Article

Analysis of Ride-Hailing Passenger Satisfaction and Life Satisfaction Based on a MIMIC Model

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Abstract: Well-being enhancement is an essential goal of urban transportation. As an emerging and popular mode of urban transportation, the impact of the ride-hailing service on people's well-being has not been well examined, especially in developing countries. In order to study the influencing factors of ride-hailing passenger satisfaction and the relationship between passenger satisfaction and subjective well-being, a conceptual framework of the relationships between ride-hailing passengers' characteristics, the service quality of ride-hailing (service perception, operation service, external influence, and safety perception), passenger satisfaction, and life satisfaction is developed and verified with data collected in Dalian city, China. A comparative analysis between express and hitch in the ride-hailing service is conducted by a multiple indicators multiple causes model. The result shows that service perception, safety perception, external influence, and operation service have significantly positive effects on passenger satisfaction in both express and hitch, but they play diverse roles. Passenger satisfaction in express and hitch positively and differently affects their respective life satisfaction with the consideration of individual heterogeneity in terms of socio-economic characteristics. These findings complement the interaction mechanism of service quality, passenger satisfaction, and life satisfaction in the field of ride-hailing; they provide critical insights for ride-hailing platforms and policymakers to satisfy the diversified travel needs and the well-being improvement of the public.

Keywords: ride-hailing; passenger satisfaction; life satisfaction; multiple indicators multiple causes model; service quality

1. Introduction

Ride-hailing refers to the business activities of building a service platform based on internet technology, integrating supply and demand information, and using qualified vehicles and drivers to provide taxi-booking services. In conjunction with rail transit and buses, ride-hailing, by overcoming the fixed route limitation and offering 24 h door-to-door services to the public, is considered to be an essential part of an urban public transportation system [1]. In the past several years, the ride-hailing platforms, such as Uber, Lyft, Didi Chuxing, and Grab, have developed rapidly, and their services have become increasingly prevalent all over the world [2,3]. In China, Didi Chuxing, the largest ride-hailing platform, provides several options, such as premier, express, and hitch, for a variety of travelers. According to the China Internet Network Information Center, the number of ride-hailing users in China reached 453 million by December 2021 [4]. Ride-hailing provides diversified travel options for urban residents, enhances their mobility, and facilitates their daily lives. The ride-hailing passengers have become an important group of trip makers in urban transportation. Exploring the travel behavior of ride-hailing passengers is conducive to transportation planning and policy formulation. The accurate market positioning and

rational use of ride-hailing can meet the diversified travel needs of urban residents as well as promote the improvement of people's well-being through a pleasant travel experience, which contributes to the sustainable development of urban transportation.

At present, the research on ride-hailing mainly focuses on the characteristics of ride-hailing passengers [5,6], the temporal and spatial characteristics of ride-hailing trips [7–9], the impact of ride-hailing on other urban transportation modes [10–13], and the comparative analysis of different types of ride-hailing [14,15]. The service quality of ride-hailing is not only an important factor in improving passenger satisfaction with ride-hailing, it is also the key to maintaining the sustainable competitiveness of ride-hailing. Shah and Hisashi [16] analyzed the impact of ride-hailing service quality on passengers' behavior and attitude in developing countries by using a structural equation model (SEM). Nguyen-Phuoc et al. [17] used a partial least squares structural equation model (PLS-SEM) to study the perceived quality before using a ride-hailing service (such as safety, convenience, functionality, information accuracy, etc.) and after the service (such as reliability, convenience, etc.) on the willingness to continue the use of ride-hailing. Zuo et al. [18] conducted data mining for the network evaluation on the Didi Chuxing platform, analyzed the service process of ride-hailing based on the optimization method of the process chain network, and put forward corresponding suggestions for the service quality optimization. Rizki et al. [19] used the SEM to analyze the impact of service quality at different service stages on passengers' use frequency. Zhang and Zhang [20] improved the operation efficiency of different modes in the ride-hailing service by establishing a model of the vacant trip and loading rate assessment. In order to improve the service quality of ride-hailing, Sun and Ding [21] attempted to recognize the potential influencing factors with a two-level growth model.

Some studies further explore the interactions between service quality, passenger satisfaction, and loyalty. Cheng et al. [22] studied the factors affecting the online and offline service quality of ride-hailing driven by sharing economy and their impact on passenger satisfaction and loyalty, using a PLS-SEM. Nguyen-Phuoc et al. [1] analyzed the effects of perceived reservation software benefits, perceived discounts, and perceived service quality on ride-hailing passengers' satisfaction and loyalty, using a PLS-SEM, and found that perceived service quality is more important than other factors. Nguyen-Phuoc et al. [23] used a PLS-SEM to analyze the impact of perceived risk on the satisfaction and loyalty of ride-hailing passengers and found that the risks related to vehicles and drivers directly affected the satisfaction and loyalty of passengers. The articles above have not analyzed the external influences of ride-hailing on passenger satisfaction. With the rapid social and economic development, the urban transportation system in China is facing unprecedented challenges, such as traffic congestion, air pollution, and noise pollution. It has become very important for the passengers to evaluate these potential impacts of ride-hailing. This paper explores the impact of service quality on passenger satisfaction from four aspects: service perception (punctuality, convenience, and comfort); operation service (operation time range, operation area coverage, travel time, and travel cost); external influence (traffic congestion, noise pollution, and air pollution); and safety perception (information safety, personal safety, and traffic safety).

The analysis of individual heterogeneity is helpful to the formulation of transportation policy. There are few studies on the impact of personal heterogeneity on passenger satisfaction with ride-hailing. Existing studies have shown that socio-economic characteristics, such as age, education, occupation, and private car ownership, have a significant impact on the service quality and passenger satisfaction with transportation modes. Ingvardson and Nielsen [24] studied the critical elements of public transport satisfaction by using a multiple indicators multiple causes (MIMIC) model and found that there were obvious differences in the socio-economic characteristics in the passengers' satisfaction, and the satisfaction of young people with the service quality was lower than that of middle-aged and elderly people. De Oña [25] used a MIMIC model to analyze the impact of personal heterogeneity on service quality and passenger satisfaction with public transport modes

and found that gender, income, and residence had an impact on service quality, while gender and education had an impact on passenger satisfaction. This paper analyzes the impact of personal socio-economic characteristics on latent variables to understand the population heterogeneity so that the ride-hailing platform can provide targeted services for its users and enhance the satisfaction and usage intention of ride-hailing passengers.

Promoting the subjective well-being (SWB) of the public is one of the critical goals in an urban transportation policy [26] which enhances social sustainability [27]. Recently, the relationship of travel satisfaction and SWB has been widely considered and discussed in travel behavior analysis. Scholars promote the cognition and emotional experience of people's travel as an important part of subjective well-being and as a new rule to measure transportation services [28,29]. SWB includes positive emotion, negative emotion, and life satisfaction. Life satisfaction is a cognitive assessment of a person's quality of life over a long period of time [30], which generally covers several dimensions, such as family life, work life, and leisure life [31]. Through the evaluation of the impact of car ownership and usage on travel and life satisfaction, Li et al. [26] found that car owners' attitudes towards the instrumental and affective roles of cars have a great positive influence on their travel and life satisfaction. De Vos et al. [32] explored the relationship between travel and well-being and confirmed that travel played a role in SWB through travel experience and activity participation. Yin et al. [33] revealed by an SEM that travel by subway significantly affected passengers' life satisfaction through the connecting bus service quality, walking environment, and travel satisfaction in China. Moeinaddini et al. [34] used a comprehensive dataset to illustrate that the public transport satisfaction is one of the important factors affecting life satisfaction in European cities. It facilitated the making of better decisions about European policies regarding urban life quality. Gärling and Connolly [35] found that increasing travel satisfaction can obviously reduce the negative impact on emotional well-being and life satisfaction. Ma et al. [36] found out that regular travel by bicycle had an influential effect on reducing psychological distress and improving life satisfaction.

The existing research on passenger satisfaction in ride-hailing mainly discusses the relationship between service quality, passenger satisfaction, and loyalty, which is limited to satisfying people's mobility and accessibility but rarely involves improving people's higher-level well-being needs. There is a gap of understanding of the mechanism of passenger satisfaction and individual life satisfaction in the ride-hailing field. Meanwhile, people usually evaluate the level of service of ride-hailing and show attitudes towards their lives differently due to the individual heterogenicity, which requires the implementation of different transportation policies towards different groups of targets. There is little research on the impact of individual heterogeneity of ride-hailing passengers on service quality, passenger satisfaction, and life satisfaction. The SEM is one of the most commonly used methods to explore the behavior intention, but this model ignores the heterogeneity of the socioeconomic characteristics of individuals. A few studies include the social and economic characteristics of travelers, such as gender, age, and income, in the SEM as a construct. However, as these characteristics have no commonality and cannot be measured by a Likert scale, it is unreasonable to regard them as the same construct. Moreover, even if they are included in the model, the impact of each social and economic characteristic on latent variables cannot be analyzed in depth. Therefore, some scholars put forward a MIMIC model on the basis of the SEM. As a MIMIC model has the advantage of considering the unobservable latent variables and better explaining the cause variables, such as personal socio-economic characteristics, over the traditional SEM, the main purpose of this study conducted by the MIMIC model is to construct and validate a conceptual framework representing the interrelationships between service quality, passenger satisfaction, and life satisfaction with the consideration of the heterogeneity of passengers in terms of socio-economic characteristics. This study contributes to both the theory and the practice of the ride-hailing service. The usage impact of ride-hailing, as an emerging and personalized travel mode for residents, on personal life satisfaction is examined. It theoretically contributes the mechanism between service quality, travel satisfaction, and

life satisfaction in the literature, especially in the ride-hailing field, which is not explored in the previous studies. It also becomes a basis of the policy making for the improvement of the life quality of urban residents. From a practical perspective, this paper makes a comparative analysis of two kinds of widely used ride-hailing, express and hitch, with consideration of individual heterogeneity, aiming to promote the ride-hailing platform in order to provide targeted services for its users and improve the satisfaction and usage willingness of the ride-hailing passengers and to provide a theoretical basis and policy suggestions for the ride-hailing market segmentation.

The remainder of the paper is structured as follows. Section 2 describes the collection of the data and the respondents' characteristics; this is followed by the research method in Section 3, describing the research hypothesis of the ride-hailing passengers' socio-economic characteristics, service quality, passenger satisfaction, and life satisfaction. The model estimation is presented in Section 4. The findings are discussed in Section 5, followed by the conclusions in Section 6.

2. Questionnaire Survey and Data Analysis

2.1. Design and Implementation of Questionnaire

This survey adopts the method of combining the revealed preference survey and the stated preference (SP) survey. The main contents of the survey include three parts: basic personal and family information, usage and evaluation of ride-hailing on a daily trip, and SP in travel behavior. In the first two parts of the questionnaire, the five-point Likert scale was used to evaluate various ride-hailing services and personal life satisfaction, with 1, 2, 3, 4, and 5 indicating very dissatisfied, dissatisfied, average, satisfied, and very satisfied, respectively. This paper mainly uses the first two parts of the questionnaire to analyze the relationships between personal characteristics, service quality, travel satisfaction, and life satisfaction.

From May to June 2018, a random sampling survey was conducted in Xi'an Road, Qingniwa Bridge, High-Tech Wanda, and Huanan Square, four main business districts of Dalian city, Liaoning Province, China. These four survey areas are representative crowd gathering places in Dalian city, involving commercial, office, residential, and other land use, which makes it more convenient to investigate all kinds of people using ride-hailing. Several screening questions were used in the questionnaire to ensure that the respondents could be more representative of ride-hailing passengers and meet our survey needs. For example, "How old are you?" and "Have you ever used an express or hitch?" were used to select respondents in the survey. A total of 2158 questionnaires were distributed. After data processing, the questionnaires with contradictory contents and non-response items in the main variables were deleted. Finally, 1362 valid questionnaires were used for express and 1031 for hitch. Sections 2.2 and 2.3 explain the variables that were used in the analysis.

2.2. Descriptive Analysis of Data

Table 1 presents the demographic information of the respondents, such as gender, age, education, occupation, and family monthly income. This paper uses SPSS 26 to analyze the survey data. It can be seen that the proportion of men and women was relatively balanced in express and hitch. Nearly half of respondents were aged from 18 to 25 years old in express and hitch. The number of respondents aged from 26 to 30 and from 31 to 40 was roughly the same (about 22% of the total). The proportion of people over 40 who use ride-hailing was the lowest. More than half of the respondents in express and hitch had an undergraduate university degree, followed by college. In express, the respondents with a family monthly income of more than RMB 13,000 accounted for the largest proportion. Conversely, in hitch, the respondents with a family monthly income between RMB 5000 and 7000 accounted for the largest proportion. In both express and hitch, the lowest proportion of respondents comprised those with a family monthly income of less than RMB 5000. Generally, the passengers in express had a higher family monthly income than the ones in hitch. More than three quarters of the respondents in express and hitch had no children.

More than half of the respondents in express and hitch had private cars, and the proportion was a little larger in express than the one in hitch.

Table 1. Socio-economic characteristics of the sample.

Socio-Economic Characteristics (%)	Express *n* = 1362	Hitch *n* = 1031
Gender		
Male	52.4	52.5
Female	47.6	47.5
Age		
18–25	46.4	45.9
26–30	23.8	23.0
31–40	20.6	21.4
41–50	7.4	7.6
51 or above	1.8	2.1
Education		
High school or below	9.3	9.5
College	17.5	17.3
Undergraduate university degree	64.2	64.8
Postgraduate university degree or above	9.0	8.4
Occupation		
Worker	4.6	5.2
Farmer	0.3	0.6
Government officer	8.8	7.1
Student	38.1	38.8
Service industry personnel	12.8	15.3
Educational researchers	5.0	4.4
Medical staff	3.1	2.3
Management technician	10.0	9.9
Self-employed	8.7	7.4
Other	8.7	9.0
Family monthly income (RMB)		
<5000	9.9	12.3
5000–7000	20.5	23.2
7000–9000	17.2	17.8
9000–11,000	14.6	13.7
11,000–13,000	15.9	14.7
>13,000	22.0	18.3
Couple with children		
Yes	23.8	24.0
No	76.2	76.0
Car ownership		
Yes	62.4	58.4
No	37.6	41.6

2.3. Reliability and Validity Test of Data

In order to test the rationality of the questionnaire and the survey data quality, this paper tests the reliability and validity of the data with the help of SPSS 26 software. The reliability of the survey data was tested by a Cronbach's alpha coefficient. Generally, a Cronbach's alpha coefficient greater than 0.7 indicates that the data have strong internal consistency. The validity of the data was tested by KMO statistics and the Bartlett sphere test. Generally, the KMO value is >0.5 [37], the significance probability value of the Bartlett sphere test is $p < 0.001$ [38], and the factor loading in the component matrix is greater than 0.5 [38], indicating good validity.

The results in Table 2 show that except for the Cronbach's alpha coefficient of passenger satisfaction, the other Cronbach's alpha coefficients are greater than 0.7. Rhodes et al. [39,40]

showed that when the number of indicator variables used by the latent variables is smaller, i.e., passenger satisfaction with the two indicator variables of pleasant degree of taking ride-hailing and overall service evaluation, as included here, a Cronbach's alpha coefficient of 0.5 is acceptable and indicates stronger internal consistency. Therefore, the internal consistency of the questionnaire is ideal.

Table 2. Reliability and validity test of data.

Latent Variables		Indicator Variables	Cronbach's Alpha	KMO	Bartlett's Spherical Test	Factor Loadings
Express	Service perception	Punctuality Convenience Comfort	0.80	0.693	0.000	0.84 0.88 0.82
	Operation service	Operation time range Travel time Travel cost Operation area coverage	0.76	0.651	0.000	0.80 0.77 0.72 0.76
	External influence	Traffic congestion Noise pollution Air pollution	0.88	0.743	0.000	0.89 0.91 0.90
	Safety perception	Information safety Personal safety Traffic safety	0.84	0.717	0.000	0.86 0.89 0.85
	Passenger satisfaction	Pleasant degree of taking ride-hailing Overall service evaluation	0.48	0.500	0.000	0.81 0.81
	Life satisfaction	Health Work/study Free time Family life Social life	0.84	0.833	0.000	0.78 0.82 0.74 0.77 0.83
Hitch	Service perception	Punctuality Convenience Comfort	0.80	0.705	0.000	0.84 0.86 0.82
	Operation service	Operation time range Travel time Travel cost Operation area coverage	0.75	0.668	0.000	0.78 0.75 0.72 0.78
	External influence	Traffic congestion Noise pollution Air pollution	0.87	0.739	0.000	0.89 0.89 0.89
	Safety perception	Information Personal safety Traffic safety	0.85	0.727	0.000	0.87 0.89 0.87
	Passenger satisfaction	Pleasant degree of taking ride-hailing Overall service evaluation	0.50	0.500	0.000	0.82 0.82
	Life satisfaction	Health Work/study Free time Family life Social life	0.85	0.835	0.000	0.80 0.82 0.75 0.78 0.83

The KMO values of the data in Table 2 are all greater than 0.5, the significant probability *p* values of Bartlett spherical test are all less than 0.001, and the factor loadings in the component matrix are all greater than 0.5, indicating that the data validity is ideal. The

indicator variables in the measurement model can be well explained by the corresponding latent variables.

3. Model

3.1. Multiple Indicators Multiple Causes Model

A multiple indicators multiple causes (MIMC) model can correct the deviation caused by the heterogeneity of user perception under different travel conditions and socio-demographic characteristics [41]. A MIMIC model describes the causal relationship between latent variables and between latent variables and indicator variables.

The latent variable linearly determined by a set of observable exogenous causes is

$$\eta = \Gamma x + \xi \tag{1}$$

The latent variable is linearly determined by observable endogenous indicators as follows:

$$y = \Lambda \eta + v \tag{2}$$

where η is a latent variable vector; x is the vector of the cause variable that is causally related to the latent variable η; y is the indicator variable vector that has a measurement relationship with the latent variable η; Γ and Λ are the parameter matrices to be estimated; and ξ and v are the measurement errors.

Equations (1) and (2) constitute the MIMIC model, in which the multiple causes part is represented by Equation (1), and the multiple indicators part is represented by Equation (2). According to this study, the specific expression of the multiple causes part of express is modelled as

$$\begin{aligned} \eta_{ln} = {}& c_{l1}gender_n + c_{l2}young_n + c_{l3}middle_n + \\ & c_{l4}mincome_n + c_{l5}hincome_n + c_{l6}car_n + \xi_n \end{aligned} \tag{3}$$

According to this study, the specific expression of the multiple causes part of hitch is

$$\begin{aligned} \eta_{ln} = {}& c_{l7}young_n + c_{l8}middle_n + c_{l9}mincome_n \\ & + c_{l10}bachelor_n + c_{l11}children_n + \xi_n \end{aligned} \tag{4}$$

where l indicates service perception, operation service, external influence, safety perception, passenger satisfaction, and life satisfaction. n is the observed individual. c represents the parameter to be estimated.

That is, the causes for the individual's latent preferences are gender (equal to one if male); young (equal to one if the individual's age is between 18 and 30 years old); middle (equal to one if the individual's age is between 31 and 40 years old); mincome (equal to one if the family monthly income is between RMB 9000 and 13,000); hincome (equal to one if the family monthly income is more than RMB 13,000); car (equal to one if car ownership is equal to one or greater); bachelor (equal to one if the individual's education is bachelor's degree or above); and the presence of children in the household (equal to one if there is a child in the household).

3.2. Research Hypothesis

The hypotheses are proposed from three aspects.

(1) The impact of service quality on passenger satisfaction.

The existing research shows that service quality, such as comfort [1], economy [1], and safety [23], directly affects passenger satisfaction. This paper discusses the impact of service quality on passenger satisfaction from four aspects: service perception, operation service, external influence, and safety perception. Therefore, the following hypotheses are proposed in this paper.

H1. *Service perception has a directly positive impact on passenger satisfaction.*

H2. *Operation service has a directly positive impact on passenger satisfaction.*

H3. *The satisfaction of external influence has a directly positive impact on passenger satisfaction.*

H4. *Safety perception has a directly positive impact on passenger satisfaction.*

(2) The impact of passenger satisfaction on life satisfaction.

Life satisfaction refers to the cognitive evaluation of a person's quality of life in a period of time [28]. De Vos argued that travel satisfaction will directly or indirectly affect life satisfaction [42]. Travel satisfaction could have a direct influence on life satisfaction through the spill-over effect of the subjective experience during travel, such as good impressions or emotions [29,42,43]. Travel satisfaction could play a role in life satisfaction indirectly through activity participation [44,45]. Travel satisfies personal daily activity needs, whose utility contributes to life satisfaction [29,46]. Meanwhile, satisfaction with various life domains theoretically contributes to overall life satisfaction [47]. Travel is an important part of personal life, so travel satisfaction conceptually has an effect on life satisfaction [33]. A positive impact of travel satisfaction by public transport on life satisfaction has been confirmed [33,34], and this study believes that the passenger satisfaction in ride-hailing travel also has a certain impact on the passenger's life satisfaction. Therefore, this paper proposes the following assumption.

H5. *Passenger satisfaction has a directly positive impact on life satisfaction.*

(3) The influence of the socio-economic characteristics of ride-hailing passengers on service quality, passenger satisfaction, and life satisfaction.

In the study of individual heterogeneity in other transport modes, it is concluded that socio-economic characteristics, such as age [24], occupation [24], gender [25], education [25], income [42], children [42], and car ownership [48], have significant differences in the latent variables. Therefore, this paper puts forward the following hypothesis for the ride-hailing service.

H6. *Socio-economic characteristics have a direct impact on service perception, operation service, external influence, safety perception, passenger satisfaction, and life satisfaction.*

Therefore, the hypothetical model framework of passenger satisfaction and life satisfaction for both express and hitch is shown in Figure 1.
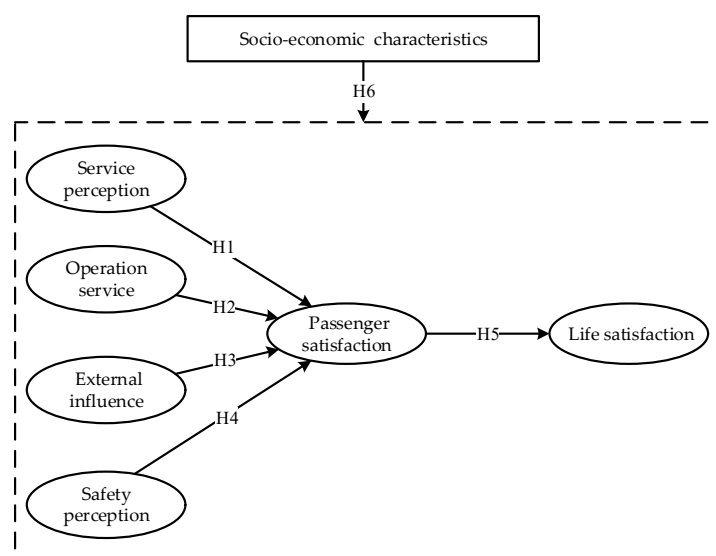

Figure 1. Framework of a hypothesis model for both express and hitch.

4. Model Results

4.1. Model Fitting Test

This paper uses Amos 21 to solve the MIMIC model to analyze the relationships between socio-economic characteristics, service quality, passenger satisfaction, and life satisfaction. According to Mardia's multivariate test statistics, it was found that the Mardia's multivariate test statistics of express and hitch were greater than 5, and the critical ratio was higher than 1.96, indicating that the data of both express and hitch deviated from the multivariate normal distribution at the 95% confidence level [49,50]. Therefore, this paper used Bollen–Stine bootstrapping procedures on 2000 samples to solve the violations of multivariate normality. After the adjustment of the Bollen–Stine bootstrap estimation method, the goodness of fit results of the model were obtained, as shown in Table 3. Their model fitting indices indicate the good establishments of the MIMIC models of express and hitch, where χ^2/df is less than 3, the root mean square error of approximation (RMSEA) is less than 0.08, and the values of the goodness of fit index (GFI), the adjusted goodness of fit index (AGFI), the comparative fit index (CFI), and the Tucker–Lewis index (TLI) were greater than 0.9.

Table 3. Goodness of fit of MIMIC models in express and hitch.

	χ^2	df	χ^2/df	RMSEA	GFI	AGFI	CFI	TLI
Express	363.12	293	1.24	0.01	0.98	0.97	1.00	0.99
Hitch	339.22	269	1.26	0.02	0.97	0.97	0.99	0.99

4.2. Structural Model Analysis

It can be seen from Table 4 that service perception, operation service, external influence, and safety perception have a significantly direct and positive impact on passenger satisfaction; so H1, H2, H3, and H4 are supported. Passenger satisfaction has a significantly positive impact on life satisfaction; so, H5 is supported. This result confirms that the satisfaction of ride-hailing passengers has a certain impact on their life satisfaction, which is consistent with the conclusions obtained for the subway and other public transportation [27,30].

Table 4. Results of hypothesis testing for express and hitch.

	Path	Estimate	p Value
Express	Passenger satisfaction←Service perception	0.363	***
	Passenger satisfaction←Operation service	0.535	***
	Passenger satisfaction←External influence	0.397	***
	Passenger satisfaction←Safety perception	0.374	***
	Life satisfaction←Passenger satisfaction	0.283	***
Hitch	Passenger satisfaction←Service perception	0.508	***
	Passenger satisfaction←Operation service	0.437	***
	Passenger satisfaction←External influence	0.438	***
	Passenger satisfaction←Safety perception	0.281	***
	Life satisfaction←Passenger satisfaction	0.246	***

Note: *** $p < 0.001$.

The effects of various latent variables of express are shown in Table 5. The total effect of operation service on passenger satisfaction is the largest, indicating that operation service is the key indicator to improve the passenger satisfaction of express, and the service level should be maintained and improved in four aspects: operation time range, operation area coverage, travel time, and travel cost. The impacts of the other latent variables on passenger satisfaction are external influence, safety perception, and service perception, respectively. Although the impacts of the three are similar, ride-hailing passengers pay a little more attention to the external influence than the other two in express. This can infer that ride-hailing passengers are relatively satisfied with the convenience and safety of the express

and have a deeper feeling of the external influence caused by the express, such as traffic congestion. Therefore, the ride-hailing platforms should plan the routes more reasonably, regulate driving behavior, and reduce the impact on urban traffic as much as possible. The total effect of passenger satisfaction on life satisfaction is larger and significant, indicating that the passenger satisfaction brought by good express service and utilization experience does play a certain role in improving the life satisfaction of express passengers.

Table 5. Effects among the latent variables in express and hitch.

	Dependent Variable/Mediating Variable	Independent Variable	Direct Effect	Indirect Effect	Total Effect
	Life satisfaction	Service perception		0.103	0.103
	Life satisfaction	Safety perception		0.106	0.106
	Life satisfaction	External influence		0.112	0.112
	Life satisfaction	Operation service		0.152	0.152
Express	Life satisfaction	Passenger satisfaction	0.283		0.283
	Passenger satisfaction	Service perception	0.363		0.363
	Passenger satisfaction	Safety perception	0.374		0.374
	Passenger satisfaction	External influence	0.397		0.397
	Passenger satisfaction	Operation service	0.535		0.535
	Life satisfaction	Service perception		0.125	0.125
	Life satisfaction	Safety perception		0.069	0.069
	Life satisfaction	External influence		0.108	0.108
	Life satisfaction	Operation service		0.107	0.107
Hitch	Life satisfaction	Passenger satisfaction	0.246		0.246
	Passenger satisfaction	Service perception	0.508		0.508
	Passenger satisfaction	Safety perception	0.281		0.281
	Passenger satisfaction	External influence	0.438		0.438
	Passenger satisfaction	Operation service	0.437		0.437

Combined with Tables 4 and 5, the total effect of service perception on passenger satisfaction is the largest in hitch; safety perception has the smallest total effect on passenger satisfaction. External influence and operation service have basically the same impact on passenger satisfaction in hitch. The total effect of passenger satisfaction on life satisfaction is larger and significant, indicating that passenger satisfaction also plays a certain role in improving the life satisfaction of hitch passengers.

As shown in Table 6, the socio-economic characteristics of express passengers have a significant impact on service perception, external influence, safety perception, and life satisfaction and have no significant impact on operation service and passenger satisfaction; so, H6 is partially supported in express. The cause variables reflecting individual heterogeneity among express passengers are gender, age, family monthly income, and private car ownership. In the express, men have a positive impact on safety perception, the ages of 18–30 and 31–40 have a positive impact on service perception, and the higher age group is more sensitive to service perception. Ride-hailing passengers with a family monthly income of RMB 9000 or more have a significantly positive impact on life satisfaction, and the higher the family monthly income, the higher the life satisfaction, which is consistent with the existing research conclusions in the other fields. Ride-hailing passengers from high-income households (family monthly income > RMB 13,000) pay significant attention to the external influence (traffic congestion, noise pollution, and air pollution) brought by ride-hailing, which to some extent reflects the strong environmental awareness of high-income family passengers. The significant coefficient of private car ownership shows that a private car has an important positive effect on improving life satisfaction.

Table 6. Parameter estimation of the express MIMIC model.

	Gender	Young	Middle	Mincome	Hincome	Car
Service perception	-	0.097 **	0.116 ***	-	-	
Safety perception	0.090 **	-	-	-	-	
External influence					0.057 **	
Life satisfaction				0.076 **	0.130 ***	0.085 **
Operation service	-	-	-	-	-	
Passenger satisfaction	-	-	-	-	-	-

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

As shown in Table 7, the socio-economic characteristics of hitch passengers have a significant impact on safety perception, passenger satisfaction, and life satisfaction and have no significant impact on service perception, operation service, and external influence; so, H6 is partially supported in hitch. The causal variables reflecting individual heterogeneity among hitch passengers are age, education, family monthly income, and the presence or absence of children. The results show that people with low education (below undergraduate) pay more attention to the safety of hitch. Ride-hailing passengers with a bachelor's degree or above, with a family monthly income of RMB 9000–13,000, and with children have significant satisfaction with the use of hitch. Ride-hailing passengers aged from 18 to 40 have a positive impact on life satisfaction, which reveals that the use of ride-hailing can meet people's daily personalized travel needs and thereby promote the improvement of life satisfaction to a certain extent.

Table 7. Parameter estimation of the hitch MIMIC model.

	Young	Middle	Bachelor	Mincome	Children
Safety perception	-	-	−0.082 **	-	-
Passenger satisfaction	-	-	0.082 **	0.085 **	0.108 **
Life satisfaction	0.106 **	0.109 ***	-	-	-
Service perception	-	-	-	-	-
External influence	-	-	-	-	-
Operation service	-	-	-	-	-

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

4.3. Measurement Model Analysis

The multiple indicators part of the MIMIC model is a confirmatory factor analysis model. There are 3, 3, 4, 3, 2, and 5 indicator variables for the latent variables: service perception, safety perception, operation service, external influence, passenger satisfaction, and life satisfaction, respectively. As shown in Table 8, all the factor loadings in the measurement model are positive and significant, indicating that the indicator variables can well reflect the latent variables.

Among the indicator variables of service perception in express, convenience has the greatest impact. Express passengers are most concerned about personal safety in safety perception rather than traffic safety and information safety. The satisfaction of the operation time range mostly affects the passengers' evaluation of the express operation service. In the external influence, the three indicators are not much different, and the noise pollution caused by express has a little greater impact. In terms of passenger satisfaction in express, the overall service evaluation plays an important role. Compared with health, family life, and other aspects, people's social life satisfaction evaluation has the greatest impact on life satisfaction. The results reflected by the indicator variables of hitch are basically consistent with those of express, but air pollution and operation area coverage have a little greater impact on external influence and operation service, respectively.

Table 8. Results of express and hitch measurement models.

Latent Variables	Indicator Variables	Estimates	
		Express	Hitch
Service perception	Punctuality	0.739 ***	0.754 ***
	Convenience	0.858 ***	0.794 ***
	Comfort	0.693 ***	0.710 ***
Safety perception	Information safety	0.771 ***	0.789 ***
	Personal safety	0.858 ***	0.849 ***
	Traffic safety	0.755 ***	0.786 ***
Operation service	Operation time range	0.799 ***	0.770 ***
	Travel time	0.563 ***	0.544 ***
	Travel cost	0.513 ***	0.507 ***
	Operation area coverage	0.752 ***	0.772 ***
External influence	Traffic congestion	0.825 ***	0.825 ***
	Noise pollution	0.877 ***	0.826 ***
	Air pollution	0.835 ***	0.827 ***
Passenger satisfaction	Pleasant degree of ride-hailing	0.324 ***	0.319 ***
	Overall service evaluation	0.654 ***	0.682 ***
Life satisfaction	Health	0.688 ***	0.739 ***
	Work/study	0.744 ***	0.769 ***
	Free time	0.649 ***	0.663 ***
	Family life	0.698 ***	0.702 ***
	Social life	0.787 ***	0.777 ***

Note: *** $p < 0.001$.

5. Discussion

5.1. Theoretical Implications

This paper explores the influencing factors of ride-hailing passenger satisfaction and life satisfaction, which were not well examined in the previous studies of travel behavior, and complements the interaction mechanism of service quality, passenger satisfaction, and life satisfaction in the field of ride-hailing. Based on the data obtained from the travel behavior survey of residents who have used ride-hailing in Dalian, China, the conceptual framework of the direct and indirect influence relationships between service perception, operation service, external influence, safety perception, passenger satisfaction, and life satisfaction is verified, theoretically contributing to the knowledge of the formation of passenger attitudes (satisfaction) towards ride-hailing services from the influence factors of service perception, operation service, external influence, and safety perception. Exploring these factors affecting the satisfaction and life satisfaction of ride-hailing passengers is critical, particularly in the context of China where ride-hailing services are considered as a better diversified and personalized transport mode, complementing the urban public transportation.

The study has confirmed that there are significantly direct and positive influences of service perception, safety perception, external influence, and operation service on passenger satisfaction. In express, the total effect of operation service on passenger satisfaction is the largest. Passengers in express services have higher satisfaction when they enjoy a high-quality of operation service, including operation time range, operation area coverage, travel time, and travel cost. The influences of other latent variables on passenger satisfaction are external influence, safety perception, and service perception in turn, but such influences of the three are not much different. In hitch, the total effect of service perception on passenger satisfaction is the largest among the operation service, external influence, safety perception, and service perception, indicating that service perception in terms of punctuality, convenience, and comfort is an important factor in improving passenger satisfaction with hitch. Safety perception has the lowest effect on passenger satisfaction in hitch (the total effect was 0.281), inferring that the hitch passengers generally

neglect safety protections issues, comparatively, when they pursue affordable hitch. In addition, with the insufficient safety protection measures of hitch provided by the Didi platform, two tragic casualty events consequently occurred in hitch, and the Didi hitch service was shut down and forced to rectify later in that survey year. The influences of external influence and operation service on passenger satisfaction are almost the same in hitch, which means the enhancement of the passenger satisfaction also needs to consider the external influences such as traffic congestion, noise pollution and air pollution, and operation services, such as operation time range and operation area coverage.

The satisfaction of express and hitch passengers has a significantly positive impact on their life satisfaction, which reveals that ride-hailing, as an important mode of urban transportation, has played a significant role in meeting diversified individual travel needs. Ride-hailing promotes the improvement of passengers' life satisfaction with the well passenger evaluation and the pleasure brought by the daily good service experience, which is in line with previous studies of the relationship between passenger satisfaction and life satisfaction in the public transport field [33,34]. This study contributes empirical evidence for the interaction mechanism between passenger satisfaction and life satisfaction in the ride-hailing field.

Furthermore, the finding of the study reveals a mediating role of passenger satisfaction between the relationships of service quality from the four aspects discussed above, including service perception, safety perception, external influence, operation service, and life satisfaction. These indirect relationships between these constructs were initially uncovered in this study, offering a basis to understand the formation of the mobility and well-being needs of ride-hailing passengers. As these factors, including service perception, safety perception, external influence, and operation service, have obviously affected passenger satisfaction, in order to enhance life satisfaction, the above-mentioned factors should be the direction of improvement in ride-hailing.

The findings of this study show that the socio-economic characteristics of ride-hailing passengers have a significant impact on service quality (service perception, safety perception, external influence, and operation service), passenger satisfaction, and life satisfaction. The socio-economic characteristics of express and hitch passengers have different effects on various latent variables. Family monthly income and private car ownership have a significant impact on life satisfaction in express passengers, while different age groups have a significantly positive effect on life satisfaction in hitch passengers. The different influencing rules of the passengers' socio-economic characteristics on latent variables reveal that express and hitch passengers have different individual heterogeneity, reflecting that ride-hailing platforms really need to provide different types of ride-hailing services for passengers with different needs. This study is an important supplement to the existing research about the impact of individual heterogeneity in terms of socio-economic characteristics on service quality, passenger satisfaction, and life satisfaction in the ride-hailing field and even in public transportation.

5.2. Practice Implications

From the practical perspective, several important implications in the study are suggested for ride-hailing platforms to improve the service quality of express and hitch, to distinguish the concerns of passengers between the two, and to enrich the understanding of the role and fair usage of ride-hailing in urban public transportation. All these point out the direction for policy-making and can effectively promote the improvement of the well-being of urban residents advocated by transportation policy makers through a good travel experience. With the purpose of improving the travel experience (passenger satisfaction) of ride-hailing that greatly contributes to the continuous usage intention of ride-hailing [15], ride-hailing platforms should first improve the operation service, which is the most critical factor affecting the passenger satisfaction in express. It is found that operation time range and operation area coverage have higher effects on operation service in express. Ride-hailing platforms should continue to keep the advantages of operation

time and area coverage by positioning and expanding the operation service coverage according to the temporal and spatial needs of travelers in different cities and regions. Meanwhile, ride-hailing platforms should take various countermeasures to optimize the travel routes and should distribute discount coupons to reduce the travel time and cost to enhance the experience of the operation service. Correspondingly, as the most influential factor on passenger satisfaction in hitch is service perception, ride-hailing platforms should improve the level of service in terms of convenience by, for example, further improving the algorithm accuracy of the travel-demand matching between drivers and passengers and passengers and passengers, and by reducing the waiting time of passengers and making it more convenient to pick up and deliver passengers. Ride-hailing platforms should also pay attention to more accurate calculations and predictions of road condition information to ensure the timely delivery of passengers. Although taking hitch may be shared with others, based on its own operating characteristics, the platform should try to reduce the number of passengers in one trip and improve the comfort experience of passengers from the perspectives of the driver's attitude and the internal environment of the vehicle.

It is noteworthy that the significant impact of the external influence of ride-hailing on passenger satisfaction is an important finding. Since the birth of ride-hailing, there has been some controversy about the its negative effects on the urban transportation system, such as traffic congestion and environmental pollution [9,51]. With the continuous enhancement of people's awareness of environmental protection, the public is more concerned about the external influence of ride-hailing. The total effects of external influence on passenger satisfaction in express and hitch are statistically significant, and both reach about 0.4, which proves that. Nowadays, China is ambitiously promoting the strategy of green and low-carbon travel. By the end of March 2022, the number of new energy vehicles reached 8.915 million, accounting for 2.90% of the total number of cars in China [52]. New energy vehicles will be one of the main development directions of China's automotive industry in the future [53]. At present, some ride-hailing drivers have adopted hybrid and pure electric models to engage in the ride-hailing services, which greatly reduces fuel costs and exhaust emissions, and improves the economic and social benefits. The ride-hailing platform needs to make full use of high-tech technologies to reduce the impact of ride-hailing operations on traffic congestion. At the same time, it should comply with the national macro transportation policies and continue to encourage and actively promote the new energy vehicle strategy by means of publicity and subsidies and other means, so as to reduce environmental pollution. The authorities should develop a sustainable urban public transportation system in a more comprehensive way and provide the guidance and support of corresponding policies for the wide application of new energy vehicles for ride-hailing. This contributes to a sustainable city while meeting the diversified travel needs of urban residents and improving residents' life satisfaction.

In terms of safety perception, passengers in express pay much more attention to safety issues than those in hitch, based on the total effects, and furthermore, the significant effects order of the indicator variables is personal safety, information safety, and traffic safety. The ride-hailing platforms should continue to strengthen and improve the personal safety protection measures of passengers, such as continuously improving the review and training of ride-hailing drivers and using the real-time positioning and monitoring, the one-click alarm, etc., which are being widely used at present. Although the model results show that the influence of safety perception in hitch is relatively small, the murder of hitch passengers in 2018, after this survey, resulted in people's generally increasing awareness of personal safety in the use of hitch. In suburban areas at night, female passengers in particular are more inclined to choose other means of transportation rather than ride-hailing. The personal safety of ride-hailing passengers is more important when the monitoring system in developing countries is relatively backward. Secondly, with the wide application of the internet and big data technology, passengers are more sensitive to the protection of personal information. Ride-hailing platforms should take various effective measures to avoid passengers' concerns about the leakage and abuse of their own information. In

contrast, passengers worry less about the traffic safety of using ride-hailing, which shows the current good daily operation of ride-hailing.

The order of the total effect of each latent variable on passenger satisfaction between express and hitch is different, indicating that express and hitch have different service characteristics, and the ride-hailing platforms need to continue to deepen the positioning and service level of express and hitch according to their characteristics so as to improve passenger satisfaction. This study provides specific suggestions for two types of ride-hailing to improve passenger satisfaction. The improvement of passenger satisfaction is not only conducive to maintaining the use intention of existing passengers, but also to encouraging potential users to take ride-hailing. As an important supplement to public transport, the passenger satisfaction of ride-hailing will have a significant impact on the life satisfaction of express and hitch passengers, which shows that improving the service quality (service perception, operation service, external influence, and safety perception) of ride-hailing and then improving passenger satisfaction is of great significance in improving citizens' life satisfaction.

The relationship between the socio-economic characteristics and various latent variables, including service quality, passenger satisfaction, and life satisfaction has shown that the personal heterogeneity plays obviously different roles in express and hitch. In order to improve passenger satisfaction and life satisfaction, attention should be paid to people in the express service aged 18–40 or their families with middle and high income (>RMB 9000) and with private cars, while strengthening the collection and feedback of other age groups and female passengers. The good experience of people with high education, middle income, and children or those aged 18–40 should be maintained in the hitch service. Meanwhile, the concerns of people with lower education on the safety of hitch should be strengthened. In these ways, ride-hailing platforms can provide accurate services for all types of passengers, improve the passengers' evaluation of ride-hailing, improve passengers' ride experience, and further expand potential users and improve the quality of life of the passengers.

At present, China is vigorously developing a modern urban public transportation system. As a newly emerging transportation mode under the sharing economy, ride-hailing meets people's personalized travel needs. For example, the express provides people with fast response and economic and comfortable travel services and hitch provides people with economy, convenience, and emission-reduction travel services. Ride-hailing needs accurate market positioning and rational use. While moderately competing with mass transit, it should play a more complementary role in enriching the travel modes of urban residents and organically combining with mass transit. For example, the authorities should guide and encourage the ride-hailing platform by supporting policy to solve the "first mile, last mile" problem of urban residents choosing long-distance public transport and by supporting their travel needs in the times and regions not covered by public transport. Ride-hailing, with its convenient reservation and economical and comfortable travel service, has attracted widespread use by Chinese residents, which may aggravate urban traffic congestion and cause air pollution. In order to realize the sustainable development of urban transportation, local governments should continue to promote the construction of a green and modern urban public transportation system, such as by expanding the coverage of urban public transport, extending the operation time of public transport on holidays, improving the transfer connections between urban public transport and urban external hubs such as railway stations, airports, and long-distance bus stations, and continuously improving the service level of mass transit by policy guidance. In this way, subway, bus, and ride-hailing become reasonably coordinated in the urban public transport system to meet the travel needs, improve the accessibility and pleasant travel experience, and thus promote life satisfaction for urban residents.

6. Conclusions

The relationships between service perception, operation service, external influence, safety perception, passenger satisfaction, and life satisfaction were first analyzed using

data from a developing country in the context of a ride-hailing service. The findings in this study provide valuable insights into the theory and practice of economical ride-hailing types, i.e., express and hitch. With respect to the theory, this study complements the interaction mechanism between passenger satisfaction and life satisfaction in the field of public transportation, especially in the ride-hailing service, and enriches the understanding of the influencing factors on the ride-hailing passenger's satisfaction and life satisfaction. In addition, the impacts of individual heterogeneity in terms of socio-economic characteristics contributes to an important supplement to the existing research on ride-hailing. With respect to the practice, the finding in this study has shown the different influences of latent variables on travel satisfaction and life satisfaction and the different influences of indicator variables and cause variables on the latent variables in express and hitch, respectively. According to these influences, the ride-hailing platform should take differentiated countermeasures to specifically meet the diversified travel needs and improve the travel experience of urban residents so as to naturally improve their life satisfaction.

A few limitations that future research could address need to be acknowledged. First, the current framework of particularly referring to the relationship between passenger satisfaction and life satisfaction in the ride-hailing field is empirically examined in a developing country. The differences and similarities across countries should be investigated. Second, with the inclusion of the latent variables in this study, the complex mechanism of ride-hailing's service quality, passenger expectation and complaint, travel satisfaction, passenger loyalty, and subjective well-being, should be further explored to meet the travel mobility and higher needs of the public. Third, the impact of ride-hailing loyalty on the substitution of private car ownership is another interesting issue for the future.

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