the public transport management department releasing the most effective information, helping achieve the healthy development of urban public transportation, which is in line with the idea of intelligent transportation.

The rest of this paper starts with the literature review in Section 2 and then methodologies, where the data, variables, and hypotheses are clarified in Section 3. The results are analyzed in Section 4. Section 5 summarizes the research and give more discussion.

2. Literature Review

Recent years have witnessed an increased interest in the impact of real-time bus information. Many types of research have consistently shown that real-time bus information has positive effects on bus quality of service. Dziekan and Kottenhoff [4] concluded that real-time information displayed at bus stops reduces waiting times and uncertainty, resulting in higher customer satisfaction and a better image of public transportation. A study conducted from 2006 to 2007 on the University of Maryland [5] measured the effects of a real-time bus arrival information system for the university's shuttle service; the authors concluded that real-time information did not significantly affect passengers' bus trip frequency but significantly boosted their overall level of satisfaction. Watkins et al. [6] indicated that real-time information system could reduce passengers' waiting time. Brakewood et al. [7] studied the effect of real-time bus information by a behavioral experiment, in which participants were divided into two groups with or without real-time bus information; results showed that real-time information significantly decreases average waiting time and improves travel experience.

Researches have also shown that real-time bus information can increase the use of transit. In 2009, a web-based survey of over 400 users was asked if their average number of transit trips per week changed as a result of real-time bus information [8]. About 31% of users replied that there were increases in noncommute trips, while few people reported increases in commute trips. A follow-up survey in 2012 has found similar results [9]. An empirical evaluation of a real-time bus information system in Chicago modeled average weekday route-level bus usage for each month from 2002 to 2010 [10]; results showed that the system did increase bus ridership, although the average increase is modest. Later, a research in New York City also indicated that investments in customer information systems have had a significant impact on bus ridership levels [11]. Just to name a few. For more related studies, Brakewood and Watkins [12] gave a comprehensive review of the impact of real-time bus information.

Certainly, the effects of different types of information are different. Molin and Timmermans [1] studied the relative importance of a variety of types of transit information; the study showed that the importance of information in descending order is real-time information, route planning options, payment-related information, and walking route to the transit station. Grotenhuis et al. [2] investigated which type of information is most desired by passengers during different stages of a transit trip. Through an Internet survey, Mulley et al. [3] presented that users are aware and seek different information at different stages of the journey.

Although there are a plethora of studies indicating the positive effect of real-time bus information, researches on the difference between the effects of different types of information—both real-time and stationary information—are relatively insufficient [3]. Psychology studies [13] have shown the significance of multisource information in people's decision and behavior. Therefore, this paper aims to investigate the effects of various types of information. To this end, a field survey was designed and conducted, and the results are analyzed by elaboration likelihood model (ELM). ELM is a theory proposed by psychologists Petty and Cacioppo [14] describing the change of attitudes. The model provides a tool to explain how people's attitudes change by different types of stimuli. Many researches on information processing have used the ELM as its theoretical basis [15]. Examples include but not limited to advertising and marketing, e-commerce, politics, and tourism [16]. Regarding intelligent bus information, passengers are also facing a process of receiving information, changing behavior, and making decisions; ELM is therefore perfectly suitable in this context.

The ELM believes that people process information with different levels of thought (elaboration), ranging from a low degree (low elaboration) to a high degree (high elaboration), and high elaboration plays a dominating role in decision-making. There are two types of route to process information—central route and peripheral route. When people process information centrally, they process the information at high elaboration, and the corresponding information is more persuasive.

3. Methodologies

3.1. Data Collection. SP surveys are declarative preference surveys, also known as intention surveys. This kind of surveys presets some hypothetical scenarios and organically combines them so that the respondents can make a preference choice. This study used a stated preference (SP) survey on bus stop platforms to investigate the preferences of bus passengers on departure time, route, and mode of travel under different intelligent bus information.

In Harbin, bus stops can be divided into two kinds according to intelligent bus information. One is the conventional bus stop, and the other is the bus stop with electronic board providing additional information; bus electronic stop boards are only set up in the main urban area. For example, 16 bus routes in Harbin have been improved and 50 bus stops have set up electronic stop boards. At conventional bus

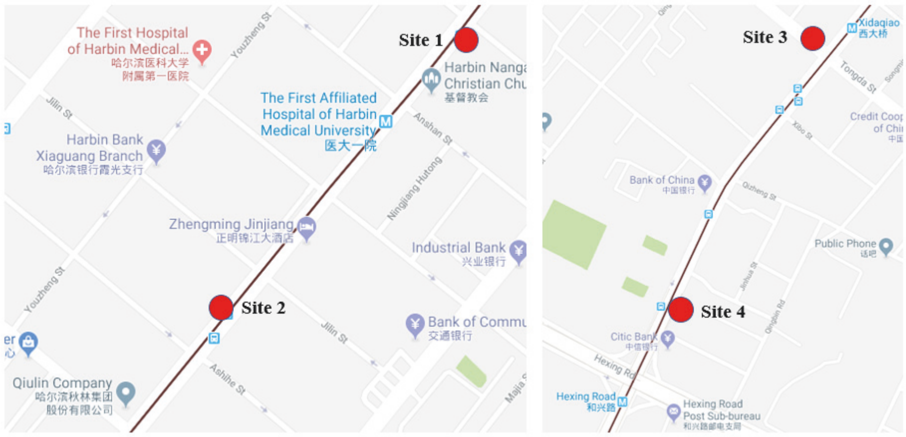

Figure 1: Four sites for questionnaire distribution in Harbin, China.

stops, passengers can only access static bus route information which shows the name of each bus stop along the route. At bus stops with electronic boards, besides static bus route information, and locations of the upcoming bus are also available. However, the estimated travel time, estimated time of arrival, congestion inside bus, road congestion, and bus fare are not provided in the electronic boards.

The acquisition of intelligent bus information is mainly from the bus electronic stop boards and the mobile applications. The passengers' travel choice behavior includes the departure time, the travel route, and the travel mode; therefore the investigation of the bus stop is the location of the questionnaire distribution. And the choice of the bus stops should meet the following criteria:

(1) There should be plenty of passengers. The adequacy of the passenger flow can reduce the complexity of the questionnaire survey and help carry out the investigation faster. At the same time, it can increase the reliability of random sampling and include the passengers of all ages.

(2) There should be an electronic stop board. The bus information on the electronic board is more convenient and more popular. Therefore, the bus stops with electronic board are chosen.

(3) There should be a subway station nearby. The nearby subway will compete with the bus, so the passengers will choose a preference after getting some real-time information about bus arrivals. Choosing a bus stop near a subway station to investigate will also make the research results more accurate and reliable.

According to the previous conditions, the following stops in Harbin were selected as questionnaire sites: First Affiliated Hospital of Harbin Medical University, Qiulin Company, Tongda Street, and Hexing Road (Figure 1).

The survey conducted has the attributes of simple random sampling. Therefore, sufficient sample size must be ensured to make the final statistical results credible and accurate. According to the calculation of sampling survey, when sample capacity is more than 271 in this study, the error rate of +/- 5% at a 90% confidence level is satisfied. Then the final sample should be over 271 copies after eliminating unqualified samples. Between 8 am and 5 pm on weekdays, volunteers handed survey cards to passengers who were asked to respond and return them to volunteers. Surveys were administered to passengers waiting on the bus stop platform. The questionnaires were distributed at the four bus stops selected, and in each site 80 copies were distributed, with a total of 320 issued. After excluding some unqualified questionnaires, there were 285 valid copies.

The questionnaire survey is divided into two parts. The first part is a survey of the basic information of the respondents, including gender, age, occupation, education, and income. The second part is the core of the survey, that is, the impact of intelligent bus information on passengers' travel choice behavior. Since the ELM is established in this paper, eighteen research hypotheses are proposed, so the corresponding eighteen problems are designed to verify these hypotheses. As we want to get the results of the degree of impact, the answer is measurement of degree, which needs to be designed on a 1-5 Likert scale, based on the qualitative measurement of feelings and cognition.

3.2. Variables Identification. To study the impact of intelligent bus information on passengers' travel choice behavior by ELM, we need to identify the independent variables (stimuli) and the dependent variables (behavior change).

The intelligent bus information will be the independent variables of the research. We incorporate a wide range of information, including the information of bus lines, estimated travel time, estimated time of arrival, congestion inside bus, road congestion, and bus fare. According to ELM, the central route focuses on the content revealed by the information itself. The essence of the information is that the main factor affects their attitudes. The peripheral route is not much related to the information itself, and it is probably some marginalized modification. Referring to the relative importance of bus-related information [1] and considering that passengers pay more attention to the bus service itself rather than the outside environment, we propose

Table 1: Summary of variables identification.

Independent variables		Dependent variables
Central route information	Peripheral route information	Travel choice behavior
bus line	congestion inside bus	departure time
estimated travel time	road congestion	travel route
estimated time of arrival	bus fare	travel mode

that central route information can be established as follows: bus line information, estimated travel time, and estimated time of arrival. The peripheral route information includes congestion inside bus, road congestion information, and bus fare information.

We mainly focus on three types of passengers' choice behavior, which are the departure time, travel route, and travel mode. These three kinds of travel choice behavior are dependent variables in modeling. Therefore, the problem of the model is whether the above intelligent bus information has an impact on these three kinds of travel choice behavior of the bus passengers, as well as the significance of the impact (Table 1).

3.3. ELM Modeling and Hypotheses. The information of the bus line covers the name of each station on the road or the common line, and travelers can get several bus ride schemes according to their own destination. Choosing the no transfer bus plan or halfway transfer plan is the impact of bus line information on the passenger travel route. If there is no direct passenger destination bus or bus complex transfer, passengers may choose a taxi. There seems to be no impact on the departure time. Therefore, the following hypotheses are put forward:

H_{1a}: bus line information has no significant impact on departure time.

H_{1b}: bus line information has a significant impact on passengers' travel routes.

H_{1c}: bus line information has a slight impact on passengers' travel modes.

Estimated travel time information is expected to allow passengers to have a general perception of their travel time before they travel, so that they can reasonably arrange their own departure time. For different travel plans, including subway schemes, travelers may tend to choose shorter travel time. Therefore, the estimated travel time information is expected to affect the departure time, route, and mode of travel. The following hypotheses are made:

H_{2a}: estimated travel time information has a significant impact on departure time.

H_{2b}: estimated travel time information has a significant impact on passengers' travel routes.

H_{2c}: estimated travel time information has a significant impact on passengers' travel modes.

The estimated time of arrival information can be intuitively understood by the traveler to know the distance between the bus and stop and how long it would take. If travelers feel that this is too long to wait, they may choose other means of transportation such as taxis, subways, and so on, which is the impact on passengers' travel mode. At the same time, the traveler can also view this information before travel, to arrange their own travel time and avoid unnecessary waiting, which is the influence on passengers' travel time. Therefore, the following hypotheses are put forward:

H_{3a}: estimated time of arrival information has a slight impact on passengers' departure time.

H_{3b}: estimated time of arrival information has a significant impact on passengers' travel routes.

H_{3c}: estimated time of arrival information has a significant impact on passengers' travel modes.

When travelers get information like congestion inside bus, they may give up the current crowded bus and wait a few minutes more for the next bus or maybe directly choose the bus that is not crowded inside. Moreover, they will abandon bus travel to choose a taxi, subway, shared bicycle, and other transit means. The information of congestion affects the travel time, route, and mode of travel so the following hypotheses are made:

H_{4a}: information of congestion inside bus has a significant impact on departure time.

H_{4b}: information of congestion inside bus has a significant impact on passenger travel routes.

H_{4c}: information of congestion inside bus has a slight impact on passenger travel modes.

According to road congestion information, travelers can avoid peak hours, so travel time changes. At the same time, they can look for other travel routes to avoid congested sections, so travel routes change. They can also directly select subway, so there is a change of travel mode. Therefore, the following hypotheses are put forward:

H_{5a}: road congestion information has a significant impact on passengers' departure time.

H_{5b}: road congestion information has a significant impact on passengers' travel routes.

H_{5c}: road congestion information has a significant impact on passengers' travel modes.

Bus fare information has no significant impact on passenger travel time. When passengers are faced with a variety of bus travel plans, they may choose the lowest fare scheme, which has an impact on the travel route. If the bus travel schedule transfer is too high, especially when several people travel together, they may choose to take a taxi and have an impact on the way they travel. The following hypotheses are put forward:

H_{6a}: bus fare information has no significant impact on passengers' departure time.

H_{6b}: bus fare information has a slight impact on passengers' travel routes.

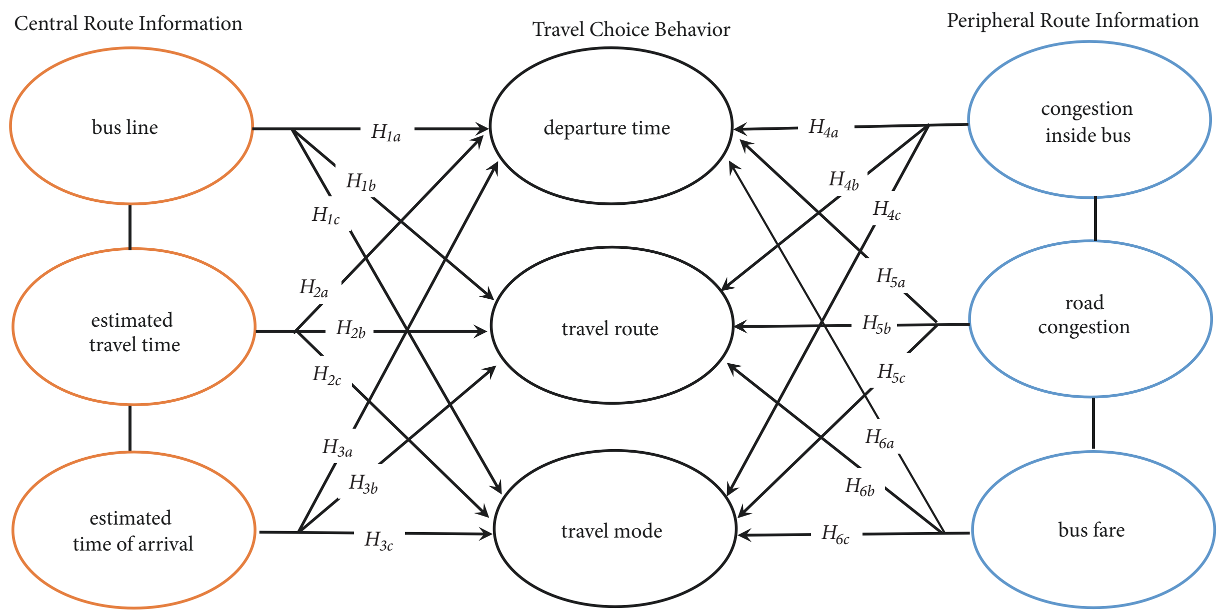

FIGURE 2: ELM research model and hypotheses.

H_{6c}: bus fare information has a slight impact on passengers' travel modes.

If each piece of bus information has an impact on the decision of passengers, the six kinds of intelligent bus information correspond to eighteen kinds of influences, so there are eighteen hypotheses. The overall modeling process can be seen in Figure 2.

4. Results

4.1. Analysis of Reliability and Validity of Questionnaire. The questionnaires were distributed at the four bus stops selected, and 80 copies were distributed at each site, with a total of 320 issued. After excluding some unqualified questionnaires, there were 285 valid copies.

Since the main weakness of SP survey is its reliability bias, the reliability and validity of the survey data should be tested after the investigation. Reliability is an indicator reflecting the stability and consistency of the results of the questionnaire. There are five main methods to estimate reliability, and this study applies Cronbach's α in the software SPSS to test reliability. The questions of the second part are marked as Q_{1a}, Q_{1b}, Q_{1c}, and so on (Table 2).

Firstly, if the alpha coefficient is higher than 0.8, the reliability is high. If this value is in the range 0.7~0.8, the reliability is good. If this value is in the range 0.6~0.7, the reliability is acceptable. If this value is less than 0.6, it is not reliable. Secondly, if the CITC value is below 0.3, the question can be deleted. Moreover, if the Cronbach's α (the question deleted) has been significantly higher than the Cronbach's α, it can be considered to reanalyze the term after being deleted. Table 2 displays an overview showing that the reliability values are all greater than 0.6, which indicates that the reliability of the data is acceptable.

Validity refers to that how much the questionnaire has raised the results that the researcher wants, such as attitude and behavior and whether the results can correctly and effectively explain the phenomenon to be studied. Validity includes content validity, convergent validity, criterion-related validity, and construct validity. Construct validity means that the questionnaire can measure the degree of this internal structure, focusing on theoretical assumptions and hypothesis testing. In this paper, factor analysis is used, and the result of SPSS software is shown as follows (see Table 3).

If the Kaiser-Meyer-Olkin (KMO) value is higher than 0.8, the validity is higher; if this value is in the range 0.7~0.8, the validity is good; if this value is in the range 0.6~0.7, the validity is acceptable; and if this value is less than 0.6, the validity is bad. Secondly, if the correspondence between question and factor is the same as that of psychological expectation, it means that the validity is good. The criteria for deleting questions are as follows: the communality value is less than 0.4, and there is a serious deviation between question and factor. From Tables 2 and 3, we can see that the KMO value is higher than 0.8, indicating that the validity is high, and the corresponding relationship between them is consistent with expectation.

4.2. Hypothesis Verification of ELM

4.2.1. Single-Sample t-Tests. t-Tests were used to analyze the relationship between information and impacts. For the 18 items of the second part of the questionnaire, the form of the five-level scale is adopted, which is divided into strongly agree (support), agree, general, disagree, and strongly disagree (opposed), and the corresponding numbers in the single-sample t-test are 1-5, respectively.

Table 2: Reliability test of questionnaire data.

Intelligent bus information	Questions	CITC	Cronbach's α (the question deleted)	Cronbach's α
Bus line	Q_{1a}	0.454	0.578	0.654
	Q_{1b}	0.573	0.417	
	Q_{1c}	0.382	0.664	
Estimated travel time	Q_{2a}	0.411	0.579	0.634
	Q_{2b}	0.492	0.481	
	Q_{2c}	0.439	0.55	
Estimated time of arrival	Q_{3a}	0.519	0.5	0.669
	Q_{3b}	0.418	0.526	
	Q_{3c}	0.543	0.577	
Congestion inside bus	Q_{4a}	0.537	0.635	0.72
	Q_{4b}	0.527	0.65	
	Q_{4c}	0.562	0.606	
Road congestion	Q_{5a}	0.543	0.466	0.662
	Q_{5b}	0.491	0.542	
	Q_{5c}	0.394	0.662	
Bus fare	Q_{6a}	0.449	0.598	0.656
	Q_{6b}	0.51	0.511	
	Q_{6c}	0.455	0.575	

Table 3: Factor analysis of questionnaire data.

Questions	Factor loadings						Communality
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	
Q_{1a}	0.055	0.092	0.01	0.818	-0.077	0.333	0.797
Q_{1b}	0.001	0.066	0.36	0.713	0.299	0.072	0.736
Q_{1c}	-0.243	0.266	0.693	0.229	0.057	0.167	0.694
Q_{2a}	0.285	0.081	0.392	0.635	0.215	-0.076	0.696
Q_{2b}	0.123	0.073	0.407	0.06	0.462	0.492	0.645
Q_{2c}	0.068	0.542	0.505	0.043	0.19	0.095	0.601
Q_{3a}	0.36	0.045	0.736	0.266	0.033	0.045	0.747
Q_{3b}	-0.022	0.115	0.083	0.127	0.802	0.176	0.712
Q_{3c}	0.098	0.781	0.054	0.005	0.353	0.019	0.748
Q_{4a}	0.542	0.369	0.197	0.116	0.049	0.245	0.544
Q_{4b}	0.447	0.396	0.117	0.07	0.556	0.045	0.686
Q_{4c}	0.388	0.688	0.215	0.035	0.061	0.067	0.68
Q_{5a}	0.475	0.254	0.239	0.164	0.009	0.566	0.694
Q_{5b}	0.222	0.095	-0.011	0.201	0.381	0.743	0.796
Q_{5c}	0.023	0.589	0.121	0.193	-0.089	0.42	0.583
Q_{6a}	0.743	0.042	0.146	-0.041	-0.041	0.192	0.616
Q_{6b}	0.687	0.098	-0.14	0.129	0.397	0.023	0.677
Q_{6c}	0.563	0.482	-0.226	0.262	-0.05	0.028	0.672
Eigenvalue	6.035	1.907	1.324	1.237	0.937	0.883	-
Variance	33.53%	10.60%	7.36%	6.87%	5.21%	4.90%	-
Cumulative variance	33.53%	44.13%	51.48%	58.35%	63.56%	68.46%	-
Eigenvalue (rotated)	2.564	2.445	1.999	1.935	1.794	1.586	-
Variance (rotated)	14.25%	13.58%	11.10%	10.75%	9.97%	8.81%	-
Cumulative variance (rotated)	14.25%	27.83%	38.93%	49.68%	59.65%	68.46%	-
KMO	0.832						-
Bartlett's test of sphericity	758.865						-
df	153						-
p value	0						-

Table 4: Single-sample t-test results for μ_0 = 2 and μ_0 = 3.

Items	Samples	Min	Max	Mean	Standard deviation	t	p
$\mu_0 = 2$							
Items	Samples	Min	Max	Mean	Standard deviation	t	p
Q_{1a}	285	1	4	2.32	0.99	3.5	0.00**
Q_{1b}	285	1	4	1.88	0.72	-1.83	0.07
Q_{1c}	285	1	5	2.27	0.94	3.08	0.00**
Q_{2a}	285	1	4	1.84	0.76	-2.22	0.03*
Q_{2b}	285	1	4	1.85	0.68	-2.34	0.02*
Q_{2c}	285	1	4	2	0.84	0	1
Q_{3a}	285	1	5	2.26	0.92	3.05	0.00**
Q_{3b}	285	1	5	1.99	0.85	-0.11	0.91
Q_{3c}	285	1	5	2.07	0.88	0.85	0.4
Q_{4a}	285	1	5	2.27	0.94	3.08	0.00**
Q_{4b}	285	1	5	2.12	0.86	1.52	0.13
Q_{4c}	285	1	4	2.32	0.99	3.5	0.00**
Q_{5a}	285	1	5	2.14	0.96	1.56	0.12
Q_{5b}	285	1	5	2.04	0.9	0.42	0.68
Q_{5c}	285	1	5	2.09	0.83	1.13	0.26
Q_{6a}	285	1	5	3.15	1.24	9.93	0.00**
Q_{6b}	285	1	5	2.4	1.01	4.26	0.00**
Q_{6c}	285	1	5	2.51	1.06	5.13	0.00**
* $p<0.05$	** $p<0.01$						
$\mu_0 = 3$							
Items	Samples	Min	Max	Mean	Standard deviation	t	p
Q_{1a}	285	1	4	2.32	0.99	-7.28	0.00**
Q_{1b}	285	1	4	1.88	0.72	-16.69	0.00**
Q_{1c}	285	1	5	2.27	0.94	-8.24	0.00**
Q_{2a}	285	1	4	1.84	0.76	-16.28	0.00**
Q_{2b}	285	1	4	1.85	0.68	-18.01	0.00**
Q_{2c}	285	1	4	2	0.84	-12.69	0.00**
Q_{3a}	285	1	5	2.26	0.92	-8.53	0.00**
Q_{3b}	285	1	5	1.99	0.85	-12.72	0.00**
Q_{3c}	285	1	5	2.07	0.88	-11.29	0.00**
Q_{4a}	285	1	5	2.27	0.94	-8.24	0.00**
Q_{4b}	285	1	5	2.12	0.86	-10.84	0.00**
Q_{4c}	285	1	4	2.32	0.99	-7.28	0.00**
Q_{5a}	285	1	5	2.14	0.96	-9.58	0.00**
Q_{5b}	285	1	5	2.04	0.9	-11.43	0.00**
Q_{5c}	285	1	5	2.09	0.83	-11.79	0.00**
Q_{6a}	285	1	5	3.15	1.24	1.29	0.2
Q_{6b}	285	1	5	2.4	1.01	-6.3	0.00**
Q_{6c}	285	1	5	2.51	1.06	-4.96	0.00**
* $p<0.05$	** $p<0.01$						

The original hypothesis of single-sample t-test is H_0: there is no significant difference between the mean value and the test value. The expression is H_0: $\mu=\mu_0$. μ is the mean value and μ_0 is the test value. The actual meaning of μ is the mean value of agreement degree (influence).

Let value μ_0 be equal to 1-5, respectively, and carry out t-tests. The p value of the 18 items is less than 0.05 when μ_0 equals 1, 4, and 5, which shows that no result is in agreement, disagreement, or extreme disagreement.

For μ_0 equal to 2 and 3, results are shown in Table 4. Note that p value in the table is a significant value, which describes the probability of something happening (Table 4).

We can divide the influence degree according to p value as to the influence of the intelligent bus information corresponding to each item of the questionnaire on the passenger travel choice behavior.

As shown in Table 4, when μ_0 equals 2 (the level of the agreement scale is "agree"), the p value corresponding to Q_{1b},

Table 5: The results of hypotheses.

Hypotheses	Result
H_{1a}: bus line information has no significant impact on departure time.	FALSE
H_{1b}: bus line information has a significant impact on passengers' travel routes.	TRUE
H_{1c}: bus line information has a slight impact on passengers' travel modes.	TRUE
H_{2a}: estimated travel time information has a significant impact on departure time.	TRUE
H_{2b}: estimated travel time information has a significant impact on passengers' travel routes.	TRUE
H_{2c}: estimated travel time information has a significant impact on passengers' travel modes.	TRUE
H_{3a}: estimated time of arrival information has a slight impact on passengers' departure time.	TRUE
H_{3b}: estimated time of arrival information has a significant impact on passengers' travel routes.	TRUE
H_{3c}: estimated time of arrival information has a significant impact on passengers' travel modes.	TRUE
H_{4a}: information of congestion inside bus has a significant impact on departure time.	FALSE
H_{4b}: information of congestion inside bus has a significant impact on passenger travel routes.	TRUE
H_{4c}: information of congestion inside bus has a slight impact on passenger travel modes.	TRUE
H_{5a}: road congestion information has a significant impact on passengers' departure time.	TRUE
H_{5b}: road congestion information has a significant impact on passengers' travel routes.	TRUE
H_{5c}: road congestion information has a significant impact on passengers' travel modes.	TRUE
H_{6a}: bus fare information has no significant impact on passengers' departure time.	TRUE
H_{6b}: bus fare information has a slight impact on passengers' travel routes.	TRUE
H_{6c}: bus fare information has a slight impact on passengers' travel modes.	TRUE

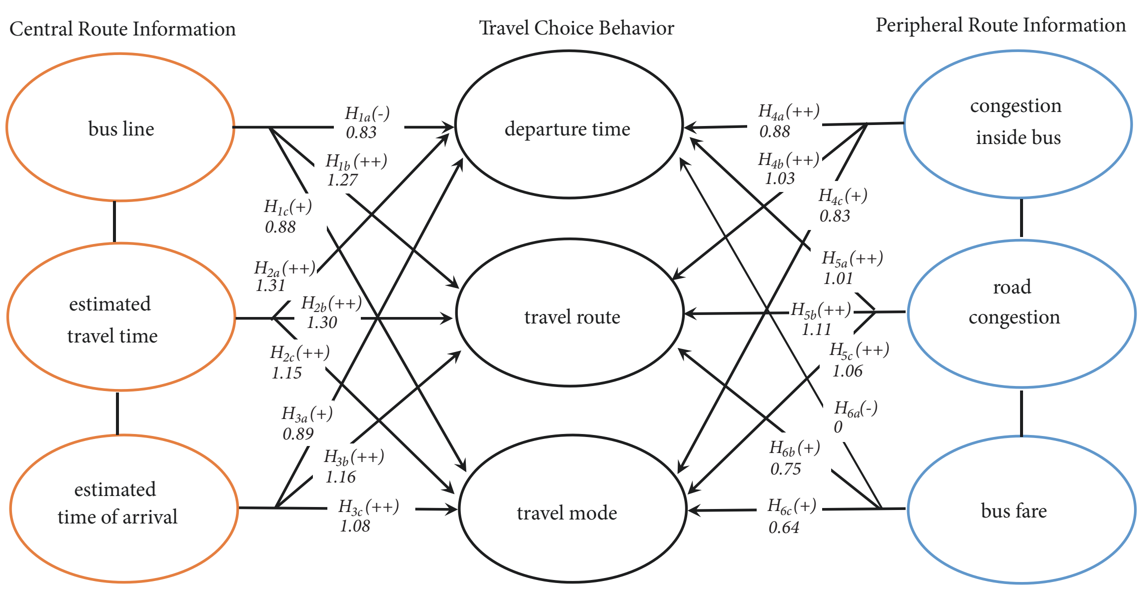

Figure 3: Test results of the elaboration likelihood model.

Q_{2c}, Q_{3b}, Q_{3c}, Q_{4b}, Q_{5a}, Q_{5b}, and Q_{5c} is greater than 0.05 so hypotheses are supported. Although Q_{2a} and Q_{2b} do not stand, their mean value is less than 2, so the degree of impact is higher. The remaining Q_{1a}, Q_{1c}, Q_{3a}, Q_{4a}, Q_{4c}, Q_{6a}, Q_{6b}, and Q_{6c} have a mean value greater than 2 so degree of impact is lower.

It can be seen from Table 4 that when μ_0 equals 3 (the level of agreement scale is "general"), only Q_{6a} is established. And combined with the mean value, it can be concluded that the degree of other items is higher than that of Q_{6a}.

4.2.2. Results of Hypotheses. In the above analysis, the 18 hypotheses are put forward, and the results are summarized (Table 5).

As hypothesis H_{6a} is supported, representing the case that there is no significant impact, the degree of influence can be simplified using H_{6a} as a standard. As is shown in Table 4, the mean value of Q_{6a} is 3.15, so the value of each question can be set equal to (3.15-mean value of question) and the greater the value, the higher the degree of influence. The final result of the ELM is calculated and illustrated as shown in Figure 3.

5. Conclusion

We classified the influences of intelligent bus information on passengers' travel choice behavior into three types: significant influence, slight influence, and no significant influence. One of the most significant findings to emerge from this study is that specific effects of various kinds of bus information on passengers' travel behavior are revealed, which is illustrated in the following.

(i) The information of bus line has a slight impact on passengers' departure time and travel mode while it has a significant impact on travel routes. It may be that bus lines are useful for choosing travel routes.

(ii) The information of estimated travel time is significantly effective in all three types of choice behavior: departure time, travel route, and travel mode. It is possible that passengers care more about travel time of the whole journey.

(iii) Estimated time of arrival information affects passengers significantly in travel route and mode. Meanwhile, this kind of information has a slight impact on passengers' departure time. It is likely that such connections exist because people care more about the waiting time for the next bus.

(iv) The information of congestion inside bus has a significant effect on travel route and mode while having a slight effect on passengers' departure time.

(v) The information of road congestion is key to all the above three types of choice behavior. It seems that road congestion influences travel from time and space dimensions.

(vi) The information of bus fare has no significant impact on departure time and influences travel route and mode slightly.

In general, therefore, this research also has several implications for transit operational agencies. Estimated time of travel is main information that should be obtained before travel. Vehicle arrival information can be displayed with bus icons to indicate which stop it has been moving to. The number of people in vehicle can show that in real time to provide the passengers with a more direct understanding of spare room inside bus. The application of mobile phone can provide the passengers with the road congestion situation of the entire urban road network for their reference.

In sum, this research confirms the effects of intelligent bus information on passengers' travel behavior and offers insight into finding the degree of impacts. Although the findings should be interpreted with caution because of sample size, this study has several strengths: a model called elaboration likelihood model (ELM) mainly used in information technology is introduced to solve the problem of transit. It also represents a comprehensive examination of effects of intelligent bus information and helps transit operational agencies to determine which kinds of information shall be highlighted, detected, and provided to passengers in the long term.

Ideally, a corresponding RP survey should be designed to validate the hypotheses of the SP survey. However, the RP survey cannot be conducted given that the passengers cannot access all six kinds of information by current intelligent bus system. It is highly recommended that the stated survey responses be validated by a RP research in future research when the bus system gets updated. Meanwhile, it is unfortunate that the study does not include complex situations, so it is relatively simple, providing a general reference direction. As the travel of bus passengers is a very complicated problem and individual differences are obvious, it is recommended that further research be undertaken with the individual characteristics and travel purposes of travelers being taken into consideration. Besides, one certain travel choice behavior of different people should be analyzed. What is more, future studies are required to develop a deeper understanding of the relationship between bus information and passengers' travel behavior, so that the results of the study are more comprehensive and accurate.

Appendix

A. The Questionnaire of the Survey

A Survey of Bus Passengers' Travel Choice Behavior

Dear passengers:

We are conducting a research on the impact of intelligent bus information on passengers' travel choice behavior. We need you to answer some questions, which are divided into two parts, 23 items. Thank you for your cooperation and help!

Part I Basic Information

(1) gender: □male □female

(2) age: □less than 18 □18~35 □36~55 □over 56

(3) occupation: □student □staff □the retired □freelance □other

(4) educational background: □high school or below □college or bachelor □master or above

(5) monthly income (RMB): □none □less than 1000 □1000~1999 □2000~3999 □4000~5999 □6000~7999 □more than 8000

Part II Influence of Intelligent Bus Information on Travel Choice Behaviors. If you can get more comprehensive information of buses (bus lines, estimated travel time, estimated time of arrival, congestion inside bus, road congestion, bus fare) from electronic stop boards or mobile apps, then will you choose to do as follows? Please reply with "√" in the corresponding "□" according to your consent level (see Table 6).

B. Basic Analysis of Respondents' Information

See Table 7.

Table 6

Questions	definitely	probably	possible	not likely	impossible
(1) Will you adjust departure time according to buses' route information and transfer information?	☐	☐	☐	☐	☐
(2) Will you adjust travel plan according to buses' route information and transfer information?	☐	☐	☐	☐	☐
(3) Will you choose to transfer to taxis, subways and so on because of receiving buses' route information and transfer information?	☐	☐	☐	☐	☐
(4) Will you adjust the departure time according to the estimated travel time information of this bus trip?	☐	☐	☐	☐	☐
(5) Will you choose a shorter bus ride based on the estimated travel time information for each bus ride plan?	☐	☐	☐	☐	☐
(6) Will you choose to take taxi, subway and so on because the estimated travel time of that bus trip is long?	☐	☐	☐	☐	☐
(7) Will you adjust the departure time according to the estimated arrival time or the real-time location?	☐	☐	☐	☐	☐
(8) Will you choose another route because the next bus is expected to arrive for a long time or too far away?	☐	☐	☐	☐	☐
(9) Will you choose to take a taxi or subway because the next bus is expected to arrive for a long time or too far away?	☐	☐	☐	☐	☐
(10) Will you adjust the departure time because it is too crowded inside the next bus?	☐	☐	☐	☐	☐
(11) Will you choose another bus line because it is too crowded inside the next bus?	☐	☐	☐	☐	☐
(12) Will you choose to take a taxi or subway because it is too crowded inside the next bus?	☐	☐	☐	☐	☐
(13) Will you change the departure time of travel according to the road congestion information?	☐	☐	☐	☐	☐
(14) Will you choose to take the bus riding on the non-congested section according to the road congestion information?	☐	☐	☐	☐	☐
(15) Will you choose to take a taxi, subway and so on because of road congestion information?	☐	☐	☐	☐	☐
(16) Will the bus fare information have an impact on your departure time?	☐	☐	☐	☐	☐
(17) Will you choose a less expensive bus ride plan based on the fare information?	☐	☐	☐	☐	☐
(18) Will you choose to take a taxi, subway, etc. because the bus fare is beyond the acceptable range?	☐	☐	☐	☐	☐

Table 7: Basic information of respondents.

Basic information	classifications	frequency	proportion
gender	male	145	51%
	female	140	49%
age	less than 18	17	6%
	18~35	190	67%
	36~55	60	21%
	over 56	18	6%
occupation	student	110	38%
	staff	120	42%
	freelance	22	8%
	the retired	8	3%
	other	25	9%
educational background	high school or below	58	20%
	college or bachelor	199	70%
	master or above	28	10%
monthly salary	none	95	33%
	less than 2000	43	15%
	2000~3999	52	18%
	4000~5999	42	15%
	6000~7999	38	13%
	more than 8000	15	5%

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

Acknowledgments

This research was supported by the National Natural Science Foundation of China (71603063, 91846301), Natural Science Foundation of Heilongjiang (No. E2016032), China Postdoctoral Science Foundation funded project (No. 2013M540299), and the Fundamental Research Funds for the Central Universities (No. HIT.NSRIF.2015075).

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