Investigating the Determinants of Transfer Passengers' Compliance to Route Guidance Information in Metro Stations

Chen Zhang, Xiaokun Wang, Caixia Chen

***Abstract*— Congestion often occurs in interchange stations of urban rail transit in China. Guidance information is often used to alleviate the congestion of facilities and routes in subway stations. But, most of them are static guidance signs and staff guidance, which can't show the service ability of each transfer route. And, while grasping the determinants of passengers' compliance to the guidance information, it can satisfy passengers' preferences for guidance information and optimize the attributes of guidance information. However, the determinants of passengers' compliance to the guidance information are rarely studied, and the uniqueness of guidance information in the urban rail transit is justified. Therefore, we analyze the key factors of passengers' compliance to the guidance information at the metro interchange station. An empirical study using samples from Xi'an Road Subway Station in Dalian was conducted, and survey data were collected via the Internet. Specifically, respondents' social demographic data and travel attribute variables are obtained, and their preferences for the content, release channel and release cycle of route guidance information are obtained. On this basis, an ordinal logistic model and partial proportional odds model were estimated to investigate the key factors of passengers' compliance to the guidance information. The results show that the partial proportional odds model provides the best statistical fit. Then, based on the results of the partial proportional odds model, the significant results of the determinants are obtained. Furthermore, for the elasticity analysis of determinants, we find that social demographic (e.g., gender, age, occupation, and weight of luggage) and travel attributes (e.g., travel purpose, number of people traveling together, number of station passes per week, and familiarity with the station) have a significant impact on passengers' compliance of route guidance information. Additionally, the preference for the content, release channel and release cycle of route guidance information have a significant and positive impact on passengers' compliance of route guidance information.**

Key words: Rail transit station, guidance information, passengers' compliance, ordered logistic model, partial proportional odds model

I. INTRODUCTION

Urban rail transit is widely regarded as an efficient and environment-friendly transport mode countering the growing travel demand. At the end of 2017, 165 urban rail transit lines had been put into operation in 34 cities of China, with a total track length of 5033 kilometers [1]. With the expansion of urban rail transit network, interchange stations played a very important role to connect between different metro lines, resulting in a higher travel convenience for passengers and increasing the ridership of urban rail transit [2]. In this context, with the gathering of large transfer passenger flow, the rail transit interchange station will not only cause congestion, but also bring inconvenience to the transfer. Evidence showed that providing sufficient transfer route guidance information to the transfer passengers can ease the congestion in the interchange station and improve the transfer efficiency [3-4]. At present, in China, there are only a few ways to provide passengers with transfer route information inside the rail interchange station. Most of them are static guidance signs and staff guidance, which can't show the service ability of each transfer route [5].

The research on static guidance information layout is mostly focused on urban rail transit interchange stations [6-8]. The guidance information in hubs and urban rail transit stations is mostly static. And most scholars often study the layout of guidance information signs, rather than the content, release channel and release cycle of route guidance information. In hubs or urban rail transit stations, static guidance information, as a means of organizing internal passenger flow, is a powerful guarantee for the smooth transfer of passengers [9,25]. Additionally, it is necessary to set reasonable static guiding signs at appropriate locations so that passengers can follow the designed streamlines [10-11]. Furthermore, some scholars often use a binary linear program and a multi-objective mode to analyze the layout of static guide signs [12-13]. Although the research results of static guide signs are numerous, static guide signs do not accurately reflect the level of service of the route, and passenger compliance with static guide signs has not been investigated.

In addition, many scholars have studied the determinants of driver's compliance to guidance information. When real-time traffic information is included in the determinants, the traffic efficiency of congested roads can be significantly improved, which indicates that drivers will have high compliance with the determinants [14-15]. Moreover, there is evidence that when the guidance information includes that provides real-time traffic information (e.g., incident reports and peak congestion) and encourages road users to choose alternative routes, passengers have a higher compliance with the guidance information. resulting in road congestion being alleviated [16,54,55]. At present, the congestion at interchange stations of urban rail transit often occurs, and the congestion often presences in the interchange route between subway lines at interchange stations [17]. Many scholars have studied how to alleviate the congestion of interchange routes of interchange stations. Luo at al [18] sed pedestrian experiments to study the method of optimizing pedestrian traffic efficiency at the transfer route of interchange station. Luo at al [19] proposes and demonstrates a set of optimization

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methods using conduction field experiments to solve the problem of congestion in the transfer routes of interchange stations. Zou at al [20] developed a station flow control system to control the number of passengers on the transfer route of interchange route. However, in the existing research, there is no scholar to study the guidance information of the transfer route at interchange stations. But, it is very important to study the key factors of passengers' compliance to the guidance information before studying the attributes of guidance information [21]. Based on analyzing the compliance of passengers to the guidance information, we can get the preference of passengers to the guidance information [22]. Moreover, the research on passengers' compliance to guidance information mainly focuses on urban roads, but less on urban rail transit. Therefore, it is necessary to study the determinants of passengers' compliance to the guidance information of the transfer route at urban rail transit interchange stations.

This paper takes the transfer travelers in Xi'an Road rail interchange station in Dalian as the research object. Based on the RP (revealed preference) and SP (stated preference) survey, the travelers' demographic data, travel attribute variables, the preferences for the content, release channel and release cycle of route guidance information are analyzed. Ordinal Logistic model and partial proportional odds models were used to analyze the data of the questionnaire. Then, we found that the proportional odds model has the best statistical fit. The results of partial proportional odds models are used as the basis for elastic analysis, and the results of elastic analysis are used to improve the content design and release design of guidance information, which provides a scientific theoretical basis for improving the transfer efficiency of interchange stations.

The main contribution of this study is that we put forward a reasonable and scientific method to release the transfer guidance information in the urban rail transit station. After analyzing the relationship between travelers' demographic data, travel attribute variables, guidance information release strategies and passenger compliance with guidance information, we provide scientific transfer route guidance information to rail transfer passengers. At the same time, this study also provides a reference for the release of transfer route guidance information of other subway interchange stations.

II. Literature review

In many traffic scenarios, such as subway interchange stations, intersections, and urban traffic, guidance information has been widely used to solve the congestion problem. Most studies have focused on factors that determine driver route choice behavior in the presence of guidance information [49-53]. Jou et al. [49], Dia [50] and Kattan et al. [51] investigated that real-time traffic information is the most important factors influencing route-switching behavior in response to guidance information. Chatterjee et al. [52] confirmed the influence of incident information, route guidance information, continuous information describing the traffic state on a major route and travel time information on passengers' route change. Al-deek et al. [53] found the guidance information including travel times, traffic congestion, and special events can change the driver's route choice decision. These studies only focus on the preference of the influencing factor for the guidance information, however, it is significant to investigate the travelers' compliance for guidance information [56]. After understanding the preference of passengers for the compliance of guidance information, we can analyze factors that determine driver route choice behavior.

On the other hand, whether the compliance of guidance information is accepted or not has individual preference [23]. So that the guidance information has different effects on individual compliance [24-25]. Therefore, many scholars have conducted many studies to explore the determinants of compliance with guidance information, which are regarded as endogenous variables [26]. These determinants include individual-related and guiding information-related attributes. The former refers to socio-demographic characteristics [27-29], familiarity with the route [30-31], driving experience through guidance information [32-33], trip purpose [32,34], average number of daily trips as a driver [33,35], number of peers [36-37], and willingness to change driving route [38-39]. The latter includes the content of information (e.g., roadworks and congestion [40-42], road construction, qualitative minute delay and the suggested route diversion information [43]), the format of information [44-46], the display frequency [32,47], locations of guidance information [48].

So far, there is little research on the guidance information of the transfer route in the subway interchange station. One of the critical reasons is the uncertainty of the compliance for guidance information attributes (e.g., the content, release channel and release cycle of route guidance information). If their compliance of guidance information is vague or even contrary, the traveler tends to neglect guidance information and then, the improvement of traffic efficiency at subway interchange station slows down regardless of the use of guidance information [21]. Therefore, this paper tried to bridge the deficiency., and incorporated the above relevant findings as candidate variables into a causal model to explore the key influencing factors of the compliance to the guidance information.

III. Methods

3.1. Survey design

The survey site of this data is Xi'an Road subway station in Dalian, China, and most of the survey questions are related to the actual situation of passengers passing through the subway station. Therefore, this survey is mainly a revealed preference (RP) survey. However, the interviewees were also asked to answer some questions according to some hypothetical scenarios (e.g., subway transfer passengers' preferences for the release channel and content of guidance information) to analyze passengers' preferences for guidance information. Therefore, the survey can be called a mixture of RP and SP (stated preference) surveys. The transfer route selection of Xi'an Road Station of Dalian Metro is shown in Fig. 1. Prior to the survey, a preliminary presentation was made on the purpose of the survey to ensure the validity of the data and to implement the survey between August 1 and August 7, 2022. In this study, data were collected through a face-to-face field survey. Therefore, it can be guaranteed that all participants have passed through Xi'an Road Station of Dalian Metro before completing the survey. A face-to-face questionnaire survey was conducted among 1067 rail station transfer passengers, and 780 valid questionnaires were obtained through analysis and screening, with a collection rate of 73. 1%.

There are 14 questions in the questionnaire, and the description of the questions is shown in Table 1. It is divided into six parts: the travelers' demographic data (e.g., gender, age, occupation, education level, income, and weight of luggage), travel attributes of transfer travelers (e.g., travel purpose, number of people traveling together, number of station passes per week, and familiarity with the station), release channel of guidance information (e.g., dynamic display screen, broadcasting, guidance of subway staff, Metro APP, WeChat and other social media software), release cycle of guidance information (e.g., 50S/time, 30s/time, 10s/time), release content of guidance information (e.g., transfer distance, number of people waiting for escalators and elevators in the transfer route, transfer time, relatively reliable transfer route scheme), Passengers change the tendency of transfer route decision after receiving the guidance information.

Table 1. Questionnaire questions and answers

Question	Survey type	Answer
1.What is your gender?	RP	Male
		Female
2.What is your age?	RP	18-24 years
		25-30 years
		31-40 years
		41-50 years
		51 years and over
3. What is your occupation?	RP	Student
		Office workers
		Self-employed
		Others (freelancers, retirees)
4.What is the highest level of education you have completed?	RP	Bachelor degree and below
		Graduate students
5. What is your monthly income?	RP	4000ren'min and below
		More than 4000 RMB
6. What is the weight of your luggage?	RP	No luggage
		0-2kg (backpack or handbag)
		2-4kg (backpack+ handbag)
		more than 4kg (heavy objects e.g., luggage)
7.Your main purpose of trips?	RP	Leisure travel
		Commuting
		Other purposes
8.How many companions?	RP	No one
		1 person
		2 person
		More than 2 persons
9.How many times do you pass the subway station every week?	RP	1-3 times
		4-6 times
		7-10 times
		More than 10 times
10.Are you familiar with the transfer routes of the subway station?	RP	Not familiar
		Familiar
11.When you transfer at the Xi'an Road subway station, what is your preference for the release channel of transfer route guidance information?	SP	Broadcast
		Dynamic display screen
		Guidance of subway staff

Question	Survey type	Answer
		Dalian Metro APP
		WeChat and other social media software
12.When you transfer at the Xi'an Road subway station, What is your preference for the release cycle of transfer route guidance information?	SP	50s/time
		30s/time
		10s/time
13. When you transfer at the Xi'an Road subway station, What is your preference for the release content of transfer route guidance information?	SP	Transfer distance
		Number of people waiting for escalator and elevator
		Transfer time
		Relatively reliable transfer route scheme
14.If the guidance information is optimized according to the answers to questions 11, 12 and 13, will you change the original transfer route?	SP	No changing route
		Possible changing route
		Changing route

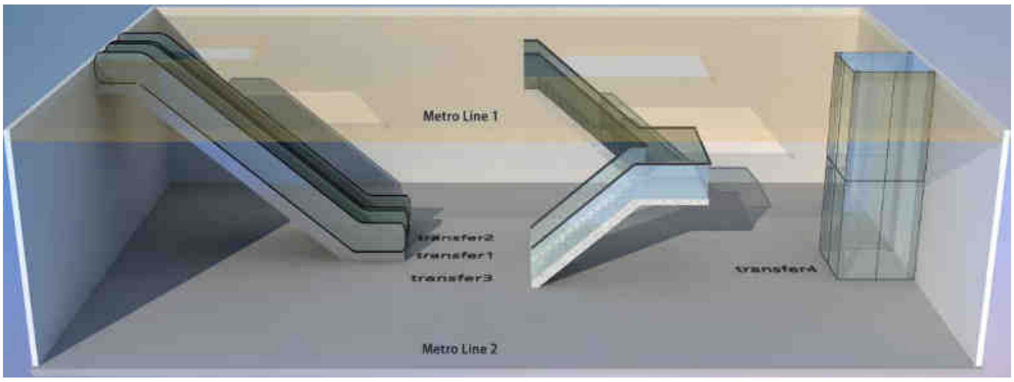

Fig 1. Stereo diagram of transfer route of Xi'an Road Subway Station

3.2. Ordered Logistic model

Ordinal logistic model is widely used in transportation field. The ordinal logistic model is used to analyze the factor of traffic collisions on urban expressways [57] and the underlying risk factors of fatal bus accident severity [58].

Each question including questions 1-13 in Table 1 was used as a independent variable and an ordered logistic model was utilized with all the remaining variables to find correlations. The ordered Logistic model is mainly used to deal with multi-categorical dependent variables, where there is an orderly relationship between the dependent variables. A table of population likelihood ratios for each independent variable is determined. Then, ordered logistic model was applied again only for the significant variables, excluding the irrelevant variables.

The ordered logistic equation is used to determine the coefficients, in other words, the correlation between the independent and dependent variables. Each of the three dependent variables is assigned to Y, $Y=1$ is that the traveler does not change the transfer route when prompted by the guidance information, $Y=2$ is that the traveler is likely to change the transfer route when prompted by the guidance information, and $Y=3$ is that the transfer traveler changes the transfer route under the guidance information.

$$ln\frac{P(Y=3|\boldsymbol{X})}{P(Y=2|\boldsymbol{X})+P(Y=1|\boldsymbol{X})}=\frac{P(Y=3|\boldsymbol{X})}{1-P(Y=3|\boldsymbol{X})}=\alpha_2+\sum_{k=1}^{n}\beta_k X_k \quad (1)$$

$$ln\frac{P(Y=2|\boldsymbol{X})+P(Y=3|\boldsymbol{X})}{P(Y=1|\boldsymbol{X})}=\frac{1-P(Y=1|\boldsymbol{X})}{P(Y=1|\boldsymbol{X})}=\alpha_1+\sum_{k=1}^{n}\beta_k X_k \quad (2)$$

$$P(Y=3|\boldsymbol{X})=\frac{\exp(\alpha_2+\sum_{k=1}^{n}\beta_k X_k)}{1+\exp(\alpha_2+\sum_{k=1}^{n}\beta_k X_k)} \quad (3)$$

$$P(Y=2|\boldsymbol{X})=1-P(Y=1|\boldsymbol{X})-P(Y=3|\boldsymbol{X}) \quad (4)$$

$$P(Y=1|\boldsymbol{X})=\frac{1}{1+\exp(\alpha_1+\sum_{k=1}^{n}\beta_k X_k)} \quad (5)$$

For both Eq. (1) and Eq. (2), the value of the k th independent variable is X_k . The intercept of the the Eq. (1) is α_2 , the intercept of the the Eq. (2) is α_1 . n represents the number variables in the Eq. (1) and the Eq. (2). Due to the characteristics of the ordered logistic model, the corresponding parameters of X_k in Eq. 1 and Eq. 2 are the same, both being β_k .Eq. (3) is the probability that the passenger changes the transfer route under the guidance information, Eq. (4) is the probability that the passenger may change the transfer route under the guidance information, Eq. (5) is the probability that the passenger does not change the transfer route under the guidance information.

3.3. Partial proportional odds model

In the application of the partial proportional odds model, Liu et al [59] analyzed the factor of the injury severity of head-on crashes in the roadway by using the partial proportional odds model and Liu et al [60] investigated the factors of that affect injury severity in crashes involving cyclists.

The above 14 survey questions are divided into SP and RP surveys, and the answers to the questions are categorical variables. The proportional odds model can analyze the relationship between categorical variables. Therefore, this study uses proportional odds model to analyze the survey data. But, the ordinal Logistic model has the limitation of the assumption of proportional dominance, that is, the coefficients of the respective variables are the same in the results of different dependent variables in the model. However, in the actual research process, the assumption of proportional dominance is often difficult to meet, usually there are one or more independent variables that meet the assumption of proportional dominance, other independent variables do not. The partial proportional odds model can loosely assume proportional dominance, and the coefficient of the independent variable that does not satisfy the ordinal logistic model can change with the probability of changing the transfer route under the guidance information. Partial proportional odds model is as follows:

$$P(Y_i > j|\boldsymbol{X}) = g(\boldsymbol{X\beta_j}) = \frac{\exp(\alpha_j + \boldsymbol{X\beta_j} + \boldsymbol{T\gamma_j})}{1 + \exp(\alpha_j + \boldsymbol{X\beta_j} + \boldsymbol{T\gamma_j})} \quad j = 1,\ 2, \cdots,\ J \tag{6}$$

In the formula, $g(\ )$ is the cumulative distribution function of the probability of travelers changing the transfer route at the j th dependent variables under the guidance information. $\boldsymbol{X}$ is the vector of independent variables satisfying the assumption of proportional dominance in the j th dependent variables. $\boldsymbol{\beta_j}$ is the undetermined parameter vector satisfying the assumption of proportional dominance in the j th dependent variables. $\boldsymbol{T}$ is the vector of independent variables in the j th dependent variables that do not meet the assumption of proportional dominance. $\boldsymbol{\gamma_j}$ is the undetermined parameter vector in the j th dependent variables that does not satisfy the assumption of proportional dominance.

As the dependent variable in this paper consists of dependent variables, the partial proportional odds model is as follows:

$$P(Y = 3|\boldsymbol{X}) = g(\boldsymbol{X\beta_2}) \tag{7}$$

$$P(Y = 2|\boldsymbol{X}) = g(\boldsymbol{X\beta_1}) - g(\boldsymbol{X\beta_2}) \tag{8}$$

$$P(Y = 1|\boldsymbol{X}) = 1 - g(\boldsymbol{X\beta_1}) \tag{9}$$

3.4. Validation of the model

The Akaike Information Criterion, the Bayesian information criterion, and the pseudo-R^2 were used to test the fit of the ordered Logistic model and the partial odds ratio model. The above three parameters are calculated as follows:

$$AIC = -2ln\,\hat{L}(L) + 2m \tag{10}$$

$$BIC = -2ln\,\hat{L}(L0) + m \times ln(N) \tag{11}$$

$$PseudoR^2 = 1 - \left[\frac{ln\,\hat{L}(L)}{ln\,\hat{L}(L0)}\right] \tag{12}$$

In the formula, AIC is the index value of Akaike Information Criterion, BIC is the index value of Bayesian Information Criterion, $PseudoR^2$ is the $pseudo-R^2$ metric value, $ln\,\hat{L}(L)$ is the likelihood function of the intercept term, $ln\,\hat{L}(L0)$ is the likelihood function value of the parameter in the model, m is the number of fitted parameters, N is the number of samples. The bigger the $PseudoR^2$ index value, the better the fitting effect of the model. The smaller the AIC and BIC , the better the fitting effect.

3.5. Elastic analysis

Because the ordered logistic model and partial proportional odds model can only measure whether the influence of each independent variable on the dependent variable is significant and they cannot be used to quantitatively analyze the relative strength of the influence of each variable on the dependent variable, we introduce the elastic analysis method to quantitatively analyze the influence of the change of each independent variable on the probability of transfer travelers changing the transfer route under the guidance information. The formula of elastic coefficient of multi-categorical independent variables is:

$$E_{X_{jk}}^{P(Y_i=j)} = \frac{\partial P(Y_i = j)}{\partial X_{jk}} \frac{X_{jk}}{P(Y_i = j)} \quad (13)$$

In the formula, $E_{X_{jk}}^{P(Y_i=j)}$ is the elasticity coefficient of the k th significant independent variable related to the j th dependent variable of the traveler's change of transfer route probability under the guidance information prompt. ∂X_{jk} is the k th significant independent variable related to the j th dependent variable.

If the independent variable is a dichotomous variable, the elastic coefficient of this independent variable cannot be calculated with eq. (14). We can obtain the pseudo elasticity coefficient by quantitatively calculating the marginal effect of dichotomous independent variable, and the formula is:

$$E_{X_{jk}}^{P(Y_i=j)} = \frac{P(Y_i = j)[X_{jk} = 1] - P(Y_i = j)[X_{jk} = 0]}{P(Y_i = j)[X_{jk} = 0]} \quad (14)$$

IV. RESULTS

4.1. Survey results

Each question was defined into a certain code, and then, each variable category was set to a specific integer . And, the probability of changing the transfer path for each variable category is analyzed. The summary statistics of variables and their abbreviations are presented in Table2.

Table 2. Variable description

Variables	**Code**	**No changing route**	**Possible changing route**	**Changing route**
1.Gender	0=Male (Reference case)	13.68%	60.26%	26.05%
	1= Female	8.49%	68.77%	22.74%
2.Age	1=18-24 years (Reference case)	27.71%	37.35%	34.94%
	2=25-30 years	6.57%	78.54%	14.90%
	3=31-40 years	9.15%	60.98%	29.88%
	4=41-50 years	65.56%	15.00%	19.44%
	5=51 years and over	61.67%	16.67%	21.67%
3.Occupation	1=Student (Reference case)	15.53%	37.86%	46.60%
	2= Office workers	6.45%	75.32%	18.23%
	3= Self-employed	34.94%	28.92%	36.14%
	4=Others (freelancers, retirees)	18.75%	50.00%	31.25%
4.Education level	0=Bachelor degree and below (Reference case)	13.51%	57.09%	29.39%
	1= Graduate students	9.58%	69.27%	21.26%
5.Monthly income*	0=4000 RMB and below (Reference case)	7.93%	73.89%	18.18%
	1=More than 4000 RMB	18.42%	42.98%	38.60%
6.Luggage weight	1= No luggage (Reference case)	12.15%	50.93%	36.92%
	2=0-2kg (backpack or handbag)	5.50%	79.67%	14.83%
	3=2-4kg (backpack+ handbag)	29.11%	34.18%	36.71%
	4=more than 4kg (heavy objects such as luggage)	32.35%	32.35%	35.29%
7.Travel purpose	1=Leisure travel (Reference case)	13.88%	51.43%	34.69%
	2=Commuting	5.85%	76.81%	17.33%
	3=Other purposes	32.88%	35.62%	31.51%
8.Number of peers	1=No one (Reference case)	29.23%	41.54%	29.23%
	2=1 person	13.48%	46.63%	39.89%
	3=2 person	3.77%	82.66%	13.57%
	4=More than 2 persons	24.04%	39.82%	36.54%
9.Number of station passes per week	1=1-3 times (Reference case)	12.30%	51.34%	36.36%
	2=4-6 times	5.88%	79.67%	14.35%
	3=7-10 times	19.80%	35.64%	44.55%

Variables	Code	No changing route	Possible changing route	Changing route
	4=More than 10 times	46.88%	28.13%	25.00%
10.Familiarity with station	0=Not familiar (Reference case)	18.13%	38.46%	43.41%
	1=Familiar	8.88%	72.82%	18.29%
11.Release channel of guidance information	1=Broadcast (Reference case)	37.29%	42.37%	20.34%
	2= Dynamic display screen	7.14%	73.98%	18.88%
	3=Guidance of subway staff	9.50%	76.03%	14.86%
	4=Dalian Metro APP	11.11%	42.42%	46.46%
	5=WeChat and other social media software	8.72%	56.38%	34.90%
12.Release frequency of guidance information	1=50s/time (Reference case)	46.67%	33.33%	20.00%
	2=30s/time	6.69%	75.73%	17.57%
	3=10s/time	11.11%	47.34%	41.55%
13.Release content of guidance information	1=Transfer distance (Reference case)	44.44%	37.04%	18.52%
	2=Number of people waiting for escalator and elevator	7.69%	72.93%	19.37%
	3=Transfer time	10.84%	61.08%	28.08%
	4=relatively reliable transfer route scheme	13.41%	54.88%	31.71%

*Monthly income: we select the average monthly income (4000 RMB) in Dalian city as a classification threshold.

4.2. The calculation results

In this paper, we use the ologit and gologit2 program packages in stata16.0 to statistically analyze the ordered Logistic model and partial proportional odds model.

4.2.1. Results of the parallelism test

we test the parallelism of each variable firstly, If P>0.05, it indicates that the variable is not statistically significant at the 95% confidence level, that is, this variable meets the proportional advantage hypothesis, and the ordered logistic model can be used for regression analysis; On the contrary, if P<0.05, it indicates that the variable does not meet the proportional advantage hypothesis, then partial proportional odds model is used for regression analysis. The results of the parallelism test of each variable are shown in in Table3.

Table 3 Test results of parallelism of variables

Variables	Chi square value	P-value
1.Gender	7.41	0.0065
2.Age	9.27	0.0023
3.Occupation	5.13	0.0235
4.Education level	10.03	0.0015
5.monthly income	57.25	0.0000
6.Luggage weight	9.59	0.0020
7.Travel purpose	0.10	0.7470
8.Number of peers	12.77	0.0004
9.Number of station passes per week	17.74	0.0000
10.Familiarity with station	54.16	0.0000
11.Release channel of guidance information	37.35	0.0000
12.Release cycle of guidance information	54.35	0.0000
13.Release content of guidance information	22.88	0.0000

As shown in the table 3, the P-value of the travel purpose variable is greater than 0.05, which satisfies the parallelism test and can be analyzed by the ordered logistic model. And the other variables are statistically analyzed by partial proportional odds model.

4.2.2. Results of model fitting

Based on the results of the parallelism test, the three dependent variables are divided into two groups for comparative analysis using the ordinal Logistic model, and the partial odds ratio model. The first group compares the dependent variables for changing route s and potentially changing route s combined as a whole with the outcome dependent variables for not changing route s; the second group compares the dependent variables for changing routes with the overall outcome dependent variables for potentially changing routes and not changing routes. As the partial proportional odds model does not satisfy the proportional dominance assumption, the partial proportional odds model analyses the two comparison scenarios one by one. On the contrary, the ordinal Logistic model should analyze the two comparison scenarios in a unified way because it meets the proportional advantage assumption. The variables are screened using a mixed stepwise selection method and the results of the analysis are shown in Table 4 below.

Table 4 Model fitting results

	Ordered Logistic Model		**Partial Proportional Odds Model**			
			（Changing Route + Possible Changing Route）vs Not Changing Route		**Changing Route vs（Possible Changing Route + Not Changing Route）**	
variable	**Parameter value**	**standard deviation**	**Parameter value**	**standard deviation**	**Parameter value**	**standard deviation**
Male (reference variable)	0.000	—	0.000	—	0.000	—
female	0.167	(0.163)	0.530*	(0.163)	-0.071	(0.163)
18-24 years (reference variable)	0.000	—	0.000	—	0.000	—
25-30 years	-0.010	(0.312)	0.608	(0.398)	-0.275	(0.334)
31-40 years	0.319	(0.334)	0.521	(0.464)	0.434	(0.362)
41-50 years	-0.859**	(0.365)	-1.112**	(0.483)	-0.790**	(0.382)
51 years and over	-0.736	(0.751)	-1.331	(1.116)	-2.152**	(0.891)
Student (reference variable)	0.000	—	0.000	—	0.000	—
office worker	-0.923***	(0.265)	0.061	(0.406)	-1.249***	(0.287)
Self-employed	-0.854**	(0.376)	-0.651	(0.468)	-0.979**	(0.394)
other	-0.469	(0.643)	0.913	(0.970)	-1.313*	(0.723)
Bachelor degree or below (reference variable)	0.000	—	—	—	—	—
graduate student	-0.015	(0.170)	—	—	—	—
4000 RMB and below (reference variable)	0.000	—	0.000	—	0.000	—
More than 4000 RMB	0.006	(0.202)	-0.176	(0.315)	0.012	(0.223)
Not carried (reference variable)	0.000	—	0.000	—	0.000	—
0-2kg (backpack or handbag)	-0.436**	(0.210)	0.101	(0.373)	-0.614**	(0.240)
2-4kg (backpack + handbag)	-0.299	(0.322)	-0.620	(0.410)	0.055	(0.329)
more than 4kg	-0.666	(0.447)	-0.879*	(0.521)	-0.221	(0.474)
Leisure travel (reference variable)	0.000	—	0.000	—	0.000	—
Commuting	-0.098	(0.186)	0.712**	(0.338)	0.712**	(0.338)
Other purposes	-0.379	(0.342)	-0.216	(0.410)	-0.216	(0.410)
No one (reference	0.000	—	0.000	—	0.000	—

	Ordered Logistic Model		**Partial Proportional Odds Model**			
			(Changing Route + Possible Changing Route) vs Not Changing Route		**Changing Route vs (Possible Changing Route + Not Changing Route)**	
variable	**Parameter value**	**standard deviation**	**Parameter value**	**standard deviation**	**Parameter value**	**standard deviation**
variable)						
1 person	0.922***	(0.347)	0.645	(0.430)	0.812**	(0.371)
2 person	0.717**	(0.355)	1.520***	(0.490)	0.196	(0.385)
More than 2 persons	0.809**	(0.367)	0.930**	(0.449)	0.605	(0.396)
1-3 times (reference variable)	0.000	—	0.000	—	0.000	—
4-6 times	-0.078	(0.217)	0.283	(0.383)	-0.413*	(0.244)
7-10 times	0.262	(0.280)	-0.517	(0.403)	0.245	(0.290)
More than 10 times	-0.847*	(0.482)	-1.126**	(0.538)	-0.247	(0.520)
Not familiar (reference variable)	0.000	—	0.000	—	0.000	—
Familiar	-0.611***	(0.209)	-0.105	(0.309)	-0.696***	(0.221)
Broadcast (reference variable)	0.000	—	0.000	—	0.000	—
Dynamic display screen	1.602***	(0.370)	1.349***	(0.500)	0.950**	(0.444)
Guidance of subway staff	1.360***	(0.362)	1.107**	(0.440)	0.648	(0.436)
Dalian Metro APP	2.148***	(0.397)	1.806***	(0.527)	1.440***	(0.443)
WeChat and other social media software	1.956***	(0.376)	2.119***	(0.510)	1.313***	(0.430)
50s/time (reference variable)	0.000	—	0.000	—	0.000	—
30s/time	1.659***	(0.370)	1.374***	(0.406)	0.473	(0.406)
10s/time	2.046***	(0.376)	1.774***	(0.444)	0.939**	(0.426)
Transfer distance (reference variable)	0.000	—	0.000	—	0.000	—
Number of people waiting	2.038***	(0.503)	1.278**	(0.571)	1.625***	(0.604)
Transfer time	1.728***	(0.509)	0.924	(0.570)	1.476**	(0.607)
Transfer route scheme	1.967***	(0.508)	1.165**	(0.578)	1.817***	(0.612)
_cons			-3.032***	(0.969)	-2.601***	(0.937)
cut1	1.857**	(0.781)	—	—	—	—
cut2	5.696***	(0.815)	—	—	—	—
sample size	745		745			
AIC	1194.972		1036.667			
BIC	1347.213		1322.697			
$PseudoR^2$	0.131		0.298			

Note: *、**、***are $p < 0.1$、$p < 0.05$、$p < 0.01$ respectively; "—"indicates that the variable does not exist in the model.

The parameters of partial proportional odds model, that is, AIC, BIC and $PseudoR^2$, were smaller than those of ordinal Logistic model. Therefore, the partial proportional odds model is better than the ordered Logistic model. Then, the results of the partial proportional odds model were used to analyze each variable. From the analysis results of the partial proportional odds model, we can learn that the variables of gender, age, occupation, weight of luggage carried, purpose of travel, number of peers, number of station passes per week, familiarity with the station, release channel of guidance information, release cycle, and release content all significantly affect the transfer route selection behavior of interchange travelers in rail stations.

4.2.3. Results of elasticity analysis of significant variables

Based on the results in Table 4, elasticity analysis was performed for the significant variables and the results are shown in the table below.

Table 5 Elasticity analysis results of significant variables

Variable Name	Variable Properties	Not Changing Route	Possible Changing Route	Changing Route
Gender	male	-3.54%	4.53%	-0.98%
Age	41-50 years old	-7.59%	-4.47%	-12.06%
	51 years old and above	15.03%	-51.82%	-36.79%
Occupation	Commuters	-0.40%	19.92%	-19.52%
	Self-employed	5.09%	10.74%	-15.83%
Luggage weight	0-2kg (backpack or handbag)	4.62%	-5.49%	0.86%
	more than 4kg (heavy objects such as luggage)	6.97%	-3.66%	-3.31%
Travel purpose	Commuting	-4.73%	11.37%	-6.64%
Number of peers	1 person	-5.98%	-5.41%	11.39%
	2 person	-11.61%	9.14%	2.46%
	More than 2 persons	-8.09%	-0.12%	8.21%
Number of station passes per week	4-6 times	-1.76%	7.57%	-5.80%
	More than 10 times	9.89%	-6.32%	-3.57%
Station familiarity	Familiarity	0.70%	9.60%	-10.30%
Release channel of guidance information	Dynamic display screen	-12.69%	1.37%	11.32%
	Guidance of subway staff	-10.89%	3.65%	7.24%
	Dalian Metro App	-15.55%	-3.20%	18.75%
	WeChat and other social media software	-17.15%	0.42%	16.73%
Release cycle of guidance information	30s/time	-12.94%	7.05%	5.89%
	10s/time	-15.43%	2.75%	12.68%
Release content of guidance information	Number of people waiting for escalator and elevator	-10.67%	-6.27%	16.94%
	Transfer Time	-8.27%	-6.61%	14.88%
	Interchange route options	-9.95%	-9.76%	19.71%

V. DISCUSSIONS

5.1. Travelers' demographic data

The gender variable does not satisfy the proportional odds assumption in the partial proportional odds model and its regression parameters are 0.530 and -0. 071 respectively, which shows that compared with male transfer travelers, female transfer travelers are more likely to choose transfer routes under the prompt of guidance information. It can be seen from Table 5 that the possibility of female transfer travelers changing transfer routes possibly under the prompt of guidance information increases by 4.53%, it can be inferred that women are more susceptible to the influence of guidance information and change their transfer routes with the prompt of guidance information. According to the analysis of the results of age variables, the regression parameters of 41-50 years old and 51 years old and above are negative and probabilities of changing transfer routes at both ages are -12.06% and -36.79% respectively for the reason that older transfer travelers tend to ignore the tips of guidance information. According to the analysis of the results of occupational variables, the regression parameters of office workers are all negative and the probability of changing transfer routes is -19. 52% for the reason that office workers are more likely to ignore guidance information in a hurry so that their compliance with guidance information is lower. According to the analysis of the results of baggage variables, the regression parameters of baggage variables with more than 4kg are all -0.879 and the possibility of not changing transfer routes is 6.97% for the reason that travelers with overweight baggage prefer to choose transfer routes with escalator and elevator facilities so that their compliance with guidance information is lower, that travelers with medium and small bags or large bags prefer to choose escalators and stairs.

5.2. Travel characteristic variable

The regression parameters of the number of traveling companions are all positive, and the probability of changing the route is 11. 39%, 2.46% and 8. 21%, which indicates that when the number of accompanying travelers is more, the compliance of travelers to the guidance information is higher. The main reason is that when there is an accompanying person, the traveler is more likely to notice the guidance information and choose the transfer route according to the guidance information under the reminder of the accompanying person; the regression parameters of the number of station passes per week variable are -0.413 and -1.126, and the possibility of changing the transfer route is negative. The main reason is that travelers are familiar with the transfer route of the interchange station because they have passed the interchange station many times, and they are more willing to choose the transfer route according to their own choice inertia, so their compliance with the guidance information is low; The regression parameter of the station familiarity variable is -0.696, and the possibility of changing the route is -10.30%, which indicates that the higher the degree of familiarity with the station, the lower the degree of compliance with the guidance information. The main reason is that travelers are more familiar with the transfer route of the station and are more inclined to choose their own inertia.

5.3. Release channel of guidance information

Due to the Dalian Metro can use the relevant APP to scan the payment code, the penetration rate of subway APP is high, travelers are more likely to accept the guidance information pushed by the APP, the regression parameters of all variables in the formal variables are all positive, and the possibility of changing the route is 11.32%, 7.24%, 18.75%, 16.73% respectively. The possibility of changing the route is ranked as follows: Dalian Metro APP>WeChat and other social media software>dynamic display screen>subway staff Guidance. At this stage, social media software is very popular, and the guidance information pushed by social media software such as WeChat is more easily accepted by travelers. As a regular channel of information release, dynamic display screen can also promote the choice of transfer routes for travelers; The subway staff guidance is the most common way to provide guidance information to travelers, but travelers' compliance is still low, and travelers prefer guidance information released by electronic devices, mobile networks and other channels.

5.4. Release cycle of guidance information

Because of the short transfer distance, short transfer time and fast transfer speed of passengers in rail transit interchange stations, transfer travelers are more inclined to guide information with a small update cycle. So, among the cycle variables, the regression parameters of 30s/time variable and 10s/time variable are both positive, and the possibility of changing the route is 5.89% and 12.68%.

5.5. Release content of guidance information

In the content variables, the regression parameters of each variable are positive, and the possibility of changing the route is 19.71%, 16.94%, 14.88%, which is ranked as transfer route scheme>number of people waiting>transfer time>transfer distance. The transfer travelers are more willing to accept the reliable transfer route scheme directly provided in the guidance information, which can save the comparative analysis time of passengers. The number of waiting people can directly reflect the level of service of the transfer route, and travelers can master the traffic efficiency of each transfer route in the shortest time; Compared with the guidance information of the transfer route scheme and the number of people waiting, the transfer travelers have lower compliance with the transfer time information and transfer distance information, due to the short passing time of the transfer route in the rail station.

Based on the above analysis, we can find that the guidance information of the transfer route has attributes that is, it is released by Dalian Metro APP, its frequency is 10s/time , and its release content is an alternative route scheme. The transfer passengers of urban rail transit have a high degree of compliance with the transfer route guidance information. When there are too many transfer passengers in urban rail transit, it may lead to congestion on the transfer route. Guidance information can remind passengers to choose other transfer routes, reduce the transfer time of passengers, improve the transfer efficiency of passengers, and increase the comfort of passengers. The decision-maker of the interchange station of urban rail transit can optimize the guidance information of the transfer route according to the above guidance information designation method.

VI. CONCLUSIONS

In this paper, a questionnaire survey was conducted in the actual choice behavior of transfer travelers in Xi'an Road station of Dalian Metro. Based on the results of questionnaires , we respectively build the ordered logistic model and the partial proportional odds model , and we analyze the compliance of the guidance information in the rail station transfer, and we take the significant analysis and elastic analysis of the factors which are the compliance of the guidance information. The main conclusions are as follows: (1) Compared with the ordered Logistic model, the partial proportional odds model has a better fitting degree and can be more accurately analyzed to the influence degree of each factor on transfer travelers. (2) Among the travelers' demographic data, the variables of gender, age, occupation and weight of luggage carried have a significant impact on the route selection behavior of transfer passengers in the rail station. Among the variables of travel characteristics, the variables of the purpose of travel, the number of passengers, number of station passes per week, and the familiarity of the station all significantly affect the route selection behavior of the transfer passengers in the rail station, and the release channel of guidance information has a significantly positive impact on the transfer route selection behavior of transfer travelers in the rail station. When guidance information is released by Dalian Metro APP, wechat and other social media software, and dynamic display screen, travelers have a high compliance with it. Besides, the variable of guidance information release cycle also has a significant positive impact on the transfer route selection behavior of transfer passengers in the rail station. When release cycle of the guidance information reaches 10s/ time and 30s/ time, passengers usually have a high compliance with guidance information. At the same time, the content of guidance information release also has a significant positive influence on the transfer route choice behavior of transfer passengers in the rail station, and the compliance of the guidance information of each variable from the largest to the smallest are as follows: the passengers transfer route scheme, the waiting number of passengers, the passengers transfer time and transfer distance.

This paper focuses on the compliance of transfer passengers to the guidance information in rail transit stations, and studies the influence of guidance information release channels, guidance information release cycle and guidance information release content on the route choice behavior of transfer passengers in rail transit stations. It provides a scientific theoretical basis for urban rail transit interchange stations to issue transfer guidance information, and provides a reference for decision makers of urban rail transit interchange stations.

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