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Research article

On parents' choice of the school travel mode during the COVID-19 pandemic

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Abstract: Based on the theory of planned behavior (TPB) and the protection motivation theory (PMT), this study examines the factors that influence parental choice of school travel mode during COVID-19. Structural equation modeling (SEM) and a hybrid choice model (HCM) are used to analyze this decision-making process. The results show that trust, perceived severity, perceived vulnerability, perceived built environment, attitude, subjective norm, and perceived behavioral control are significant factors. Perceived severity, perceived vulnerability, and the evaluation of pandemic risk, significantly impact the choice of public transit and private car, but not walking. Perceived built environment is the most critical factor influencing the choice of walking. The results provide a theoretical basis and reference for relevant government departments to formulate policies and measures during COVID-19.

Keywords: COVID-19 pandemic; hybrid choice model; parents; school travel; structure equation model

1. Introduction and literature review

1.1. Introduction

The outbreak of the COVID-19 pandemic brought an unprecedented impact on the urban transportation system. Especially in regards to school travel, parents shifted from public transit to private cars, thus exacerbating urban traffic congestion. Recently, more consideration has been given to school travel modes used by school children. Over the past few decades, the number of children in China that walk or take public transit to school has decreased, while traveling to school by car has increased [1].

In 2020, the World Health Organization declared COVID-19 a global pandemic [2]. Passengers terrified by COVID-19 began to distrust public transit because of the risk of infection from mixing

with asymptomatic infected passengers [3]. Individuals with this concern tend to pay more attention to risks and are more susceptible to believing rumors and inaccurate information [4]. The panic caused by COVID-19 increased the use of private cars for transportation to and from school. The public's trust in public transit, especially from parents, quickly turned to worry and fear. Preference for private cars increased dependency, aggravated urban traffic congestion, increased air pollution and the risk of accidents [5]. These all affected children's physical and mental health.

It has become a top priority of the government and relevant departments to reduce these travel-related anxieites from parents and rebuild confidence in public transit to relieve urban traffic burdens caused by the increae in the use of private cars. This study aimed to study the influencing factors and internal mechanisms in China of parental choice of public transit, private car, and walking during COVID-19.

This study established a theoretical framework based on data collected from a survey. The framework integrated the theory of planned behavior (TPB) and the protective motivation theory (PMT). Two additional factors were also introduced: perceived built environment and trust. Structural equation model (SEM) was used to construct a model of parental choice of school travel mode during COVID-19, and a hybrid choice model (HCM) was used to analyze the internal mechanism of parental choice regarding school travel mode. The unique contributions of this study are as follows: (1) this study is the first to examine the behavioral intentions and influencing factors of parental choice regarding school travel mode during COVID-19 (2) integrated TPB with PMT to verify the applicability of an integrated model regarding choice of school travel mode during COVID-19 (3) used the original influencing factors in the theory and incorporated perceived built environment and trust in the study of school travel. Perceived severity and perceived vulnerability, which represent parental assessment of pandemic risk, were added to expand the existing theoretical model (4) combined SEM and HCM to analyze the influence of the several variables on latent variables and the influence of various factors on travel mode choice. The research results provide a valuable reference for the application and development of research in travel behavior and related fields.

The remainder of this paper is structured as follows. Sections 1.2 and 1.3 provide a literature review, and Section 2 describes the research methods. Section 3 describes the results of the analyses. Section 4 discusses the results and models. Section 5 discusses the conclusions, limitations, and potential opportunities for future studies. The research conception and technological structure are shown in Figure 1.

1.2. Literature review: school travel mode choice

Most of the literature on school travel behavior has been primarily focused on the influencing factors of school travel mode choice in elementary and middle schools. Travel attributes, socioeconomic variables, and built environment are the most commonly studied factors in this field. Psychological factors have been rarely considered. Among the factors that influence school travel mode choice, integrating multiple factors is receiving more attention. For example, Berg et al.[6] incorporated psychological factors (trust, travel satisfaction), socioeconomic characterisitics (age, gender, family income), and travel attributes (distance, accompany or not) into a unified model to examine different factors on school travel. Mindell et al. [7] studied the influence of public transit in school travel, aiming to promote the use of green travel, such as public transit. These studies incorporated psychological-based latent variables with social-economic characteristics, built

environment, travel attributes and other observed variables. The results found that these factors significantly impact school travel mode choice. However, most of the psychological variables in previous research were examined independently. It is impossible to determine the combined effect of these latent variables on actual travel choice. School travel choice is a complex matter, therefore it is necessary to utilize a theoretical model that is more comprehensive. This study constructed a more complex theoretical model to propose a more thorough understanding of school travel choice.

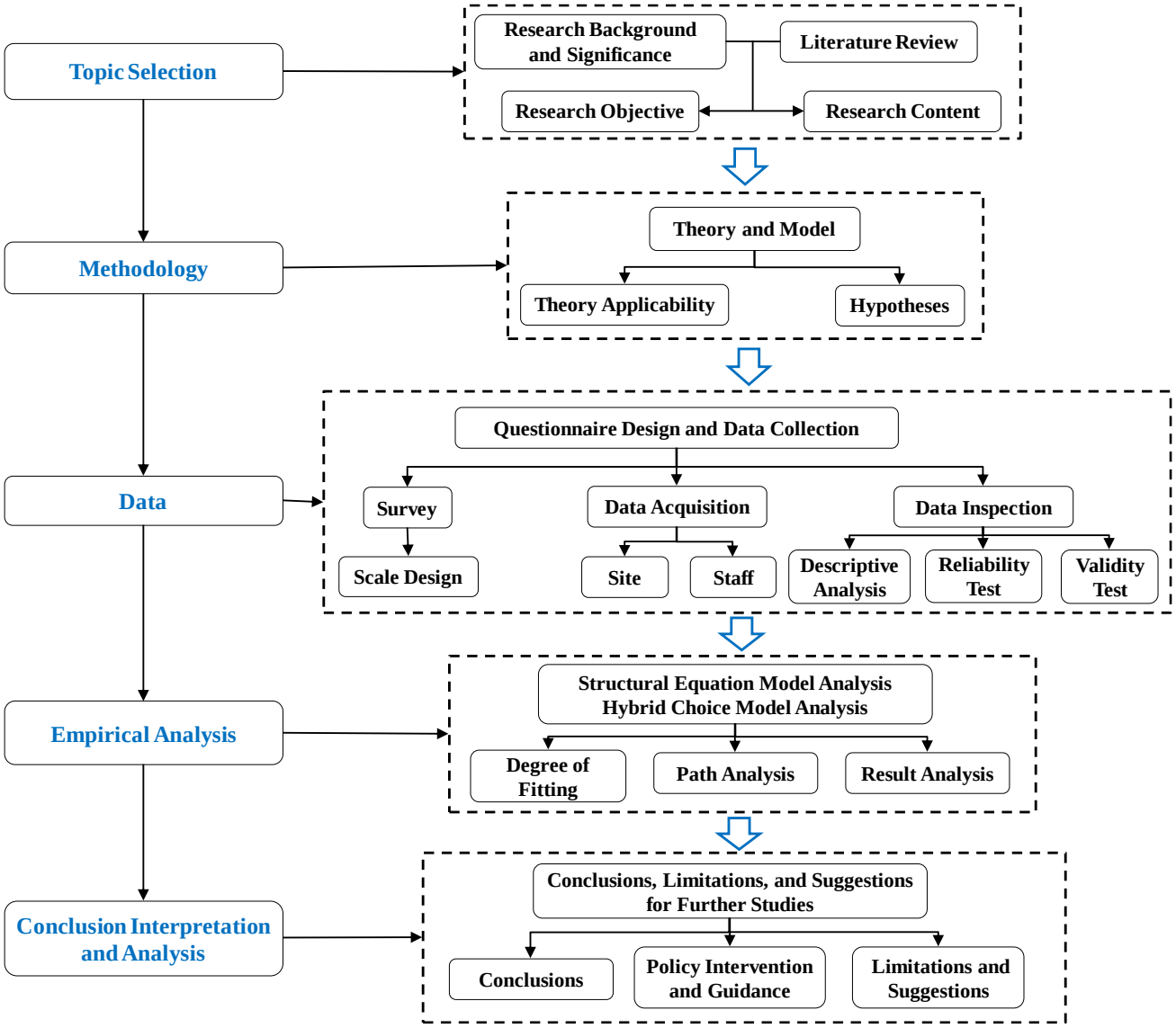


Figure 1. The research conception and technological structure.

1.3. Literature review: travel mode choice during COVID-19

Since the beginning of 2020, COVID-19 swept the world and greatly impacted transportation systems in nearly all countries. Research on transportation during COVID-19 has begun in China and abroad. As shown in Table 1, this study summarized and analyzed the existing research literature regarding the research object, travel mode, influential factors, theoretical models and research methods.

Table 1. The research for travel mode choice behavior during COVID-19.

Year of publication	Research object	Travel mode	Influential factors	Theoretical model	Research method
Khaddar (2021)	Commuter	Public transit Private car Walk	Socioeconomic attribute variable Travel attribute variable	-	Ordered logit model
Vickerman (2021)	Commuter	Public transit	-	-	Qualitative analysis
Chang (2021)	Commuter	Public transit	Socioeconomic attribute variable Travel attribute variable	-	Variance analysis
Zheng (2020)	Commuter	Public transit	Psychological latent variable	PMT	SEM
Dong (2021)	Commuter	Public transit	Psychological latent variable	-	SEM
Bergantino (2020)	Commuter	Public transit	Socioeconomic attribute variable Travel attribute variable psychological latent variable	-	Ordered logit model
Parady (2020)	Commuter	Public transit	Socioeconomic attribute variable Psychological latent variable	-	Logit model
Zenker (2021)	Commuter	Public transit	Socioeconomic attribute variable Psychological latent variable	-	SEM
Anwari (2021)	Commuter	Public transit	Socioeconomic attribute variable Travel attribute variable	-	Logistic regression model
Scorrano (2021)	Commuter	Public transit Private car Walk	Socioeconomic attribute variable psychological latent variable	TPB	Hybrid logit model
Ozbilen (2021)	Commuter	Public transit Private car Shared travel	Socioeconomic attribute variable Psychological latent variable	-	Binomial logit model
Beck (2020)	Commuter	Public transit Private car	Socioeconomic attribute variable Travel attribute variable Psychological latent variable	-	Ordered logit model
Dai (2021)	Commuter	Public transit	-	-	Synthetic control method
Basu (2021)	Commuter	Public transit Shared travel	-	-	Qualitative analysis
Teixeira (2020)	Commuter	Public transit Shared travel	Travel attribute variable	-	GIS

Regarding the research object, most existing studies have focused on commuters and explored the impact of COVID-19 on commuter choice of travel mode. Khaddar and Fatmi [8] used the ordered logit model to study the effect of commuter socioeconomic status and travel characteristics on travel. Bergantino, Intini, and Tangari [9] found that commuter perception of urban infrastructure construction and active travel were essential factors affecting the change of Italian residents from

public transit to private car during the pandemic. However, existing studies rarely examined the impact of COVID-19 on school travel choice. With disease or pollution, children have greater vulnerability than other populations [10]. Although the government has taken measures to ensure public transit safety under COVID-19, parental anxiety about security will be higher than the actual level of danger.

Existing research can be divided into three categories: studies that only included observed variables, those that only incuded psychological latent variables, and those that combined observable variables and psychological latent variables. Beck, Hensher, and Wei [11] introduced socioeconomic characteristics, travel attributes and psychological latent variables into a travel mode choice model. Scorrano and Danielis [12] integrated TPB and established a hybrid logit model to verify the feasibility of a model for travel mode during the pandemic. However, their study did not consider the influence of travel attributes on mode choice. In addition, in reference to psychological latent variables, only the traditional TPB was used and expanded, which may cause the study's results to greatly deviate from the actual situation.

In general, the following conclusions can be drawn from the relevant literature.

(1) Although many researchers have studied the influence of psychological latent variables, social economy, built environment, travel attributes, and other variables on school travel, few studies have proposed a theoretical model that integrates psychological factors.

(2) Few studies have integrated socioeconomic characteristics, travel attributes and latent psychological variables into a comprehensive theoretical framework, and few studies have expanded psychological theory to study parental choice of school travel mode during COVID-19.

2. Methodology

2.1. Extended theory of planned behavior

The purpose of using TPB was to study whether an individual's intention to conduct a certain behavior will affect the actual behavior. TPB postulates that perceived behavior control, attitude and subjective norms impact behavioral intentions simultaneously, and also have reciprocal influences. Perceived behavior control may directly affect actual behavior under certain circumstances.

Researchers have found that in the decision-making process of travel mode choice, individual socioeconomic characteristics (e.g., gender, age, economic level, cultural background) and travel attributes (e.g., travel distance, travel costs) will impact travel mode choice. At the same time, psychological characteristics of travelers in the decision-making process also impact the results of the choice of travel mode. TPB has shown good explanatory and predictive power in travel behavior.

School travel is a specific type of travel behavior. Parents are the main decision-makers and their choice determines their children's school travel mode. Parents have different psychological considerations and concerns when choosing among different travel modes. Under existing traffic conditions, traffic congestion and chaos during the peak attendance periods have put enormous pressure on the school's surrounding areas. Perception of the environment around the school (i.e., perceived built environment) will make parents more inclined to use a private car and forego school travel by public transport [13]. Perceived severity and perceived vulnerability are additional factors that parents consider when making decisions regarding school travel. In the context of COVID-19, parental fear of the pandemic may lead them to choose transport to and from the school that feels safer.

To summarize, this study used perceived behavior control, attitude, and subjective norm in TPB. It added perceived built environment, trust, perceived severity and perceived vulnerability in PMT to expand the model. The model's framework is shown in Figure 2.

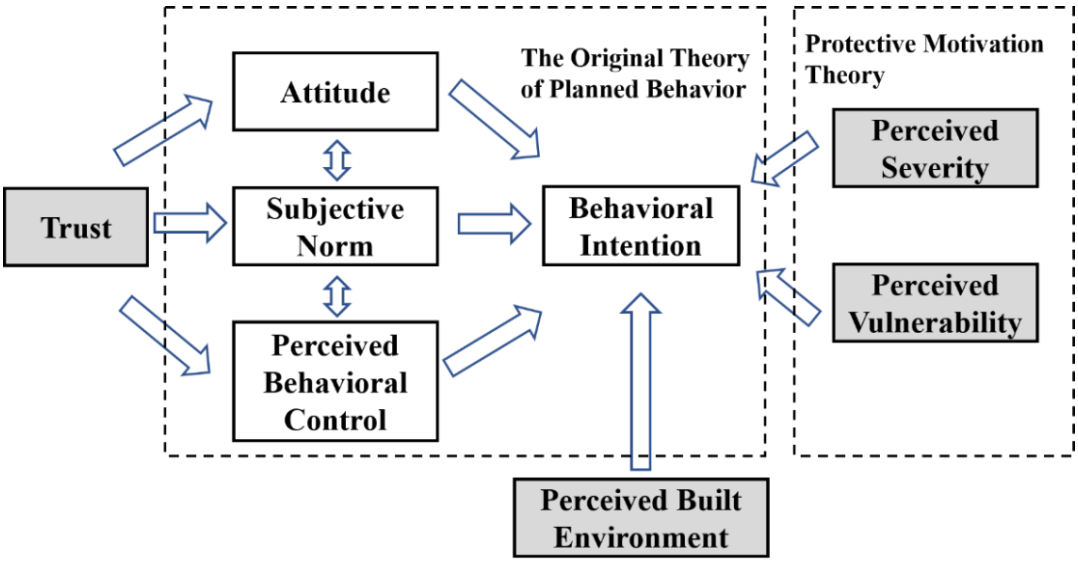


Figure 2. Theoretical framework of extended TPB.

Based on existing research, this study expanded the original TPB. The assumptions of influencing factors proposed by the model are shown in Table 2.

This study attempted to establish a theoretical model on the choice between three school travel modes: public transit, private car, and walking. Figure 3 shows the choice intention model for the public transit mode. Private car and walking modes are shown in Appendix A.

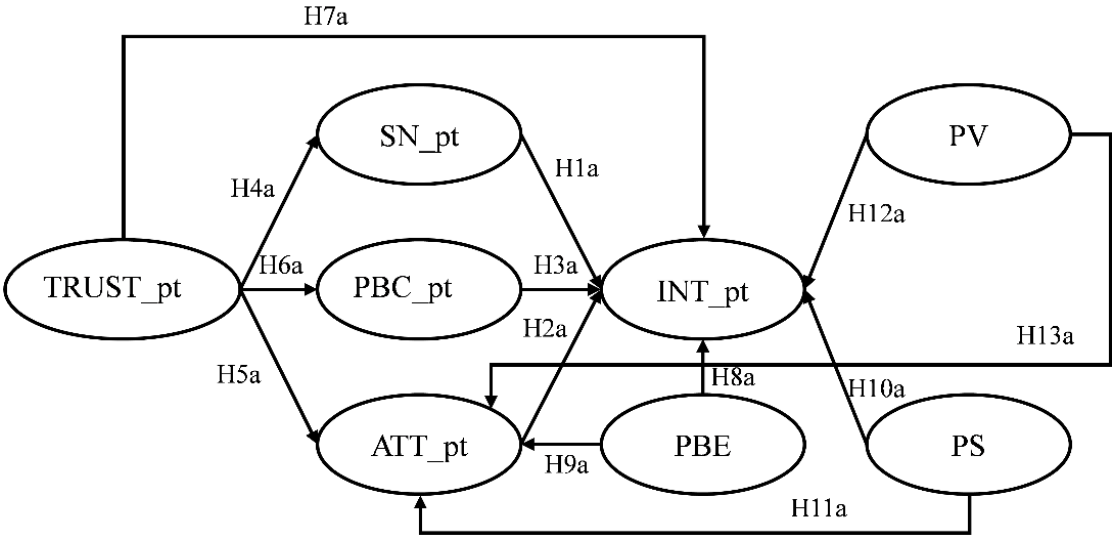


Figure 3. Research model and hypothesis of school travel mode choice intention (public transit).

Table 2. Factor assumption.

Hypotheses	Assumption
H1a	Under COVID-19, Subjective Norm has a negative impact on parents' Intention to choose public transit.
H1b	Under COVID-19, Subjective Norm has a positive impact on parents' Intention to choose public transit.
H1c	Under COVID-19, Subjective Norm has a positive impact on parents' Intention to choose walk.
H2a	Under COVID-19, Attitude has a negative impact on parents' Intention to choose public transit.
H2b	Under COVID-19, Attitude has a positive impact on parents' Intention to choose private car.
H2c	Under COVID-19, Attitude has a positive impact on parents' Intention to choose walk.
H3a	Under COVID-19, Perceived Behavioral Control has a negative impact on parents' Intention to choose public transit.
H3b	Under COVID-19, Perceived Behavioral Control has a positive impact on parents' Intention to choose private car.
H3c	Under COVID-19, Perceived Behavioral Control has a positive impact on parents' Intention to choose walk.
H4a	Under COVID-19, Trust has a negative impact on parents' Subjective Norm of choosing public transit.
H4b	Under COVID-19, Trust has a positive impact on parents' Subjective Norm of choosing private car.
H4c	Under COVID-19, Trust has a positive impact on parents' Subjective Norm of choosing walk.
H5a	Under COVID-19, Trust has a negative impact on parents' Attitude of choosing public transit.
H5b	Under COVID-19, Trust has a positive impact on parents' Attitude of choosing private car.
H5c	Under COVID-19, Trust has a positive impact on parents' Attitude of choosing walk.
H6a	Under COVID-19, Trust has a negative impact on parents' Perceived Behavior Control of choosing public transit.
H6b	Under COVID-19, Trust has a positive impact on parents' Perceived Behavior Control of choosing private car.
H6c	Under COVID-19, Trust has a positive impact on parents' Perceived Behavior Control of choosing walk.
H7a	Under COVID-19, Trust has a negative impact on parents' Intention to choose public transit.
H7b	Under COVID-19, Trust has a positive impact on parents' Intention to choose private car.
H7c	Under COVID-19, Trust has a positive impact on parents' Intention to choose walk.
H8a	Under COVID-19, Perceived Built Environment has a positive impact on parents' Intention to choose public transit.
H8b	Under COVID-19, Perceived Built Environment has a negative impact on parents' Intention to choose private car.
H8c	Under COVID-19, Perceived Built Environment has a positive impact on parents' Intention to choose private car.
H9a	Under COVID-19, Perceived Built Environment has a positive impact on parents' Attitude of choosing public transit.
H9b	Under COVID-19, Perceived Built Environment has a negative impact on parents' Attitude of choosing private car.
H9c	Under COVID-19, Perceived Built Environment has a positive impact on parents' Attitude of choosing walk.
H10a	Under COVID-19, Perceived Severity has a negative impact on parents' Intention to choose public transit.
H10b	Under COVID-19, Perceived Severity has a positive impact on parents' Intention to choose private car.
H10c	Under COVID-19, Perceived Severity has a negative impact on parents' Intention to choose walk.
H11a	Under COVID-19, Perceived Severity has a negative impact on parents' Attitude of choosing public transit.
H11b	Under COVID-19, Perceived Severity has a positive impact on parents' Attitude of choosing private car.
H11c	Under COVID-19, Perceived Severity has a negative impact on parents' Attitude of choosing walk.
H12a	Under COVID-19, Perceived Vulnerability has a negative impact on parents' Intention to choose public transit.
H12b	Under COVID-19, Perceived Vulnerability has a positive impact on parents' Intention to choose private car.
H12c	Under COVID-19, Perceived Vulnerability has a negative impact on parents' Intention to choose walk.
H13a	Under COVID-19, Perceived Vulnerability has a negative impact on parents' Attitude of choosing public transit.
H13b	Under COVID-19, Perceived Vulnerability has a positive impact on parents' Attitude of choosing private car.
H13c	Under COVID-19, Perceived Vulnerability has a negative impact on parents' Attitude of choosing walk.

2.2. Structural equation model

Structural equation model is a multivariate statistical method that establishes the relationship between variables by examing the covariance among the proposed variables [14]. SEM is a linear

equation system composed of multiple unobservable and observable variables. SEM relies heavily upon a theoretical construction and is only meaningful if it has a theoretical basis. SEM analysis is an extension of multiple regression and factor analysis, which can be combined to simultaneously analyze the causal relationships between all latent and observed variables.

2.3. Hybrid choice model

Individuals are affected by various factors in the decision-making process of travel mode, such as the individual socioeconomic characteristics and travel mode attributes [15]. HCM incorporates latent psychological variables into the discrete choice model (DCM). The psychological variables involved in HCM to explain travel intention and heterogeneity between individuals were measured using the latent variables in SEM.

Compared with the traditional DCM, HCM considers more comprehensive factors. HCM associates latent psychological variables with observed variables (e.g., socioeconomic characteristics) relevant to decision-makers and random error terms used to account for data noise. HCM combines the advantages of DCM and SEM to enhance the interpretative ability of the model.

3. Empirical analyses

3.1. Data acquisition and inspection

The survey used a 7-point Likert scale to measure the factors that affect parental intention to choose various travel modes. This study conducted a 6-day survey, from January 11, 2021 to January 16, 2021. Based on the principle of random distribution, a questionnaire was administered in several commercial complexes, including Suning Plaza, Wanda Plaza, and Wuyue Plaza in Zhenjiang City. The passenger flow of these large-scale commercial complexes can help ensure that the sample was representative of the general population. After a brief introduction, we asked participants to complete the questionnaire if they agreed to continue. A total of 503 questionnaires were collected. After data cleaning, 460 valid questionnaire responses were retained. The socio-demographic information is listed in Table 3.

This study evaluated the reliability of the psychological variables. Cronbach's alpha (α) and composite reliability (C. R.) were used to assess reliability. Cronbach's alpha is a measure of internal consistency that indicates how related items are in the measure. The formula for Cronbach's alpha is:

$$\alpha = \frac{n}{n-1}(\sigma^2{}_X - \sum \sigma^2{}_i)/\sigma^2{}_X \tag{1}$$

Where n is the number of items, $\sigma^2{}_X$ is the total test score variance, and $\sigma^2{}_i$ is the item variance.

C.R. can be thought of as being equal to the total amount of true score variance relative to the total scale score variance. The formula is:

$$\text{C.R.} = \frac{(\sum \lambda_i)^2}{(\sum \lambda_i)^2 + \sum \text{var}(\delta_i)} \tag{2}$$

Where λ_i is completely standardized loading for the i-th indicator, and var (δ_i) is the variance of the error term for the i-th indicator.

Table 3. Descriptive statistics of participant characteristics.

Demographic variables		Sample size	Percentage (%)
Gender	Men	217	47.17
	Women	243	52.83
Age	18–25	30	6.52
	26–30	77	16.74
	31–35	154	33.48
	36–40	88	19.13
	41–45	56	12.17
	46–50	30	6.52
	Older than 50	25	5.44
Education level	Primary (elementary/middle school)	18	3.91
	Secondary (high school)	35	7.61
	Junior college	108	23.48
	University (undergraduate)	260	56.52
	Postgraduate	39	8.48
Family monthly income (RMB)	<5000	10	2.01
	5001–10,000	117	25.48
	10,001–15,000	123	26.74
	15,001–20,000	132	28.65
	> 20,000	78	17.12
Occupation	Private enterprise	197	42.83
	Joint venture /foreign-invested enterprises	32	6.96
	State-owned enterprises	67	14.56
	Non-profit organization/institution	3	0.65
	Government agencies	26	5.65
	Schools, research institutes and other academic institutions	51	11.09
	Other	84	18.26
Driver's license	Yes	355	77.17
	No	105	22.83
Number of car ownership	0	54	11.74
	1	294	63.91
	2	101	21.96
	3	11	2.39
Number of electric bicycles owned	0	107	23.26
	1	196	42.61
	2	126	27.39
	3	23	5
Number of children (<18 years old)	1	386	83.91
	2	68	14.78
	3	5	1.09
	4	1	0.22
Child Gender	Boy	270	58.7
	Girl	190	41.3
Child age	6–11	315	68.48
	12–4	68	14.78
	15–18	77	16.74
Distance from school to home	Less than 0.5 km	68	14.78
	0.5 km–1.0 km	105	22.83
	1.0 km–-1.5 km	77	16.74
	1.5 km–2.0 km	50	10.87
	2.0 km–2.5 km	58	12.61
	2.5 km–3.0 km	25	5.43
	More than 3.0 km	77	16.74

As presented in Table 4, the value of α ranged from 0.718 to 0.892, which is acceptable internal consistency. The value of C.R. ranged from 0.712 to 0.908, higher than the minimum standard, suggesting a satisfactory estimation.

Table 4. Reliability test results (public transit / private car / walk).

Psychological variables	N of Items	α	C.R.
Perceived Built Environment	6	0.772	0.877
Perceived Severity	3	0.783	0.872
Perceived Vulnerability	3	0.851	0.896
Subjective Norm	3/3/3	0.776/0.786/0.779	0.898/0.838/0.703
Perceived Behavior Control	2/2/2	0.732/0.745/0.718	0.815/0.880/0.833
Trust	2/2/2	0.857/0.764/0.892	0.795/0.908/0.712
Attitude	2/2/2	0.891/0.839/0.890	0.892/0.7854/0.807
Intention	3/3/3	0.824/0.854/0.823	0.879/0.893/0.870

Note: α<0.6, unacceptable reliability; 0.6⩽ α <0.7, acceptable reliability; 0.7⩽ α <0.8, high reliability; 0.8⩽ α <0.9, very high reliability; α ⩾0.9, extremely high reliability. CR>0.6, good reliability.

Validity refers to the degree that a scale (or survey) measures what it is supposed to measure. Higher validity suggests that the measurement tool is an accurate reflection of the construct being measured. Validity can be assessed by calculating the average variance extracted (AVE) and normalized factor loading coefficient. AVE is used to assess the relationship between the total variation of the observed variable and the potential structural variation. The average variance extracted is calculated as follows:

$$\mathrm{AVE} = \frac{\sum \lambda_i^2}{\sum \lambda_i^2 + \sum \mathrm{var}(\delta_i)} \tag{3}$$

Where λ_i is the standardized loading for the *i*-th indicator, and var (δ_i) is the variance of the error term for the *i*-th indicator.

As shown in Table 5, AVE exceeded the critical value of 0.5, and the normalized factor loading coefficient was greater than 0.7, which indicates that the questionnaire used in the model has good convergent validity.

3.2. Structural equation model analysis

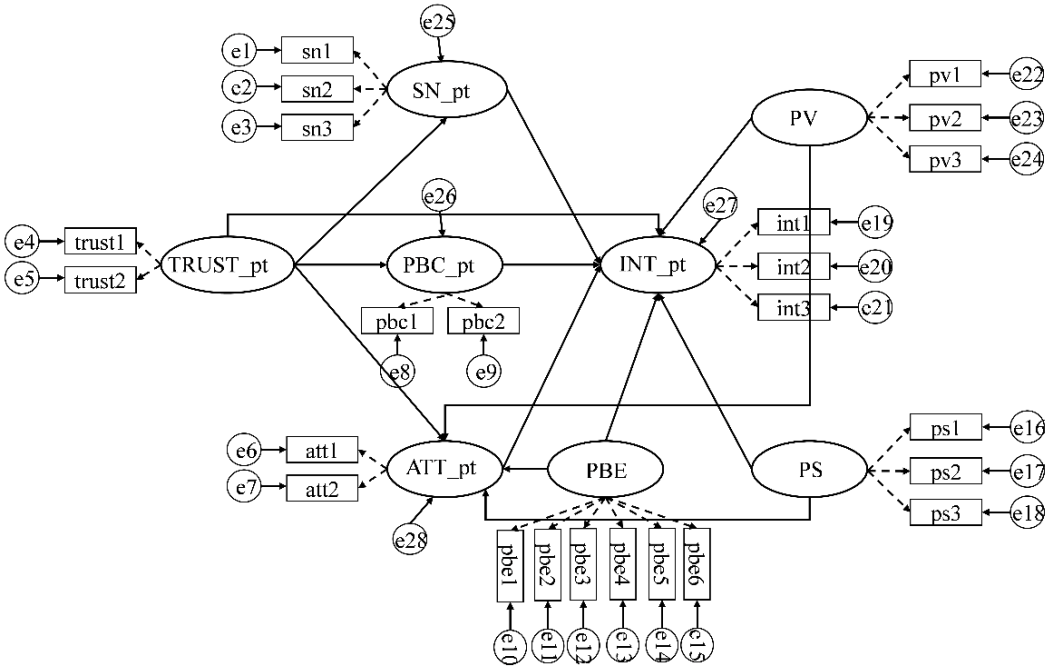
Based on the correlation between the latent variables and their assumptions, a framework was built for SEM analysis. The box in the model is the observed variable, the ellipse is the latent variable, the circle is the error term, the solid line represents the causal relationship between the latent variables, and the dotted line represents the relationship between the latent variable and the observed variable. Since the choice of school travel mode during the pandemic involves three modes, this study established a separate SEM for each of the three travel modes. It substituted the data into the model to compare the fit. Figure 4 is a diagram of the SEM for public transit travel mode. Since the latent variables contained in the three travel modes were the same, the private car and walking models were similar and can be found in Appendix B.

Table 5. Variable convergence validity test (public transit / private car / walk).

Psychological variables	Observed variables	Normalization factor loading coefficient	AVE
Perceived Built Environment	PBE1	0.847	0.703
	PBE2	0.855	
	PBE3	0.813	
	PBE4	0.863	0.6863
	PBE5	0.841	
	PBE6	0.779	
Perceived Severity	PS1	0.838	0.6951
	PS2	0.84	
	PS3	0.823	
Perceived Vulnerability	PV1	0.891	0.7415
	PV2	0.865	
	PV3	0.826	
Subjective Norm	SN1_pt / SN1_car / SN1_walk	0.851/0.822/0.839	0.7467/0.633/0.877
	SN2_pt / SN2_car / SN2_walk	0.886/0.754/0.839	
	SN3_pt / SN3_car / SN3_walk	0.855/0.809/0.837	
Perceived Behavior Control	PBC1_pt / PBC1_car / PBC1_walk	0.843/0.886/0.907	0.6874/0.785/0.909
	PBC2_pt / PBC2_car / PBC2_walk	0.815/0.872/0.918	
Trust	TRUST1_pt / TRUST1_car / TRUST1_walk	0.813/0.901/0.871	0.6593/0.8319/0.832
	TRUST2_pt / TRUST2_car / TRUST2_walk	0.811/0.924/0.817	
Attitude	ATT1_pt / ATT1_car / ATT1_walk	0.893/0.822/0.904	0.8046/0.6467/0.893
	ATT2_pt / ATT2_car / ATT2_walk	0.901/0.786/0.893	
Intention	INT1_pt / INT1_car / INT1_walk	0.824/0.842/0.796	0.706/0.736/0.670
	INT2_pt / INT2_car / INT2_walk	0.857/0.875/0.837	
	INT3_pt / INT3_car / INT3_walk	0.842/0.856/0.857	

Note: AVE > 0.5, good convergent validity; normalization factor loading coefficient > 0.5, good convergent validity.

Path analysis was conducted using Mplus. The data fit were obtained as shown in Tables 6 and 7. To test the fit of the structural model based on empirical research, the following six indicators were tested to verify the suitability of the model: χ^2/df, root-mean-square error (RMSEA), incremental fit index (IFI), goodness of fit index (GFI), normed fit index (NFI), and comparative fit index (CFI). If the RMSEA was <0.05, IFI, GFI, NFI, and CFI exceeds 0.90, and the χ^2/df value was <3, it indicates that the model is acceptable. The results of χ^2/df, RMSEA, IFI, GFI, NFI, and CFI all met the standards and are presented in Table 6, indicating that the theoretical model obtained an excellent fit.



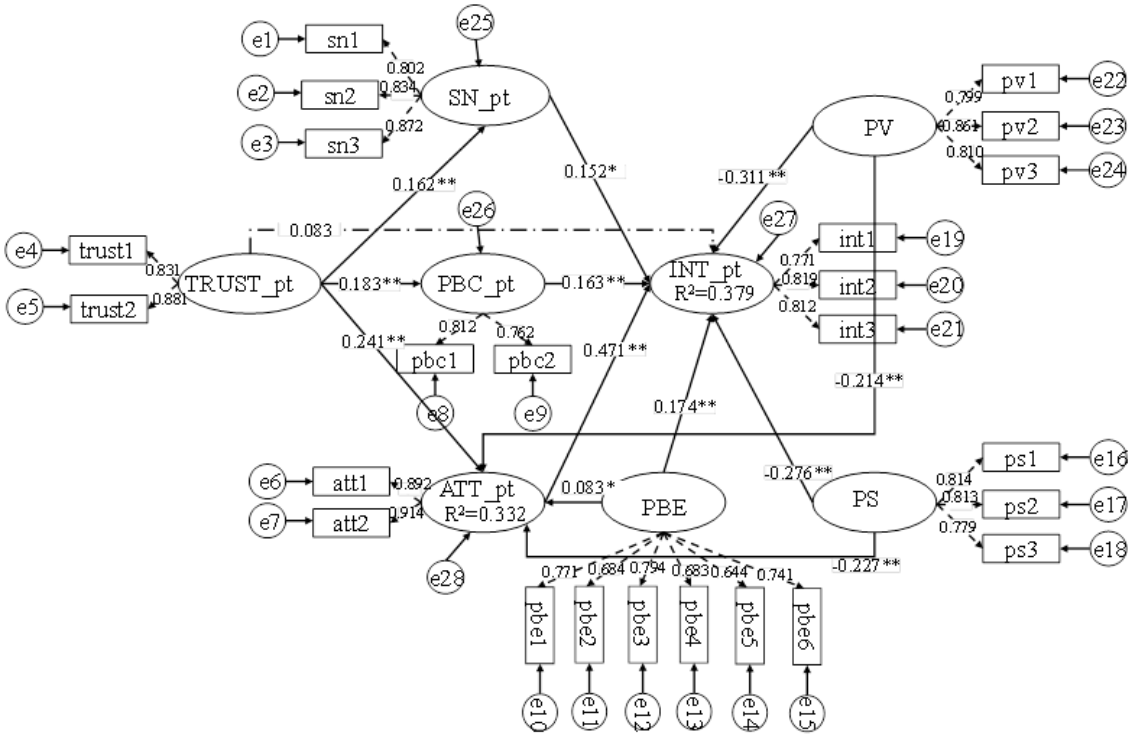
Note: TRUST_pt = trust, SN_pt = subjective norm, PBC_pt = perceived behavior control, ATT_pt = attitude, PV = perceived vulnerability, PS = perceived severity, PBE = perceived built environment, INT_pt = intention.

Figure 4. The structural equation model analysis diagram of school travel mode choice (public transit).

Table 6. Results of structural equation model fitting (public transit / private car / walk).

Index name	χ2/df	RMSEA	IFI	GFI	NFI	CFI
Test critical value	<3, Good	<0.05, Excellent	>0.90	>0.90	>0.90	>0.90
	<5, Accepted	0.05-0.08, Good				
Model parameter value (public transit)	4.48	0.062	0.917	0.902	0.900	0.907
Model parameter value (private car)	3.97	0.059	0.921	0.916	0.908	0.914
Model parameter value (walk)	3.69	0.070	0.911	0.904	0.901	0.900

This study used significance (p) as the test criteria of the hypotheses. A $p < 0.05$ indicates that the null hypothesis could be rejected. As shown in Figure 5 and Table 7, all hypotheses are supported, except H7a. Attitude（ATT, $\beta = 0.471$, $p < 0.01$）, perceived severity（PS, $\beta = -0.227$, $p < 0.01$）, and perceived vulnerability（PV, $\beta = -0.311$, $p < 0.01$）had the most significant effect on intention of choosing public transit as a travel mode. The impact of perceived behavior control (PBE, $\beta = 0.174$, $p < 0.01$) on parental intention was relatively weak. This also indicated that, compared with perceived built environment, parents were more concerned about whether their children will be affected by COVID-19 during school travel. Additionally, there were many other significant effects on intention, including subjective norm（SN, $\beta = 0.152$, $p < 0.05$）and perceived behavior vontrol PBC, $\beta = 0.163$, $p < 0.01$.).



Note: TRUST_pt = trust, SN_pt = subjective norm, PBC_pt = perceived behavior control, ATT_pt = attitude, PV = perceived vulnerability, PS = perceived severity, PBE = perceived built environment, INT_pt = intention.

Figure 5. Standardized path coefficients of the structural equation model analysis diagram of school travel mode choice (public transit).

Table 7. The result of path coefficients for school travel choice (public transit).

Null hypotheses	Path	Standardized Regression Coefficient (β)	Standard Error of Estimate (S.E.)	Significance (p)
H1a	SN_pt→INT_pt	0.152	0.060	p <0.05
H2a	ATT_pt→INT_pt	0.471	0.046	p <0.01
H3a	PBC_pt→INT_pt	0.163	0.051	p <0.01
H4a	TRUST_pt→SN_pt	0.162	0.061	p <0.01
H5a	TRUST_pt→ATT_pt	0.241	0.068	p <0.01
H6a	TRUST_pt→PBC_pt	0.183	0.036	p <0.01
H7a	TRUST_pt→INT_pt	0.083	0.048	-
H8a	PBE_pt→INT_pt	0.174	0.057	p <0.01
H9a	PBE_pt→ATT_pt	0.083	0.047	p <0.01
H10a	PS_pt→ATT_pt	-0.276	0.052	p <0.01
H11a	PS_pt→INT_pt	-0.227	0.039	p <0.01
H12a	PV_pt→INT_pt	-0.311	0.066	p <0.01
H13a	PV_pt→ATT_pt	-0.214	0.046	p <0.01

Trust had a significant impact on subjective norm（SN, β = 0.162, p < 0.01）, attitude（ATT, β = 0.241, p < 0.01）, and perceived behavior control（PBC, β = 0.183, p < 0.01）. Parental trust in public transit affected attitudes towards choosing public transit. In addition, attitude was influenced by perceived severity（PS, β = -0.276, p < 0.01）and perceived vulnerability（PV, β = -0.214, p < 0.01）negatively, while perceived built environment（PBE, β = 0.083, p < 0.01）had a positive impact on attitude.

In addition, this study established two other models for school travel mode choice during COVID-19: private car and walking travel modes. The results of these analyses are shown in Appendix C.

3.3. Hybrid choice model analysis

People generally pursue utility maximization in the decision-making process of travel mode choice. Considering the objective based on stochastic utility maximization, DCM was used to express travel choice behavior, which is described as:

$$U_{mj} = \varepsilon_{mj} + \sum h_{jl} OV_{jlm} \tag{4}$$

Where U_{mj} is the utility of decision-maker m choosing travel mode j, and ε_{mj} is the error term. In the model, OV_{jlm} is the l-th significant variable in the j-th travel mode, h_{jl} represents the normalized factor loading coefficient of the l-th significant variable in the j-th travel mode.

The SEM was integrated into the traditional DCM, and the HCM was obtained. The utility function U_{mj} is described as:

$$U_{mj} = CONST_j + \sum a_{jl} OV_{jlm} + \sum b_{jk} LV_{jkm} + \varepsilon_{mj} \tag{5}$$

Where $CONST_j$ is the constant term in the DCM, a_{jl} represents the normalized factor loading coefficient of the l-th significant variable in the j-th travel mode, and b_{jk} represents the normalized factor loading coefficient of the k-th significant variable in the j-th travel mode. In the model, LV_{jkm} is the k-th latent variable in the j-th travel mode chosen by the decision-maker m.

The SEM of the model can be described as:

$$I_{jkmz} = \zeta_{jkmz} LV_{jkm} + \theta_{jkmz} \tag{6}$$

Where I_{jlm} is the z-th observed variable of the k-th latent variable in the j-th travel mode selected by the decision-maker m, ζ_{jlmz} is the estimated parameter corresponding to the k-th latent variable selected by decision maker m, and θ_{jlmz} is the error term.

The influence of observed variables on latent variables is described as:

$$LV_{jkz} = \beta_{jkz} OV_{jkz} + \upsilon_{jkz} \tag{7}$$

Where LV_{jlz} is the k-th latent variable in the j-th travel mode, β_{jkz} is the estimated parameter corresponding to the k-th latent variable in the j-th travel mode, OV_{jkz} is the k-th observed variable in the j-th travel mode, and υ_{jkz} is the error term.

The HCM formula is given by:

$$y_{mj}\begin{cases}1, U_{mj}=Max\{U_j\}\\ 0 \quad\quad , \text{Others}\end{cases} \tag{8}$$

Where y_{mj} is the selection indicator in the model, and U_j is the set of all utilities in the decision-maker.

Considering the distribution of latent variables and indicators, the following formulas were used:

$$f_I\left(I_{jkmz}\left|LV_{jkm};\zeta_{jkmz},\sigma_{\theta z}\right.\right)=\frac{1}{\sigma_{\theta kz}}\phi\left(\frac{I_{jkmz}-\zeta_{jkmz}LV_{jkm}}{\sigma_{\theta vz}}\right) \tag{9}$$

$$f_{LV}\left(LV_{jkm}\left|OV_{jkz};\beta_{jkz},\sigma_{vz}\right.\right)=\frac{1}{\sigma_{vz}}\phi\left(\frac{LV_{jkz}-\beta_{jkz}OV_{jkz}}{\sigma_{vz}}\right) \tag{10}$$

The choice probability of travel mode is described as:

$$P_{mj}=\int P_{mjz}\left(LV_{jkm}\left(\nu_{jkm}\right)\right)f_{LV}\left(\nu_{jkm}\right)f_I\left(LV_{jkm}\left(\nu_{jkm}\right)\right)f\left(\nu\right)d\nu \tag{11}$$

This study established the HCM for parentalschool travel mode choice during COVID-19, adding psychological variables such as trust, subjective norm, perceived behavior control, attitude, perceived built environment, perceived severity, and perceived vulnerability as explanatory variables. In addition, the observed variables in HCM were further divided into four types: family socioeconomic characteristics, child attribute variables, travel attribute variables and psychometric indicators. HCM combined observed variables and latent variables as covariates to measure behavior. The structural framework is shown in Figure 6.

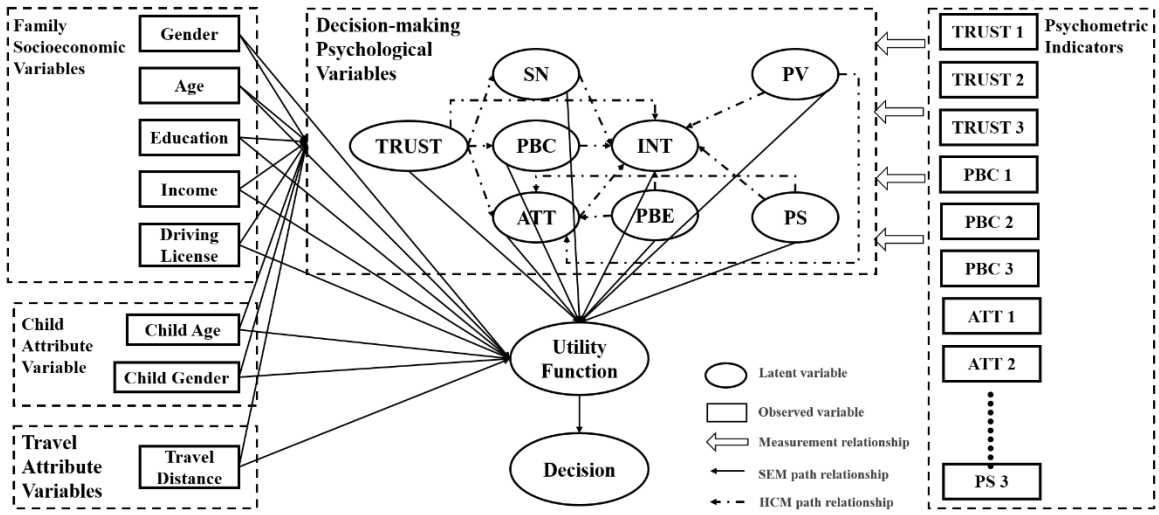


Figure 6. Hybrid choice model of school travel mode.

The HCM for school travel mode was divided into three parts: the influence of observed variables on latent variables, the relationships among the latent variables, and the impact of latent variables and observed variables on travel mode choice. The formula is expressed as follows:

$$U_{ki} = h_{k1}Gender + h_{k2}Age + h_{k3}Education + h_{k4}Income + h_{k5}Kid\_age + h_{k6}Travel\_distance + h_{k7}Kid\_gender + h_{k8}Driving\_license \quad (12)$$

$$k = TRUST, SN, PBC, ATT, PBE, PS, PV, INT$$

There were two stages of analysis: (1) the first stage was the analysis of the relationships between observed and latent variables; (2) the second stage was the path analysis of observed and latent variables.

This study analyzed the influence of observed variables on eight psychological latent variables in three travel mode choice models. In this study, relevant results were obtained through SEM and CLOGIT commands in STATA. Table 8 shows the path coefficients of observed and latent variables for the public transit travel mode choice model. The values in parentheses refer to the path *z*-test results. Results for the private car and walking choices are shown in Appendix D.

Table 8. The influence of observed variables on latent variables of school travel mode (public transit).

	Gender	Age	Edu	Income	Car_number	Child_gender	Child _age	Distance
Trust_pt	0.0735	0.065	0.036	-0.046	-0.104*	-0.069	0.064	0.068
	（1.44）	(0.097)	(0.061)	(-0.033)	(-2.14)	(-1.62)	(1.33)	(0.67)
SN_pt	0.056	0.016	0.049	-0.026	0.023	0.067	0.055	0.092
	(1.76)	(0.46)	(1.43)	(-0.68)	(0.68)	(1.02)	(1.06)	(1.66)
PBC_pt	0.069	0.015	-0.049	-0.036	-0.036	0.073	0.069	0.089
	(1.76)	(0.46)	(-1.23)	(-1.00)	(-0.88)	(1.33)	(0.96)	(1.44)
ATT_pt	0.051	0.094	-0.098*	-0.117*	-0.135**	0.067	0.064	0.012
	(0.96)	(0.99)	(-1.97)	(-2.31)	(-2.94)	(1.22)	(0.66)	(0.031)
PBE	0.046	-0.016	-0.039	0.094	0.064	-0.056*	0.074*	-0.107**
	(0.96)	(-0.15)	(-0.66)	(0.69)	(0.99)	(-1.97)	(2.04)	(-2.57)
PV	0.091	0.046	0.019	0.081*	0.098	0.056	0.078	0.095
	(0.51)	(0.62)	(0.91)	(2.33)	(1.55)	(0.61)	(0.99)	(1.09)
PS	0.041	0.066	0.091	0.097*	0.033	0.016	0.069	0.035
	(0.97)	(1.01)	(0.68)	(2.55)	(1.35)	(0.96)	(0.68)	(0.68)
INT_pt	0.039	-0.011	-0.066	-0.069*	-0.106*	0.015	0.059	0.038
	(0.98)	(-0.61)	(-0.98)	(-0.89)	(-2.37)	(0.89)	(0.61)	(0.15)

Significance level: non-significant p > 0.05, *** p < 0.001, ** p < 0.01, and * p < 0.05.

In the public transit school travel mode choice model, education level, family income, and number of car ownership all had a significant negative impact on attitudes about public transit to school travel. This revealed that parents with higher education levels, higher family income, and car ownership had more negative attitudes towards choosing public transit as a school travel mode during COVID-19. Child gender, child age, and travel distance had a statictically significant impact on perceived built environment. Family income had a significant positive impact on both perceived severity and perceived vulnerability. In addition, family income and number of car ownership had a statisticaly significant negative impact on parental intention to choose public transit as a school travel mode.

In the private car school travel mode choice model, family income had a significant positive

impact on parental trust in choosing a private car as the school travel mode. Number of car ownership and child age had a significant impact on parental attitudes towards choosing private cars. Number of car ownership had a significant impact, while child age had a negative impact. The reason may be that as children grow older, alternative forms of school travel are gradually accepted and adopted. Parents may gradually reduce the frequency of using private cars to transport their children to and from school. In addition, family income, number of car ownership, and child gender had a significant impact in parental intention to choose a private car. Family income and number of car ownership had a positive impact, while child gender had a negative impact.

Table 9. The result of HCM fitting.

Inspection index	Index fitting result		Explanation
	Public transit	Private car	
Cox&Snell R^2	0.571	0.557	The model fits well
Log likelihood	-3214.123	-3172.462	
Hosmer-Lemeshow	>0.05	>0.05	

Table 10. Parameter estimation results of HCM.

Attribute variable	Public transit			Private car		
	Parameter estimation	Z test	P test	Parameter estimation	Z test	P test
Constant	-2.574*	5.12	0.00	2.146*	3.54	0.01
Gender	0.087	1.47	0.15	-0.104*	-2.23	0.03
Age	0.037	1.17	0.24	-0.118*	2.17	0.03
Edu	-0.066	-1.37	0.27	0.126*	4.33	0.00
Income	-0.038	-1.35	0.31	0.347*	5.21	0.00
Car_number	-0.154*	-3.21	0.01	0.139*	4.92	0.00
Kid_gender	0.084	1.17	0.24	-0.105*	-6.34	0.00
Kid_age	0.141	0.53	0.61	-0.131*	-4.12	0.00
Distance	0.046	0.17	0.89	0.119	0.55	0.42
Trust_pt	0.134*	3.11	0.01	-	-	-
SN_pt	0.035	0.41	0.65	-	-	-
PBC_pt	0.054	1.16	0.25			
ATT_pt	0.178*	3.64	0.01	-	-	-
INT_pt	0.314*	3.96	0.01	-	-	-
Trust_car	-	-	-	0.164*	3.24	0.01
SN_car	-	-	-	0.071*	1.16	0.02
PBC_car	-	-	-	0.015	0.65	0.51
ATT_car	-	-	-	0.165*	3.59	0.01
INT_car	-	-	-	0.217*	2.89	0.02
PV	-0.242*	-4.91	0.01	0.289*	3.58	0.01
PS	-0.234*	-4.76	0.00	0.204*	4.34	0.00
PBE	0.104	1.56	0.10	0.143	1.33	0.19

Significance level: non-significant $p > 0.05$, *** $p < 0.001$, ** $p < 0.01$, and * $p < 0.05$.

Travel distance had a significant impact on the walking to school travel mode choice model. This variable had a significant affect on attitude, perceived built environment and intention. The influence on attitude was the highest, indicating that travel distance was the most important influencing factor for parents to choose walking as the active travel mode. This result replicates findings of previous studies [16].

After analyzing the influence of observed variables on latent variables, the latent variables were substituted into the discrete choice model, and the model was estimated together with socioeconomic characteristics, child attribute variables, and travel attribute variables. Walking travel mode was taken as the utility benchmark for comparative analysis of hybrid choice. Table 9 shows the goodness of fit for HCM. The results show that the model fits well. Table 10 shows the results of the path analysis and model fitting of HCM.

Gender had a significant impact on private car travel mode choice. Women were more inclined than men to choose a private car as the school travel mode. Age had a significant impact on parental choice of school travel mode as well. The results show that the younger the parents, the more they prefered to use a private car for school travel.

Education level and family income had a significant positive impact on parental choice of private car travel. This shows that the higher the parents' educational background, the higher the family income, and the higher the likelihood they chose a private car for school travel mode.

Child gender and child age had a significantl negative impact on parental choice of private car travel. When the child was a girl, parents were more willing to use a private car. As their children got older, parents gradually abandoned the use of private cars and switched to active modes of school travel, such as bicycles and walking. These results are consistent with the conclusions of previous research [6].

Travel distance did not have a significant impact on private car and public transit school travel modes. The reason may be that these two travel modes are both mobile modes, and families using these two modes live far from their school. Parents were not affected by travel distance.

Trust and attitude had a significant impact on parental choice of school travel mode. Generally speaking, the stronger the trust and attitude of parents towards a particular travel mode, the more inclined they were to choose this mode. This demonstrates that trust and attitude were key factors that affected parental choice of school travel mode.

Subjective norm had a positive and significant impact on parental choice of private car as a school travel mode, while perceived behavioral control had no significant impact on private car and walking school travel modes. This demonstratest hat during COVID-19, parents were more concerned about other people's suggestions on which school travel mode they chose.

Perceived severity and perceived susceptibility were variables that indicated parental assessment of pandemic risks. The results showed that perceived severity and perceived susceptibility had a significant negative impact on parental choice of public transit and a significant positive impact on parental choice of private car. This indicates that these two variables were key factors influencing parental choice of school travel mode. Even though COVID-19 in China had been well-controlled, parental risk assessment of the pandemic made them more inclined to choose a private car and other relatively safe travel modes.

Intention is a key factor affecting parental choice of travel mode. Generally speaking, the more strongly parents intended to choose a certain travel mode, the more they likely they were to choose it. However, Perceived built environment thad no significant influence on school travel choice.

4. Results

4.1. Analysis of key influencing factors

First, observed variables were analyzed. The influence of observed variables were divided into two categories: those directly acting on the decision of school travel mode choice, and those affecting parents' psychological factors that indirectly influence their decision-making. Among parental choice of public transit and private car, family income and number of car ownership greatly impacted the latent variables in the two models, which ultimately directly or indirectly affected the final decision. It can be seen that family income and number of car ownership were very important influencing factors. It can also be seen from the descriptive analyses that the proportion of families with a monthly income of more than 15,000 yuan was 45.77%, and the proportion of families that owned a car was 88.26%. Therefore, understanding how to restore this group's confidence in public transit is key to increasing their use of public transit for trasnporting their children to and from school. For the walking school travel mode, travel distance was a decisive factor influencing parental choice. This is consistent with the results of Medeiros et al., [17] which showed that when families lived within 1 kilometer of the school's buffer zone, they will choose to walk.

Next, psychological latent variables were analyzed. Through the analysis of the model results, it was found that trust, subjective norm, perceived behavior control, attitude, perceived built environment, perceived severity and perceived vulnerability all had significant impacts on parental school travel mode choice intention.

（1）Trust and attitude

Attitude was the most significant factor affecting choice of public transit school travel mode. With the walking travel mode, attitude was a strong factor. This indicates that whether parents had a positive attitude towards a certain mode of travel largely determined whether they chose that travel mode or not. This is consistent with the results of Keall et al. [18].

This study added he four factors to the model: trust, perceived built environment, perceived susceptibility and perceived severity. Among them, the last three directly influenced the choice of behavioral intention. However, trust did not have a direct influence on behavioral intention. In the public transit and private car travel models, trust indirectly influenced choice intention; with the walking travel model, trust only indirectly influenced choice intention through attitude. Parents that trusted a particular mode of travel chose this way, and they had a more positive attitude towards this mode. This shows that trust was an important factor predicting parental choice of school travel mode.

（2）Perceived severity and perceived vulnerability

Perceived severity and perceived vulnerability were both significant predictors in the model. As factors in risk assessment, perceived severity and perceived vulnerability represented parental risk perception of COVID-19. These two factors significantly impacted the choice of public transit and private car, negatively and positively, respectively. The higher the level of parental perception of the risk of COVID-19, the more they preferred to use a private car instead of public transit. Eeven if the pandemic was under control, parents wanted to ensure their children's safety, and private cars seemed to be the best choice. In addition, due to the rapid development of the Internet, information reagarding COVID-19 was sometimes confusing and involved rumors, which made information-sensitive groups anxious and uneasy. If parents believed misleading information, their

judgments regarding the risk of COVID-19 would be magnified, and their trust in public transit lost. This is consistent with the results of Rosen and Knäuper [19].

（3）Perceived built environment

Perceived built environment was a significant predictor of travel intentions. Perceived built environment was the most influential factor in the walking school travel mode model. With the public transit and private car travel mode models, it had a minor effect compared to risk assessment factors. Parental perception of the built environment was divided into perception of infrastructure construction, neighborhood relations, traffic safety and crime risks. This study found that walking was a relatively flexible and safe way of travel during COVID-19, but parental perception assessment of pandemic risk was less important compared to the impact of the built environment on walking.

4.2. Suggestions and strategies

The results of the analyses indicate that whether parents had a positive attitude towards a particular travel mode determined whether they chose that mode or not. During COVID-19, improving traveler confidence in public transit, especially among parents, has become a vital matter for the traffic management department. When a major social crisis occurs, the Internet and social media can convey relevant information in a timely manner [20, 21]. However, this direct communication channel is a double-edged sword.

On the one hand, this kind of instant information can ensure that the public keeps abreast of the latest developments regarding COVID-19, new government policies, effective protection measures, and other related content, thereby reducing the anxiety of travelers. On the other hand, sensational information and rumors are often combined with valuable information, which confuses the public, especially sensitive groups such as parents who are more influenced by this information [22]. In addition, if some parents cannot obtain relevant content in time, anxiety may cause them to believe and spread rumors to other parents. Studies have shown that information from reliable media sources can effectively reduce public anxiety and suppress rumors [23]. Therefore, when restoring public transit, schools and traffic management departments should provide parents with timely and accurate information, which is also the goal of traffic information management organizations during times of crises [22], including details pertaining to effective measures taken to protect passengers and the number of people infected on public transit.

Perceived assessment (perceived severity and perceived vulnerability) of the risk of COVID-19 is a key factor that affects parental choice of school travel mode. It reflects parental subjective experiences and views on COVID-19. Public opinion plays a key role in whether it will take the recommended preventive measures [24]. The research of Dong et al. [25] showed that during a major public crisis, the frequency of social media use by the public will increase significantly. Therefore, in emergency management, the adoption of targeted and effective protective measures based on parental subjective perceptions of COVID-19 will be of greater importance. The traffic management department should deliver effective information about COVID-19 in a timely manner, promote the protection of passengers, and not cause unnecessary anxiety and panic.

Improving the operationsof public transit is vital. Public transit should protect passengers from the virus and meet their travel needs during a a health crisis. As public transit services resume, some cities have taken measures to improve satisfaction, such as making masks mandatory on public

transit, installing heat-sensitive scanners in subway and bus stations, and using health QR codes that indicate the risk of infection. Studies have shown that proper physical distance between travellers and increasing the frequency of public transit services during COVID-19 can effectively reduce passenger panic about traveling[25]. Passengers can regulate their trips based on social-distancing needs and scheduling. For example, in terms of social-distancing, the waiting areas of subway stations and bus stations should be reasonably divided to avoid congestion. In terms of scheduling, recommending travel time to passengers through mobile applications and allowing passengers to book in advance is an effective strategy. The traffic management department strives to create a safe riding environment, improve comfort, punctuality and service frequency, and enhance parental confidence in public transit through these methods.

This study found that parental choice of walking during COVID-19 was mainly affected by the built environment. The survey results showed that 37.6% of families lived a distance of less than 1 km from their school. Therefore, even during COVID-19, the government still needs to strengthen traffic control measures and infrastructure construction in the communities around the school, such as strengthening the management of motor vehicles, the construction of sidewalks around the school, and ensuring a low crime rate in nearby communities. Schools and communities can organize Walk School Bus (WSB). Under the supervision of the team leader, WSB can ensure that children arrive home safely, and can also make up for the loss of exercise caused by taking motor vehicles [6].

5. Conclusions, limitations, and suggestions for further studies

5.1. Research results

The specific conclusions of this research are as follows:

This study expanded previous TPB and PMT models to include psychological latent variables such as perceived severity, perceived vulnerability, perceived built environmentand, trust, as well as objective variables such as socioeconomic characteristics and travel attributes. A theoretical framework for the choice of parental school travel mode during COVID-19 was proposed. Analyses on the models were performed based on survey data, which verified the applicability of the models in explaining parental choice of school travel mode.

SEM was used to verify the main factors influencing parental choice of school travel mode during COVID-19. Modelling results demonstrated that trust, perceived severity, perceived vulnerability, perceived built environment, attitude, subjective norms and perceived behavior control greatly influenced behavioral intentions. Attitudes towards travel mode was the main factor determining whether parents chose this mode or not. Perceived severity and perceived vulnerability represented perceived pandemic risk assessment and had a significant impact on the choice of public transit and private car travel mode, but not a significant impact on choice of walking travel mode. This showed that parental choice of public transit or private car during COVID-19 was dependent upon their subjective judgment of the severity of the pandemic. However, their choice of walking was not affected by this judgement. Perceived built environment was the most important factor affecting the prediction of choosing to walk. This shows that during COVID-19, parents still paid greater attention to the built environment around the school than their perception of pandemic risk.

HCM was used to analyze the relationships between socioeconomic characteristics, travel attributes and psychological latent variables. The results showed that the observed variables had

different effects on the psychological latent variables regarding public transit, private car and walking travel modes. In addition, this study analyzed the path of numerous variables using walking travel mode as the benchmark utility, and found that familyiIncome, number of car ownership, perceived severity and perceived vulnerability were the most significant variables affecting choice of travel mode.

Through the analyses and discussion of key influencing factors, this study thoroughly expored parental school travel mode choice during COVID-19, and offers several constructive suggestions to the government and public transit management departments. These suggestions could increase parental confidence in public transit and reduce the frequency of private car use, thereby alleviating urban traffic pressure.

5.2. Research insights

Based on previous research, the main insights stemming from this research are as follows:

Current domestic and foreign research on travel modes during COVID-19 have usually focused on urban commuters. Research on parental choice of school travel mode has been typically conducted during non-pandemic times. Previous studies rarely explored the impact of COVID-19 on parental choice of school travel mode. Therefore, this study examined the impact of COVID-19 into the study of parental choice of school travel mode and analyzed and predicted parental choice of school travel mode during COVID-19.

In terms of theoretical models, this study combined TPB with PMT to examine travel mode choices during COVID-19. By combining parental characteristics and travel attributes, a more complete and systematic framework for understanding parental choice behavior that includes economic factors, travel attributes and psychological factors was constructed.

In terms of influencing factors, in order to study the impact of COVID-19 on parental choice, this study used several original influencing factors and retained perceived built environment in the study of school travel. Perceived severity and perceived vulnerability, which can represent parental assessment of pandemic risk, were added to expand the existing theoretical model.

Most previous studies used SEM to examine the influence of psychological factors on choice behavior, or use choice model to understand the influence of variables on choice behavior. However, few empirical studies have combined SEM and choice model.

Moreover, as the decision-making process is a collection of linear and non-linear relationships, it is far from enough to only use SEM. Therefore, this study combined HCM with SEM to analyze the influence of several obvious variables on latent variables and the influence of various factors on choice behavior.

5.3 Limitations and suggestions for further studies

Parents in different regions may show differences in their school travel mode choices. Since the survey data in this study only came from Zhenjiang City, it may not represent other regions in China. Future research can compare other regions in China and foreign cities.

This study introduced perceived severity and perceived vulnerability to explore parental risk assessment of COVID-19. However, it is a bit unrealistic to measure the perception of COVID-19 with only two variables. At the same time, this study considered "rational" decision-making, but only included psychological and emotional issues such as anxiety, fear, or frustration. Future research

should consider several different aspects of these factors in pandemic risk assessment.

Regarding the model's fit, some indicators were "acceptable", but not excellent. Future research should add reasonable control variables to improve the model's fit.

The results of this study show that different socioeconomic characteristic may affect parental choice of school travel mode. Therefore, future research should further divide the parent population on various attributes to provide a more detailed understanding.

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Conflict of interest

The authors declare there is no conflict of interest.

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