ISSN: 2688-8653

Research on the Influence of COVID-19 on Residents' Choice Behavior of Public Transportation

Qiongwen Lu, Guangnian Xiao*

School of Economics and Management, Shanghai Maritime University, Shanghai 201306, China

*gnxiao@shmtu.edu.cn

Abstract

During the post-COVID-19 epidemic period, the epidemic situation in China is effectively controlled, enterprises quickly resume work and production, and the demand for commuting gradually returns to the pre-epidemic level. Through the online questionnaire, binomial Logistic regression models are used to study whether residents reduce the use of public transportation during the epidemic period and its main influencing factors. Results show that during post-COVID-19 period, the main influencing factors of whether residents reduce the use of public transportation and their mechanisms include density of carriage population, commuting distance, whether the company reimburses /reimbursement, the number of bicycles owned by the family and the number of private car owned has positive effects on reducing the use of public transportation for residents; disinfection situation, reduced bus frequency, reduced ride-hailing services, the presence or absence of a driving license, and the presence or absence of new patients along the route have negative effects on reducing the use of public transportation for residents. According to the results of the study, the public transportation management and service strategies that should be adopted by traffic management departments in major epidemics are proposed, including reasonable arrangement of public transportation schedules, load ratio and route, and the application of big data-driven public transportation operation management decision support systems.

Keywords

public transportation; commuting trip; COVID-19; binomial logistic regression models.

1. Introduction

The novel coronavirus pneumonia (COVID-19) was first reported in late December 2019, and then spread to the whole country from Hubei Province, causing an outbreak. COVID-19 is very easy to spread among people. People will have a series of respiratory symptoms, such as fever, cough, shortness of breath, difficulty breathing. Severely infected people may develop pneumonia, severe acute respiratory syndrome, kidney failure, etc., or even die.

The public health emergency also caused severe damage to the national economy, and at the same time brought an inevitable impact on transportation.

Taking the epidemic situation as the background, domestic and foreign scholars mainly focused on the following two aspects in the study of transportation:

(1) The impact of the epidemic on transportation. Wu et al. found that travelers' subjective perceived risk of transportation mode had a significant impact on ride-sharing choice behavior during the epidemic [1]. Li et al. found that factors such as road density, density of public transportation network were significantly positively correlated with the risk of COVID-19 transmission in the community [2]. In the context of the spread of COVID-19, Peng and Li

ISSN: 2688-8653

proposed to use a new model of "truck-drone" collaborative delivery to carry out logistics distribution in areas with relatively severe epidemic, and further studied the value of this model on logistics distribution under the impact of the epidemic [3]. In response to the unreasonable scheduling of emergency medical supplies in the prevention and control of the new crown epidemic, Hu et al. redesigned the scheduling and distribution system of urban emergency medical supplies in the case of major public health emergencies and proposed the classification method of emergency medical supplies [4]. Jewel found that the number of subway passengers in Seoul decreased significantly in late February, but then increased slowly, indicating that people's risk perception and persistence of social distance decreased [5]. Shi et al. found that the changes in the geographical location of immigrants, the diversity of immigrant employment, the rapid growth of tourism and business travel, and the increasing distance of family gatherings are the reasons that cause the spread of COVID-19 and SARS to be different [6]. At the same time, Shi and Liu pointed out that it is misleading to say that "the massive population movement within China during the Spring Festival is the main reason for the COVID-19 sweeping China" [7]. Wen et al. predicted that COVID-19 may affect the consumption patterns of Chinese tourists, and put forward some suggestions that may help relieve the pressure related to the epidemic, which can partially alleviate the impact of COVID-19 on tourism and hotel industry [8]. Panayotis and Aris pointed out that air travel plays a decisive role in the spread of infectious diseases on a global scale [9]. Alfredo et al. analyzed the impact of the quarantine measures implemented in Spain on March 15 on the urban mobility of the northern city Santander, 2020 [10]. Zhang et al. analyzed the impact of different types of transportation on the spread of COVID-19 in terms of the number, speed and mode of transmission of imported cases in Wuhan [11]. Armando et al. used a multiple linear regression mode to quantify the influence of fluidity habits on the spread of COVID-19 in Italy [12].

(2) Management of public transportation and epidemic prevention and control. Li et al. proposed a framework of public transportation operation management decision support system for the prevention and control of infectious diseases, and established a functional framework based on public health event case database, multi-source data fusion database, public transportation data analysis technology database and public transportation epidemic prevention strategy database, and designed algorithm models of different functional modules [13]. Ma etc. found that the normal customized bus routes optimization model cannot be directly used in public health emergencies. The customized bus route optimization model and algorithm built for emergency scenarios can quickly calculate the optimization plan from many alternatives. It can not only meet the requirements of epidemic prevention, but also meet people's travel needs [14]. Zhou et al. pointed out that in addition to anti-epidemic measures such as temperature detection, wearing masks and hand washing disinfection, unconventional combined anti-epidemic strategies should be adopted based on local actual conditions and risk assessment levels [15]. The Chinese Journal of Preventive Medicine also provided technical guidelines for disinfection of public transportation during COVID-19 outbreaks and health protection guidelines for passenger stations and transporting means during COVID-19 outbreaks, which are applicable to infection prevention and control for staff and travelers on public transportation during normal operation [16, 17]. The research results of Paraskevas and Loukas demonstrated the effectiveness of the European airport system in controlling epidemics [18]. Zhen et al. searched MEDLINE, CENTRAL, Web of Science and the World Health Organization's "Coronavirus Disease Global Research (COVID-19)" database, and conducted a quick review of interventions to reduce the spread of the virus on public ground transportation. After screening 74 records, 4 eligible studies were identified. These studies show that using public transportation will increase the risk of virus transmission, and improving ventilation may reduce this risk [19].

ISSN: 2688-8653

Based on the Statistical Product and Service Solution (SPSS), this paper will study the changes in the proportion of residents choosing public transportation under the COVID-19 and the main factors for making this choice. By collecting residents' commuting choices before and after COVID-19 and the reasons for their behavior choices through online questionnaires, the most influential factors can be determined.

From the perspective of the transportation department, while grasping the reasons why passengers make the commuting behavior choice, timely adjustment and scheduling of bus schedules, disinfection measures and various regulations should be carried out. From the perspective of society, when the public transportation facilities and measures are sufficiently complete, the majority of passengers choose public transportation to commute, which can not only effectively alleviate residents' panic about the epidemic, but also improve the power of urban development, contribute to a green and orderly urban environment, and help each city to renew their economy.

Most of the previous studies have considered the influence of personal characteristics and transportation mode attributes of travelers on the choice behavior in general circumstances, but less consideration was given to the residents’ commuting travel mode in the event of major emergencies. This paper is based on the background of COVID-19, residents gradually returned to work and resumed commuting, based on two Logistic regression models to study whether the proportion of individual residents' public transportation travel decreased, the specific commuting methods and the main factors for making such choices. The content comes from the online questionnaire survey.

This research has important practical significance, which is embodied in:

(1) To supplement the travel mode choice behavior of commuters in the case of a major outbreak. Under normal circumstances, when studying the choice of commuting methods for residents, the factors considered are comfort and convenience. However, when a major outbreak occurs and self-protection needs to be strengthened, new factors such as trust in public transportation disinfection, self-protective consciousness, corporate subsidies, and commuting frequency should all be included in the study. This paper can be used as a supplementary study of travelers' commuting mode choice behavior under normal circumstances, enriching cases and arguments and improving the research in the field of travel behavior.

(2) From the perspective of short-term development: On the one hand, after grasping the reasons for residents' choice of commuting mode, the transportation department can timely adjust and dispatch bus schedules and disinfection measures; on the other hand, by adjusting and dispatching to the residents’ needs in time, more travelers are willing to choose public transportation to travel, which is of great positive significance for alleviating residents' empty talk about the spread of the epidemic and restoring the momentum of social development.

(3) From the perspective of long-term development: in the future, while preventing disasters, the transportation department has emergency experience for future emergencies, and can effectively deal with the changes of residents' commuting behavior under abnormal circumstances.

2. Research Related Theoretical Basis

This paper mainly studies the key factors that affect residents' choices of commuting mode under COVID-19. Therefore, in this chapter, the current situation will be discussed from two aspects: domestic and foreign transportation policies to deal with major epidemics and the factors affecting commuting travel mode choice behavior.

ISSN: 2688-8653

2.1. Domestic and Foreign Transportation Policies in Response to Major Epidemics

2.1.1. Traffic and Transportation Policies of Developed Countries in Response to Major Outbreaks

Developed countries such as the United States, Japan, and the United Kingdom are in the leading position in the emergency response capabilities in the face of sudden major disasters. The advanced experience and response models of these developed countries have considerable reference significance for improving the traffic prevention and control system and mechanism under major epidemics and improving China's transportation emergency management system.

(1) Japan has established a traffic emergency distribution system of "prevention first" and "multimodal transport"

Japan has always attached great importance to the prevention and control of COVID-19. It has adopted an attitude of "prevention first" and implemented "multimodal transport" as an emergency system for domestic transportation during the outbreak. According to the research of Japanese experts, there is a global pandemic of new influenza viruses every 10 to 40 years.

In order to prevent and control the spread of influenza, Japan organized the Ministry of Land to cooperate with the Labor Ministry in 2013 and issued the "Guidelines for Inter-water Measures". It explains how to deal with the virus or epidemic abroad, and arrange the entry and exit of Japanese nationals and tourists.

In 2015, the Ministry of Land issued a response plan, which included "how to maintain the transportation industry in the event of a nationwide outbreak of a new influenza virus" and proposed relevant measures to deal with domestic transportation. These two documents fully consider the most severe situation of the epidemic and provide guidance on how to strengthen the organization and leadership of epidemic prevention, support and cooperation, protect the transportation industry, and how to reduce social and economic losses.

(2) The United States has established a "plan-led, hierarchical response" transportation emergency logistics system

In 2009, the United States experienced a public health emergency of international concern: the outbreak of the H1N1 influenza virus. Since 2009, the annual number of influenza cases in the United States has been between 9 million and 45 million, and the number of deaths has been between 10,000 and 100,000. In 2018, the United States released the "2018-2022 Emergency Management Strategic Plan." One of the three goals is to prepare for emergency response to major disasters, emphasize close cooperation between the government and society, and open up the "last mile" of emergency and disaster relief material transportation. At the same time, in order to improve the efficiency of the distribution of relief supplies, the Federal Emergency Management Agency has integrated the existing complex logistics network from the state, local, commercial organizations and volunteers, clarified the relationship and rules, strengthened the research on the reconstruction of the material supply chain , and effectively utilized emerging logistics and supply chains to ensure that relief supplies can be quickly delivered to the disaster area. In general, the distribution of all disaster prevention and relief supplies in the United States is handled by the Permanent Emergency Supplies Distribution Management Department of the Federal Emergency Department, which is not only responsible for the management of the usual disaster relief supplies, but also predicts the quantity and quantity of various disaster relief supplies. Once a disaster occurs, it will receive uniformly and then distribute and send various disaster relief materials according to the requirements of the disaster [20].

In the emergency transportation business, the United States is able to respond quickly to disasters and effectively deal with information problems. Based on information analysis and data processing, it can accurately predict the people's urgent need of all types of materials and classify them. At the same time, it can accurately analyze the most reasonable distribution

ISSN: 2688-8653

network and the location and quantity of the required distribution centers. The most important thing is that the United States with the aid of advanced IT technology and equipment can minimize transportation costs and shorten disaster response time.

The three levels of cooperation among the country, state, and local constitute the U.S. public health emergency response system. Similarly, the stockpiling of emergency supplies such as medical supplies and daily necessities are also divided into three levels. Since these three levels correspond to the different numbers and scales of the emergency material reserve nodes, in order to make the emergency material reserve level and scale correspond, the transportation and distribution of emergency materials are also operated through the three-level systems of country, state, and local.

(3) The UK has formed a traffic emergency management system featuring "vertical management" and "multi-level coordination"

In recent years, the frequency of public health incidents in the UK has been extremely high. From the global spread of mad cow disease to the spread of foot-and-mouth disease, from swine fever to the widespread flu, the livestock industry and even the national economy have been devastated. The British government must summarize experience and lessons, adjust the emergency response to major epidemic models and management mechanisms, consolidate and improve the vertical management system, and establish a comprehensive framework of an authoritative, professional, and scientific health emergency response system centered on localities.

The United Kingdom has set up a non-permanent Cabinet Emergency Team to respond to emergency situations faced by the transportation industry, and designated the Cabinet Office as a working body. On this basis, the country is divided into different regional vertical administrations. At the same time, the UK has formed a "multi-level coordination" emergency management system led by local governments and supplemented by regional management.

2.1.2. China's Transportation Policy in Response to COVID-19

In order to stop the spread of COVID-19, Wuhan closed the passageways leaving the city at the end of January 2020, followed by the immediate suspension of other public transportation such as city buses, subways and ferries. After two months of unremitting efforts from Wuhan and the entire Chinese people, by the end of March, the epidemic prevention and control situation became clearer. Wuhan gradually resumed part of public transportation, such as buses, subways and ferries, and officially lifted the ban on leaving Wuhan on April 8.

Traffic between cities was forcefully prohibited during the rapid spread of the virus. Because of the rapid spread of the virus during the peak period, the government has adopted a policy of blocking urban traffic, and all external channels have also implemented blockade measures, prohibiting public transportation and other non-essential motor vehicles. In the process of continuous spread of the virus, the traffic was restricted in accordance with the epidemic prevention requirements of "preventing foreign imports and preventing internal rebounds". After the resumption of urban public transportation operations, temperature detection is required for passengers in vehicles. Buses, rail transit, trams, ferries and coach buses are all equipped with management personnel who urge passengers to wear masks, register with their real names, check their body temperature and maintain good order. Passengers can register with the "health code", scan the code and check the temperature, so that the information of fellow passengers can be traced and inquired.

At the same time, the transportation department will increase the frequency of disinfection of public facilities and public places at the stations (terminals), clean and disinfect vehicles based on the number of trips, open windows for ventilation during operation, and strictly control load factors in accordance with relevant indicators., in order to reduce the crowd density of passengers in stations and carriages and the risk of crowd gathering. During the peak period of passenger flow, the control of passenger flow density will be strengthened, and the evacuation of people will be accelerated by increasing the traffic volume and adjusting the distance from the port [21, 22].

2.2. Application of Binomial Logistic Regression Model in Travel Behavior Research

The basic structure of the Logistic regression model comes from the multiple linear regression models. In practical work, we often encounter situations where the dependent variable is a categorical variable, such as whether to change the travel mode, and we need to study the relationship between the categorical variable and a set of independent variables. However, the Logistic model can describe how the change probability of the dependent variables will change when the respective variables change, which can meet the basic needs of analysis. In SPSS, the logistics model with dichotomous variables can be implemented by "binomial logistics" [23].

3. Model Construction and Result Analysis

This paper is based on the binomial Logistic regression model to study whether residents reduce public transportation travel under COVID-19. First, it is necessary to put forward the factors that affect the reduction of residents' public transportation travel behavior in this context, set the model structure, and then conduct a questionnaire survey to obtain data samples. Finally build a model based on the sample data to study whether residents reduce public transportation travel.

3.1. Design of the Questionnaire

The questionnaire of this study will combine SP survey and RP survey, mainly using RP survey to obtain the personal attributes, travel characteristics, external factors, etc. of the interviewees, and then the SP survey method is used to collect the behaviors when the interviewees assume that the epidemic is over. The design of the questionnaire complies with the following three principles: (1) the principle of clear purpose; (2) the principle of project appropriateness; (3) the principle of consistency in interpretation.

This paper is mainly based on the binomial Logistic regression models to study whether residents under COVID-19 reduce public transportation travel. The questionnaire is mainly divided into three parts: personal attributes, travel characteristics, and external factors. It investigates commuting choices in the context of a major epidemic.

The contents of the questionnaire in each section are described in detail below. In Table 1, the attribute level under normal conditions includes the personal attributes in the questionnaire and the travel characteristics under normal conditions. The specific contents are shown in the table below.

3.2. Preliminary Analysis of the Questionnaire Results

In order to ensure the quantity and quality of the questionnaires, this survey adopts a combination of online questionnaire survey and on-site distribution.

The questionnaire of this study is divided into trial investigation stage and formal investigation stage. During the trial survey, the questionnaire was disseminated in a small area for pre-investigation. After the trial survey, the content and structure of the questionnaire were improved. In the selection of locations, the field survey needs to fully consider the credibility of the questionnaire survey, and finally select the entrance of the community during the evening rush hours of workdays and the supermarket with a large flow of people during holidays to ensure the diversity and randomness of the interviewees.

According to statistics, the total number of questionnaires recovered was 325. Considering the integrity and credibility of the sample data, the sample data needs to be screened. First, exclude

ISSN: 2688-8653

4 results that completed the questionnaire within 100 seconds. Secondly, the results of negative responses to the questionnaire survey were excluded (for example, those with many questions not filled in, or those with all the multiple-choice questions choose the first item), and 29 questionnaires are excluded. Subsequently, the data of 2 respondents who were over 60 years old and mentioned retirement in the notes were excluded. Finally, 14 questionnaires on the increase in public transportation travel during the epidemic were excluded. In conclusion, the final number of valid questionnaires was 276, and the questionnaire effective rate was 84.92%.

The questionnaire is mainly divided into three parts: personal attributes, travel characteristics, and external factors, as shown in Table 1:

Table 1. Personal attributes and external factors of respondents

	Variable name	Attribute level
Personal attributes	age18	18~25 years old
	age26	26~30 years old
	age31	31~40 years old
	age41	41~50 years old
	age51	51~60 years old
	city	Freely filled out by the interviewee
	fulltime	1: Full-time 0: Internship
	occupation	Freely filled out by the interviewee
	license	1: Have a car license 0: No car license
	bicycle	Number of bicycles owned by the family 1: 0 2: 1 3: 2 4: 3 5: 3 or more
	car	Number of private cars owned by the family 1: 0 2: 1 3: 2 4: 3 5: 3 or more
Travel characteristics	distance	One-way commuting distance 1: Less than 1km 2: 1~3km 3: 3~5km 4: 5~8km 5: 8~10km 6: over 10km
External factors	density	Density of carriage population
	disinfection	Disinfection situation
	temperature	Whether to conduct temperature checks on passengers
	mask	Whether the surrounding passengers wear masks
	reduction	Reduced bus frequency
	c_distance	Commuting distance
	time	Commuting time
	r_reduction	Reduced ride-hailing services
	cost	Commuting costs
	reimbursement	Whether the company reimburses /reimbursement
	r_license	The presence or absence of a driving license,
	n_car	Number of private cars owned
	p_cost	Parking fee
	patients	The presence or absence of new patients along the route

ISSN: 2688-8653

3.2.1. Results of Survey on Personal Attributes of Respondents

The survey results of the personal attributes of the respondents are shown in Table 2:

Table 2. Survey results of respondents' personal attributes

Personal attributes	Attribute level	Frequency	Proportion
Age	18~25 years old	74	26.80
	26~30 years old	18	6.50
	31~40 years old	80	29.00
	41~50 years old	72	26.10
	51~60 years old	32	11.60
Working status	Full-time	54	19.60
	Internship	222	80.40
Number of bicycles owned by the family	0	124	44.90
	1	116	42.00
	2	28	10.10
	3	6	2.20
	3 or more	2	0.70
Number of private cars owned by the family	0	66	23.90
	1	168	60.90
	2	32	11.60
	3	6	2.20
	3 or more	4	1.40
Have a car license or not	Yes	208	75.40
	No	68	24.60

3.2.2. Results of Respondents' Travel Characteristics

The survey results of respondents' travel characteristics are shown in Table 3:

Table 3. Survey results of respondents' travel characteristics

Travel characteristics	Attribute level	Frequency	Proportion
One-way commuting distance	Less than 1km	40	14.50%
	1~3km	50	18.10%
	3~5km	72	26.10%
	5~8km	18	6.50%
	8~10km	36	13.00%
	Over 10km	60	21.70%
Commuting mode	Walking	48.77	17.67%
	Bicycle	14.77	5.35%
	Shared bicycle	10.43	3.78%
	Battery car /motorcycle	44.19	16.01%
	Bus	24.21	8.77%
	Subway	33.92	12.29%
	Taxi	3.15	1.14%
	Ride-hailing	7.95	2.88%
	Private car	71.87	26.04%
	Other	16.15	5.85%

ISSN: 2688-8653

3.2.3. Statistics of Evaluation Results of Main Factors When Residents Choose Commuting Mode

The questionnaire asked the interviewees about the degree of influence of the following factors on the choice of commuting mode after resuming work, as shown in Table 4:

Table 4. Statistics of evaluation results of the main factors when choosing commuting mode

Problem item	Does not affect at all	Insignificant effect	General	Comparatively influential	Decisively influential
Density of carriage population	11.6%	9.4%	18.8%	25.4%	34.8%
Disinfection situation	8.7%	7.2%	19.6%	19.6%	44.9%
Whether to conduct temperature checks on passengers	10.9%	3.6%	16.7%	19.6%	49.3%
Whether the surrounding passengers wear masks	9.4%	4.3%	7.2%	18.1%	60.9%
Reduced bus frequency	19.6%	10.9%	28.3%	23.9%	17.4%
Commuting distance	19.6%	12.3%	29.0%	19.6%	19.6%
Commuting time	15.9%	14.5%	28.3%	21.0%	20.3%
Reduced ride-hailing services	20.3%	18.1%	27.5%	15.9%	18.1%
Commuting costs	17.4%	18.8%	39.1%	8.7%	15.9%
Whether the company reimburses /reimbursement	30.4%	18.1%	25.4%	8.7%	17.4%
The presence or absence of a driving license	28.3%	15.2%	23.9%	8.0%	24.6%
Number of private cars owned	29.7%	18.1%	27.5%	2.9%	21.7%
Parking fee	30.4%	15.2%	27.5%	10.9%	15.9%
The presence or absence of new patients along the route	17.4%	12.3%	18.1%	18.1%	34.1%

Adding the two columns of "comparatively influential" and "decisively influential" for each factor, the importance of the above factors can be obtained. According to the sample data, when residents choose their commuting mode, the five most important factors are whether the surrounding passengers wear masks; whether to conduct temperature checks on passengers;

ISSN: 2688-8653

disinfection situation; density of carriage population and the presence or absence of new patients along the route.

Next, analyze the general situation of residents who have changed their commuting habits after returning to work during the epidemic and the choice of commuting methods under the epidemic. As shown in Figure 1, the blue broken line is the commuting mode selection of residents under normal circumstances, and the red broken line is the commuting mode selection of residents under the epidemic. It can be clearly seen that the willingness to use buses and subways that have a large traffic volume has dropped, down 5.54% and 8.94% respectively. This part of the residents has switched to bicycles, online car-hailing, private cars, and commuting on foot.

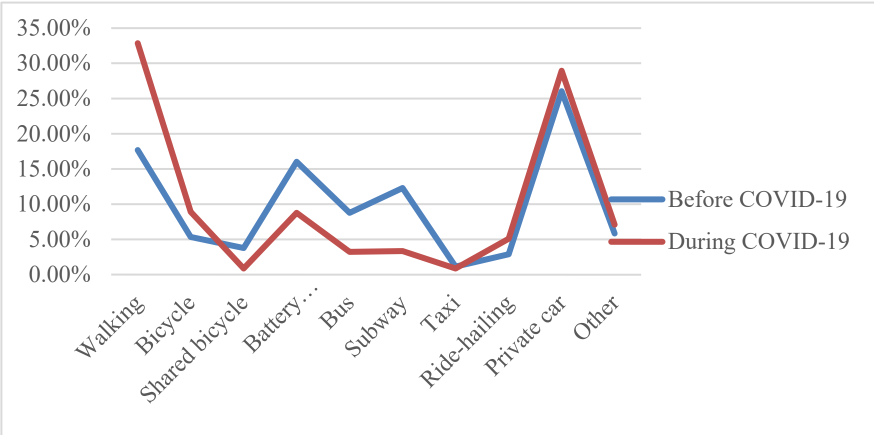

Figure 1. Changes in the proportion of each travel mode

3.3. Reliability and Validity Test of Sample Data

3.3.1. Reliability Test of Sample Data

The reliability test of the sample data in this study adopted the method of half reliability test. The method of half-reliability test is to divide the survey items in half, and then calculate the correlation coefficient of the two halves to estimate the reliability of the entire scale. The steps can be summarized as follows:

First, the Cronbach α coefficient values of the two parts are analyzed respectively.

Second, the Spearman-Brown split reliability coefficient of equal length or unequal length is confirmed to choose for the split reliability analysis.

Third, the reliability level can be analyzed comprehensively by combining Guttman Split-Half coefficient.

Fourth, the Cronbach α coefficient values, the Spearman-Brown Split-Half reliability coefficient, and the Guttman Split-Half coefficient of the two parts usually have the same judgment criteria, that is: higher than 0.8 indicates high reliability; if it is between 0.7 and 0.8, the reliability is good; if it is between 0.6 and 0.7, the reliability is acceptable; if it is less than 0.6, the reliability is not good.

A total of 57 analysis items, such as "age range" are counted. When the halving is divided into two parts, the number of analysis items in the two parts is not equal, so the unequal length halving coefficient (Spearman-Brown coefficient) should be used for reliability quality judgment. The Spearman-Brown split-half reliability coefficient value is 0.728, which is between 0.7 and 0.8, which indicates that the reliability of the research data is good. In summary, the value of the half-reliability coefficient of the research data is between 0.7 and 0.8, which indicates that the quality of the data reliability is acceptable.

ISSN: 2688-8653

3.3.2. Validity Test of Sample Data

Analyzing whether the research item is reasonable and meaningful for the research is usually based on the validity test. The data analysis method used in the validity analysis is factor analysis. The content of factor analysis includes KMO value, degree of commonality, variance interpretation rate value, factor loading coefficient value, and then the above indicators are summarized for comprehensive analysis, and the validity level of the data can be obtained. Among them, the KMO value is used to judge the validity, the degree of commonality is used to exclude unreasonable research items, the variance interpretation rate is used to indicate the level of information extraction, and the factor loading coefficient is used to measure the corresponding relationship between the factors (dimensions) and the items.

According to the validity test of the sample data, the degree of commonality of all the research items is higher than 0.4, indicating that the research item information can be effectively extracted. In addition, the KMO value is 0.872, which is greater than 0.6, indicating that the data has very good validity.

3.4. Model Structure and Principle

The Logit model was first proposed by McFadden in 1973. It uses the Logit probability distribution function, which is shown in formula (1):

$$p_i = F(y_i) = F(\alpha + \beta x_i) = \frac{1}{1+e^{-y_i}} = \frac{1}{1+e^{-(\alpha+\beta x_i)}} \quad (1)$$

Among them, p_i represents probability, and $F(y_i)$ represents Logit cumulative probability density function. For a given x_i, p_i represents the probability that the corresponding individual makes a certain choice. y_i is called a hidden (latent) variable, and the value range of y is (-∞, +∞), and y_i is converted to a probability through the Logit function.

The multinomial Logit model has $j = 1,2,\dots,J$ types for the dependent variable y, and the independent variable x has k cases, which can be explained by the following formula (2):

$$\ln\left[\frac{P(y=j|x)}{P(y=J|x)}\right] = \beta_{j0} + \sum_{k=1}^{K} \beta_{jk} x_k \quad (2)$$

Among them, $\left[\frac{P(y=j|x)}{P(y=J|x)}\right]$ is called the "risk ratio", as the relative risk in the model.

3.5. Steps of Model Analysis

First, the overall situation of the model should be explained, such as describing the R square value and listing the model formula.

Second, the influence of X on Y (relative to the comparison item) is analyzed one by one. If the p value corresponding to X is less than 0.05, it means that X has a significant influence on Y (relative to the comparison item), and the influence amplitude can be further analyzed by combining with the OR value.

Third, the analysis results are summarized.

3.6. Analysis of Model Results

This model uses "whether public transportation travel to be reduced after work resumed during the epidemic" as the dependent variable for binomial Logistic regression analysis. There are 2 items in Y: No (i.e. 0), which means there is no reduction of public transportation travel after resumption of work; yes (i.e. 1), which means reducing public transportation travel after resuming work. The working status, the number of bicycles owned by the family, the number of private cars owned by the family, have a car license or not, one-way commuting distance, age, and the main factors when choosing the way of commuting after returning to work (including density of carriage population; Disinfection situation; whether to conduct temperature checks on passengers; whether the surrounding passengers wear masks; reduced bus frequency; commuting distance; commuting time; reduced ride-hailing services; commuting costs; whether the company reimburses /reimbursement; the presence or absence of a driving license, number of private cars owned; parking fee; the presence or absence of new patients along the route, 14 factors in total) is taken as the independent variable, and "after the resumption of work, whether to reduce public transportation?" is taken as the dependent variable for binomial Logistic regression analysis. As shown in Table 5, a total of 276 samples are analyzed.

Table 5. Basic summary of binomial Logistic regression analysis

Variable Name	Options	Frequency	Percentage
After the resumption of work, whether to reduce public transportation?	No	244	88.4%
	Yes	32	11.6%
	Total	276	100.0%

Hosmer-Lemeshaw test 0 hypothesis that the p value is greater than 0.05, then the observation data and the regression model are in good fit, otherwise the fitting is not good; here the p-value is greater than 0.05, which means that the 0 hypothesis is accepted, and the establishment of the binomial Logistics regression model fits the real data well. This model construction is meaningful, and the model results analyzed later can truly and reliably reflect the relationship between the original variables.

It can be seen from Table 6 that the factors that have a significant impact on whether residents choose to reduce public transportation ($p<0.05$) are: the number of bicycles owned by the family, density of carriage population, disinfection situation, reduced bus frequency, commuting distance, reduced ride-hailing services, whether the company reimburses /reimbursement, the presence or absence of a driving license, number of private cars owned, the presence or absence of new patients along the route; among them, density of carriage population, commuting distance, whether the company reimburses /reimbursement, the number of bicycles owned by the family and number of private cars owned have a positive impact on residents' reduction of public transportation travel; and disinfection situation, reduced bus frequency, reduced ride-hailing services, the presence or absence of a driving license and the presence or absence of new patients along the route have a negative impact on residents' reduction of public transportation travel. Therefore, the final model formula of whether to reduce public transportation travel after resuming work is:

Logit (p) = -2.761 + 1.115 * the number of bicycles owned by the family + 3.330 * density of carriage population - 4.336 * disinfection situation - 2.239 * reduced bus frequency + 3.426 * commuting distance - 1.801 * reduced ride-hailing services + 1.430 * whether the company reimburses /reimbursement - 2.034 * the presence or absence of a driving license + 4.165 * number of private cars owned - 2.034 * the presence or absence of new patients along the route

Among them, the regression coefficient of the number of bicycles owned by the family is 1.115, which means that the number of bicycles owned by the family will have a significant positive impact on whether to reduce public transportation travel after resuming work. And the odds ratio (OR value) is 3.49, which means that when the number of bicycles owned by the family increases by one level (1, 2, 3, 4, 5), the probability of residents reducing public transportation travel after returning to work increases by 3.049 times. Similarly, among the main factors when residents choose the commuting mode, the probability of residents reducing public

ISSN: 2688-8653

transportation travel is 27.935 times when the impact of density of carriage population on the choice of commuting mode is increased by one level. When the impact of commuting distance on the choice of commuting mode is increased by one level, the probability of residents reducing public transportation travel is 30.746 times of the original. When the impact of whether the company reimburses /reimbursement on the choice of commuting mode increases by one level, the probability of residents reducing public transportation travel is 4.180 times of the original. When the influence of the number of private cars on the choice of commuting mode is increased by one level, the probability of residents reducing public transportation travel is 64.372 times of the original.

The regression coefficients of disinfection situation, reduced bus frequency, reduced ride-hailing services, the presence or absence of a driving license and the presence or absence of new patients along the route are negative, which means that these independent variables will have a significant impact on whether residents reduce public transportation travel when returning to work. Among the main factors in residents' choice of commuting mode, the probability of residents not reducing public transportation travel is 0.013 times as long as the degree of disinfection situation affects the choice of commuting mode by one level. When the impact of reduced bus frequency on the choice of commuting mode is increased by one level, the probability of residents not reducing public transportation travel is 0.107 times of the original. When reduced ride-hailing services is reduced by one level, the probability of residents not reducing public transportation travel is 0.165 times as high as before. When the degree of influence of the presence or absence of a driving license on the choice of commuting mode is increased by one level, the probability of residents not reducing public transportation travel is 0.131 times of the original. When the influence of the presence or absence of new patients along the route on the choice of commuting mode is increased by a level, the probability of residents not reducing public transportation travel is 0.131 times of the original.

In summary, residents with a small number of bicycles in their families are more likely to reduce public transportation travel during COVID-19. When choosing commuting modes, the residents who take density of carriage population, commuting distance, whether the company reimburses /reimbursement, the number of bicycles owned by the family and number of private cars as the main factor are more likely to reduce public transportation travel during COVID-19. After all the variables are included in the model, the most significant are the disinfection situation and the number of private cars owned among the main factors in choosing the way of commuting. Residents may maintain a positive and optimistic attitude towards the disinfection of public transportation, so those who regard disinfection situation as the main factor when choosing a commuting mode will not easily reduce their use of public transportation. At the same time, the number of private cars owned also significantly affects residents' choice of commuting methods during COVID-19.

Table 6. Summary of binomial Logistic regression analysis results

Variable	B	Significance	OR	95% confidence interval for OR	
				Lower limit	Upper limit
age18	1.534	0.251	4.638	0.338	63.659
age26	-4.258	0.057	0.014	0.000	1.137
age31	-0.701	0.547	0.496	0.051	4.859
age41	-23.859	0.993	0.000	0.000	
fulltime	1.051	0.374	2.861	0.282	29.050
license	-0.316	0.688	0.729	0.156	3.403
bicycle	1.115	0.048	3.049	1.009	9.215
car	-0.007	0.988	0.993	0.390	2.528
distance	-0.133	0.603	0.876	0.531	1.445
density	3.330	0.001	27.935	3.645	214.098
disinfection	-4.368	0.000	0.013	0.001	0.125
temperature	-0.320	0.626	0.726	0.200	2.631
mask	0.005	0.992	1.005	0.346	2.921
reduction	-2.239	0.025	0.107	0.015	0.757
c_distance	3.426	0.002	30.746	3.417	276.666
time	-0.628	0.477	0.534	0.095	3.009
r_reduction	-1.801	0.002	0.165	0.052	0.528
cost	1.212	0.072	3.359	0.896	12.590
reimbursement	1.430	0.005	4.180	1.557	11.222
r_license	-2.034	0.024	0.131	0.022	0.763
n_car	4.165	0.000	64.372	7.511	551.676
p_cost	-0.656	0.262	0.519	0.165	1.632
patients	-2.034	0.002	0.131	0.037	0.464
constant	-2.761	0.260	0.063		

4. Conclusions and Recommendations

4.1. Main Research Conclusions and Policy Recommendations

This paper is mainly based on the binomial Logistic models to study the public transportation travel behavior of residents under COVID-19, and to study the influence of external factors, travel characteristics and individual preferences on travelers' public transportation.

The main research conclusions of this paper are as follows:

(1) Generally speaking, when residents choose their commuting modes, the following factors are ranked in descending order of importance: safety, reasonable routes, time saving, health and environmental protection, good traffic conditions, comfort and favorable price.

(2) Under COVID-19, when residents choose their commuting modes, the following factors are ranked in descending order of importance: whether the surrounding passengers wear masks, whether to conduct temperature checks on passengers, disinfection situation, density of carriage population, the presence or absence of new patients along the route, commuting time,

reduced bus frequency, commuting distance, reduced ride-hailing services, the presence or absence of a driving license, whether the company reimburses /reimbursement, commuting costs, number of private cars owned, and parking fee.

(3) According to the study of the binomial Logistic models, residents with a small number of bicycles in their families are more likely to reduce their public transportation travel during a major epidemic. Residents who take density of carriage population, commuting distance, whether the company reimburses /reimbursement, and number of private cars owned as the main factors when choosing their commuting modes are more likely to reduce public transportation travel during a major epidemic.

Based on the above conclusions, the following policy recommendations are given:

(1) In terms of transportation, China can learn from the transportation policies of foreign developed countries to deal with sudden major epidemics. For example, planning should be carried out first to optimize the internal and external distribution network system, so as to realize efficient transportation of emergency supplies and effective supply of basic living supplies. We should strengthen preventive work, make scientific plans for transportation emergencies in advance, and continue to deepen and improve them according to actual conditions. Coordinate and cooperate to continuously improve the traffic accident emergency management system and supporting measures.

(2) The study found that density of carriage population and reduced bus frequency have a significant impact on whether residents reduce public transportation travel. Therefore, it is necessary to rationally arrange bus frequency according to the travel demands of residents in public health emergencies, and pay attention to the full load rate of buses.

(3) The presence or absence of new patients along the route also has a significant impact on whether residents can reduce public transportation travel. Therefore, it is necessary to optimize bus routes, determine the operating sections, and formulate emergency bus routes.

(4) The public transportation operation management decision support system can not only guarantee the safe and orderly operation of public transportation, but also contribute to prevent and control the epidemic effectively.

(5) Reduced ride-hailing services also affects residents' public transportation travel. Online riding-hailing companies should establish disinfection points in various places and strictly require online riding-hailing drivers to wear masks throughout the journey.

(6) In the end of the epidemic period, we still need to be vigilant to prevent cross-infection despite the recovery of social activities. In terms of public transportation, the density of people should be controlled according to the prescribed safety distance.

4.2. Research Features

The features of this paper are as follows:

(1) This survey combines SP survey method and RP survey method. RP survey is used to obtain actual travel information from the respondents, while SP survey provides travelers with hypothetical scenarios and records their choices in different situations. The questionnaire of this study will combine SP survey and RP survey, mainly using RP survey method to obtain the personal attributes, travel characteristics, external factors, etc. of the respondents, and then use SP survey method to collect the behaviors that the respondents assume after the epidemic is over, so the survey results are more reliable.

(2) External factors are considered. Residents' public transport travel behaviors in the context of COVID-19 epidemic were studied to supplement the research on commuters' travel mode selection behaviors in the case of a major outbreak.

ISSN: 2688-8653

4.3. Deficiencies and Prospects

Based on the binomial Logistic models, this paper studies the residents' public transportation travel behavior under COVID-19, considering whether external factors, travel characteristics, and individual preferences reduce the influence of public transportation. This research has achieved certain success, but is limited by objective factors such as time and space. The following areas can be improved:

(1) The income of the respondents is not considered in the research;

(2) The sample data is not particularly sufficient;

(3) The respondents may not know the completeness of the disinfection of urban public transportation in China. When distributing the questionnaire, the respondents should be informed of the policy and regulations, and the respondents should be encouraged to use green and environmentally-friendly ways of commuting.

References

[1] Wu J, Wang Y, Chen X. Design of commuter co-ride and organizational efficiency impact analysis during the duration of public health incidents[J]. China Journal of Highway and Transport, 1-12.

[2] Li W, Zhao S, Ji X, et al. The Influence of traffic exposure and land use patterns on the spread of COVID-19 in the communities [J]. Journal of Highway and Transport, 1-17.

[3] Peng Y, Li Y. "Truck-drone" collaborative distribution route optimization considering the impact of the epidemic[J]. Journal of Highway and Transport, 1-18.

[4] Hu X, Song L, Yang B, et al. Research on the optimal dispatch of urban emergency medical supplies under major public health emergencies[J]. China Journal of Highway and Transport, 1-11.

[5] Park J. Changes in subway ridership in response to COVID-19 in Seoul, South Korea: implications for social distancing[J]. Cureus, 2020, 12 (4): 7668-7668.

[6] Shi Q, Dorling D, Cao G, et al. Changes in population movement make COVID-19 spread differently from SARS[J]. Social Science & Medicine (1982), 2020, 255:113036-113036.

[7] Shi Q, Liu T. Should internal migrants be held accountable for spreading COVID-19?[J]. Environment And Planning A-Economy And Space, 2020, 52 (4): 695-697.

[8] Wen J, Kozak M, Yang S, et al. COVID-19: potential effects on Chinese citizens' lifestyle and travel[J]. Tourism Review.

[9] Christidis P, Christodoulou A. The predictive capacity of air travel patterns during the global spread of the COVID-19 Pandemic: risk, uncertainty and randomness[J]. International Journal of Environmental Research and Public Health, 2020, 17 (10).

[10] Aloi A, Alonso B, Benavente J, et al. Effects of the COVID-19 lockdown on urban mobility: empirical evidence from the city of Santander (Spain)[J]. Sustainability, 2020, 12 (9).

[11] Zhang Y, Zhang A, Wang J. Exploring the roles of high-speed train, air and coach services in the spread of COVID-19 in China[J]. Transport Policy, 2020, 94:34-42.

[12] Carteni A, Di Francesco L, Martino M. How mobility habits influenced the spread of the COVID-19 pandemic: results from the Italian case study[J]. The Science Of The Total Environment, 2020, 741:140489-140489.

[13] Li J, Chen T, Zhang Y. Research on public transportation operation management decision support for epidemic prevention and control of infectious diseases [J]. China Journal of Highway and Transport, 1-18.

[14] Ma C, Wang C, Hao W, et al. Optimization of customized bus lines under public health emergencies[J]. Journal of Traffic and Transportation Engineering, 2020, 20 (03): 89-99.

[15] Zhou J, Ma C, Dong S, et al. Unconventional epidemic prevention strategies for urban public transportation under COVID-19: A case study of Ningbo [J]. China Journal of Highway and Transport, 1-11.

ISSN: 2688-8653

[16] Protection C, Disinfection, Technology Team C, et al. Disinfection guideline of public transport during COVID-19 outbreak[J]. Zhonghua Yu Fang Yi Xue Za Zhi [Chinese Journal Of Preventive Medicine], 2020, 54 (4): 344-346.

[17] Protection C, Disinfection, Technology Team C, et al. Health protection guideline of passenger transport stations and transportation facilities during COVID-19 outbreak[J]. Zhonghua Yu Fang Yi Xue Za Zhi [Chinese Journal Of Preventive Medicine], 2020, 54 (4):359-361.

[18] Nikolaou P, DimitriouI L. Identification of critical airports for controlling global infectious disease outbreaks: stress-tests focusing in Europe[J]. Journal of Air Transport Management, 2020, 85.

[19] Zhen J, Chan C, Schoonees A, et al. Transmission of respiratory viruses when using public ground transport: A rapid review to inform public health recommendations during the COVID-19 pandemic [J]. Samj South African Medical Journal, 2020, 110 (6): 478-483.

[20] Wang X. Research on organizational framework, operational mechanism and emergency management of public health safety System in the United States [J]. Tianjin Science and Technology, 2020, 47 (05): 16-19.

[21] Fu Y. Research on the response strategy of urban rail transit public security organs under major epidemic-related public health emergencies[J]. Journal of Shanghai Police College, 2020, 30 (01): 23-32+68.

[22] Zhou W. Urban traffic emergency countermeasures in stages under public health and safety emergencies-a workshop on response to COVID-19[J]. Urban Planning, 1.

[23] Zhang W, Liu Y. IBM SPSS data analysis and practical case summary[M]. Tsinghua University Press, 2013.