Research on Influencing Factors of Mobile Phone Use Behavior During Electric Bicycle Riding

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Abstract: In order to analyze the influencing factors of cyclists' mobile phone use behavior during e-bike riding, this paper uses the theory of planned behavior as a framework and adds two extended variables, risk perception and riding habits, to construct an extended theory of planned behavior model. By distributing questionnaires, 387 valid questionnaires were finally obtained, and structural equation modeling was used to analyze the complex relationships among the variables and finally analyze the main factors influencing cyclists' mobile phone use behavior during cycling. The results of the study showed that the extended theory of planned behavior can well explain the mobile phone use behavior during e-bike riding, in which risk perception has the greatest influence on the total mobile phone use behavior during riding, followed by behavioral intention; subjective norm has the least influence on the mobile phone use behavior. The results of the study can help to understand mobile phone use behavior during e-bike riding and the mechanism of influence, and provide a theoretical basis for further research on distracted riding behavior and distracted riding interventions.

Keywords: mobile phone; risky riding behavior; extended theory of planned behavior; structural equation model

1 INTRODUCTION

Along with the progress of technology, smartphones have become an inseparable part of our daily life. It is reported that by 2020, the number of mobile phone users worldwide will reach 3.5 billion, and Chinese adults spend 1 hour and 40 minutes of mobile phone contact time per day, and 41.94% of college students use mobile phones for 4-6 hours per day [1-2]. With the popularity of smartphones, the use of mobile phones while driving transportation is becoming more common, and numerous studies have shown that the frequency of mobile phone use while driving transportation is significantly correlated with the number of traffic accidents [3-5]. The use of mobile phones during driving has become one of the four major causes of traffic accidents [6].

Studies on e-bikes have shown that mobile phone use behavior during e-bike riding is common, especially for online delivery workers who use e-bikes as their primary mode of transportation. Liu, K. [7] observed 1490 online delivery workers by the road test observation method and found that mobile phone use during riding is one of the most common risky

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behaviors. Truong, L.T [8] et al. found that mobile phone use during riding was 8.4% by observing 759 motorcycles and 1601 e-bikes. Mobile phones are used from time to time during riding. Using mobile phones during riding will, on the one hand, distract the rider's attention and reduce their observation of the surrounding environment; on the other hand, using mobile phones will cause one-handed operation of the vehicle, which seriously affects riding safety. Although China has introduced corresponding regulations to restrict the use of mobile phones while cycling, cyclists will ignore the consequences of such behavior and will still engage in such behavior.

Mobile phone use behavior is representative of distracted behavior and is easily analyzed and studied. Domestic and international scholars have conducted more comprehensive research on the distractive aspects of motor vehicle and bicycle driving caused by mobile phones, and some important conclusions have been drawn.

First of all, in terms of traffic safety hazards of mobile phone use in driving vehicles. Haigney et al [9] found that drivers' heart rate, perception of the environment, and reaction time are negatively affected when they drive while using a mobile phone. Rakauskas M E et al [10] found through driving simulation experiments that the driver's driving ability is affected regardless of the difficulty level of the call content. Dickde Waard [11] et al. found that both handheld and hands-free operation of mobile phones negatively affect perception and may pose a threat to cyclists' traffic safety. DickDe Waard and BenLewis-Evans et al [12] found that the use of touch phones had a greater negative impact on cycling performance than conventional mobile phones.

Secondly, in terms of the factors influencing the behavior of mobile phone use during driving transportation, Nguyen, D.V.M et al [13] found that attitudes, perceived behavioral control, and behavioral habits were associated with motorcyclists' intention to use a mobile phone while riding. Also, behavioral habits and behavioral intentions were related to motorcycle riders' use of mobile phones while riding. Sullman, M.J.M et al [14] discovered that drivers with positive attitudes toward cell phones were the most significant predictors of intention to use them while driving. Perceptual behavioral control also had a significant positive effect on mobile phone use behavior while driving. K. Jiang [15] TPB can effectively explain and predict mobile phone use behavior while cycling, with mobile phone addiction, distraction perception, and behavioral intention being the most important influencing factors.

Currently, TPB has been widely used in the field of traffic engineering. Studies involving bad traffic behavior [16], safe driving behavior [17], interchange decisions [18], and speeding [19]. For example, Zhang Yaning et al [20] used the theory of planned behavior to study the factors influencing aggressive driving behavior in a driving simulation environment and concluded that attitudes and perceptual behavioral control are the main causes of aggressive driving behavior, and subjective norms have less influence on aggressive driving behavior.

In summary, domestic and foreign scholars have conducted more comprehensive studies on mobile phone use behavior during motor vehicle and bicycle driving. However, less research has been conducted on mobile phone use behavior during e-bike riding. e-bikes are used more in China, especially online delivery workers often use mobile phones to receive orders, contact customers, and check navigation while riding e-bikes. In view of this, in order to understand the influencing factors of mobile phone use behavior during e-bike riding, this paper takes the theory of planned behavior as the main framework and explores the interrelationships among variables, so as to reduce mobile phone use behavior during e-bike riding to provide some reference basis.

2 THEORETICAL MODEL AND MODEL ASSUMPTIONS

2.1 Extending the TPB model

The Theory of Planned Behavior (TPB), proposed by Fishbein and Ajzen [21], is now widely used to predict and explain the relationship between attitudes and behaviors, with more pronounced explanatory and predictive power for unsafe traffic behavioral intentions [22] The TPB model has three potential variables that influence an individual's behavioral intention BI (an individual's willingness to perform a behavior): attitude ATT (the positive or negative evaluation an individual holds about the behavior), subjective norm SN (social pressure to perceive the behavior of others), and perceived behavioral control PBC (the ease of performing a given behavior) [23].

The Theory of Planned Behavior successfully explains part of the behavioral variance, but behavior is also influenced by other factors, so TPB allows for the inclusion of new explanatory variables, which helps to improve the explanatory effect of the TPB model [24]. In addition, risk perception and riding habits were also found to influence the riding of delivery personnel through a walk-through survey, and risk perception and riding habits have also been studied abroad; Bayer and Campbell [25] found that habits caused significant differences over TPB factors in predicting drivers' intentions to send and receive text messages while driving during the construction of driving. [26] Habit was a significant predictor of intention to engage in the same behavior. Risk perception refers to the judgments cyclists make about the consequences of their mobile phone use behavior while riding. Riding habits refer to the environment or road section where cyclists had used their mobile phones during the ride. Therefore, this paper proposes to add two extended variables, risk perception and riding habits, to construct a structural equation model of cyclists' mobile phone use behavior based on extended theory of planned behavior.

2.2 Extended TPB model assumptions

In this paper, we propose the following hypothesis to construct an extended planned behavior model to explore the analysis of factors influencing the behavior of cell phone use during e-bike riding. The extended TPB model is shown in FIG1.

H1: Behavioral attitudes have a significant positive effect on behavioral intentions.

H2: Subjective norms have a significant positive effect on behavioral intention.

H3: Rerceptual behavioral control has a significant positive effect on behavioral intention.

H4: Riding habits have a significant positive effect on behavioral intention.

H5: Risk perception has a significant negative effect on behavioral intention.

H6: Perceived behavioral control has a significant positive effect on behavior.

H7: Riding habits have a significant positive effect on behavior.

H8: Risk perception has a significant negative effect on behavior.

H9: Behavioral intention has a significant positive effect on behavior.

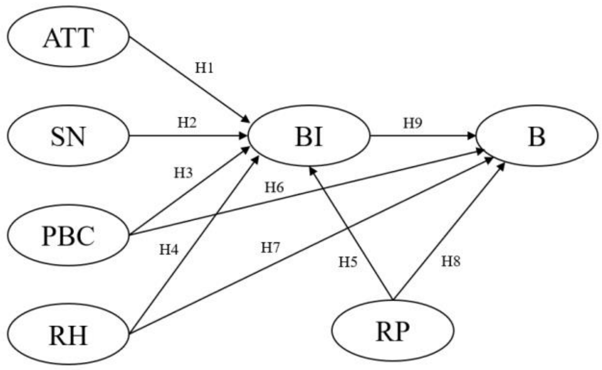

Figure 1 Research model of mobile phone use behavior during electric bicycle riding

3 DATA COLLECTION AND PROCESSING

3.1 Questionnaire design

To ensure that valid and reliable data can be obtained, this paper is based on the content of the TPB questionnaire proposed by Ajzen [25] and the preliminary questionnaire on distracted driving behavior, and modified with the characteristics of domestic e-bike riding to form the questionnaire in this paper. The questionnaire consists of three main parts.

The first part is the preamble description of the questionnaire, including the description of the purpose of the questionnaire and the description of the respondent's transfer form. The second part is the basic personal information of the respondents, including: gender, age, education level, occupation and cycling frequency, frequency of mobile phone use during cycling and other issues.

The third part of the scale question section includes.

①The Behavioral Attitude Scale uses seven observed variables to assess attitudes, such as "Using mobile phones while cycling can help you use your time effectively" and "Using mobile phones while cycling can help you grasp important information in real time."

②The Subjective Norms scale uses five observed variables to assess subjective norms, e.g., "Your family's perception of your use of a mobile phone while riding an e-bike", "The traffic police's perception of your use of a mobile phone while riding an e-bike."

③The Perceptual Behavioral Control Scale uses six observed variables to assess perceptual behavioral control, e.g., "Ability to operate a mobile phone while riding safely" and "Using a mobile phone while riding an e-bike is very easy for you."

④The Risk Perception Scale uses five observed variables to assess risk perception, for example, "Using a mobile phone while riding an e-bike affects how well you see the road around you" and "Using a mobile phone while riding an e-bike affects how accurately you respond to messages."

⑤The Riding Habits Scale uses four observed variables to assess riding experience, for example, "Ever used a mobile phone while riding an e-bike in the past year under good road conditions."

⑥The Behavioral Intentions Scale uses six observed variables to assess behavioral intentions, such as "the likelihood of you making a phone call while riding an e-bike" and "the likelihood of you responding to a message (WeChat) while riding an e-bike."

The questions in the questionnaire were scored on a 5-point Likert scale format ranging from "completely disagree" to "completely agree". The higher the score, the higher the level of the construct.

3.2 Questionnaire

Relevant studies have shown that the insufficient number of questionnaires will lead to a poor fit, and the sample size needs to reach 5-10 times the observed variables [21].In this paper, there are 33 scale items, and the number of pre-collected questionnaires is 350. To ensure the accuracy of the linguistic description of the questionnaire, a small-scale survey test was conducted before the formal distribution of the questionnaire, 100 questionnaires were distributed, the expressions of the observed variables were re-revised according to the feedback from the respondents as well as experts, and the questionnaire was factor analyzed and some question items were deleted to form the formal questionnaire.

Through the network and offline field distribution of questionnaires, all respondents who fill out the questionnaire are able to get 10 yuan. In order to ensure the validity of the questionnaire, set the same IP address can only fill out one. The final return of 411 questionnaires, less than 90s answer time or multiple consecutive questions answered the same, is defined as an invalid questionnaire. Eliminate 24 invalid questionnaires, and the final valid questionnaire is 387 The efficiency of the questionnaire was 94%.

3.3 Questionnaire data analysis

Descriptive statistical analysis was performed on the collected valid questionnaires, and the basic personal information of the respondents is shown in Table 1.

Table 1 Respondents' personal basic information

Biker Demographics	Category	Quantity	Percentage/%
Gender	Male	215	55.6%

Biker Demographics	Category	Quantity	Percentage/%
	Women	172	44.4%
Age	Under 18 years old	20	5.2%
	18~25 years old	125	32.3%
	26~30 years old	118	30.5%
	31~40 years old	93	24.0%
	Over 40 years old	31	8.0%
Education level	Junior high school and below	15	3.9%
	High school/vocational high school/junior high school	33	8.5%
	College/bachelor's degree	209	54.0%
	Master and above	46	33.6%
Career	Students	143	36.9%
	Salesman	151	39.1%
	Employee/Civil Servant	36	9.3%
	Private/self-employed workers	33	8.5%
	Service industry personnel	24	6.2%
Average daily hours of mobile phone use	<2 hours	24	6.2%
	2~4 hours	63	16.3%
	4~6 hours	124	32.0%
	More than 6 hours	176	45.5%
Average length of an e-bike ride	Service industry personnel	133	34.4%
	<2 hours	164	42.4%
	2~4 hours	59	15.2%
	More than 1 hour	31	8.0%
How often you use your mobile phone while riding your e-bike	Never use	79	20.4%
	Less frequently used	82	21.1%
	Sometimes using	142	36.7%
	Frequently used	50	12.9%
	Always use	34	8.7%

In this paper, the reliability of the questionnaire scale questions was analyzed using SSPS26.0 software, and the reliability tests were conducted separately for each dimension of the scale items and the total scale. The results showed that the overall reliability of the scale was 0.88, with high reliability; the Clonbach's alpha coefficients of the six latent variable dimensions were all greater than 0.7, indicating that the reliability quality of the questionnaire as a whole and of each dimension was good and in accordance with the questionnaire design requirements.

Table 2 Clonbach's alpha for each part of the questionnaire

Variables	**Cronbach's Alpha**	**Projects**
Attitude	0.84	5
Subjective norms	0.87	5
Perceptual Behavioral Control	0.89	6
Risk Perception	0.88	4
Riding Habits	0.86	5
Behavioral Intentions	0.90	6
Overall questionnaire	0.88	31

Validity, or validity, refers to the degree of fit between the measurement results and the psychological or behavioral traits studied by the author [28]. This was first analyzed using the KMO test and Bartlett's spherical test, and exploratory factor analysis could be conducted when KMO> 0.6 and Bartlett's spherical test p-value was significant. According to Table 3, KMO = 0.923 and Sig value of 0.00, the questionnaire sample met the prerequisites for exploratory factor analysis. In the extraction of public factors, six factors with eigenvalues greater than 1 were extracted by orthogonal rotation according to the maximum variance method, and the explained variances were 12.77%, 12.7%, 11.15%, 10.76%, 10.2%, and 9.0%, respectively, with a cumulative variance explained of 66.63%, and the factor loadings of all observed variables in each dimension were greater than 0.5, which comprehensively indicates that the questionnaire has good structural validity.

Table 3 KMO test and Bartlett's spherical test results

KMO		0.923
Bartlett Test	Chi-Square	6460.562
	df	465
	Sig	0.000

A Pearson correlation analysis was used to analyze the linear correlations between the latent variables, and Table 4 shows the results of the correlation analysis between the latent variables, with significant positive correlations between attitudes, subjective norms, perceived behavioral control, riding habits, and behavioral intentions, and negative correlations between risk perceptions and behavioral intentions.

Table 4 Correlation analysis

Foctors	**ATT**	**SN**	**PBC**	**RP**	**RH**	**BI**
ATT	1					
SN	0.363***	1				

Foctors	ATT	SN	PBC	RP	RH	BI
PBC	0.383**	0.372***	1			
RP	-0.184***	-0.142**	-0.276***	1		
RH	0.42**	0.312***	0.398***	-0.228***	1	
BE	0.472***	0.363***	0.442*	-0.397***	0.492***	1

Note: * P<0.05, ** P<0.01, *** P<0.001

Validated factor analysis (CFA) was conducted on the questionnaire scales to test for factor loadings, convergent validity, and discriminant validity. The higher the factor loadings of the observed variables, the better the validity of the potential variables. Convergent validity refers to the degree of similarity of measurement results when different measurement methods are used to determine the same target [29]. Common indicators of convergent validity are AVE and CR, and good convergent validity is indicated when the AVE value is greater than 0.50 and the CR value is greater than 0.70. According to Table 5, the standardized factor loadings are significant and greater than 0.6, and the CR and AVE values in the table are in accordance with the requirements.

Table 5 Results of Confirmatory Factor Analysis

Factor	Title	Factor loading	CR	AVE
Attitude	ATT1	0.718	0.842	0.516
	ATT2	0.784		
	ATT3	0.751		
	ATT4	0.737		
	ATT5	0.616		
Subjective norms	SN1	0.682	0.868	0.516
	SN2	0.766		
	SN3	0.769		
	SN4	0.754		
	SN5	0.795		
Perceptual Behavioral Control	PBC1	0.76	0.891	0.57
	PBC2	0.825		
	PBC3	0.723		
	PBC4	0.773		
	PBC5	0.685		
	PBC6	0.795		
Risk Perception	DP1	0.766	0.878	0.59
	DP2	0.824		
	DP3	0.727		
	DP4	0.745		
	DP5	0.783		
Riding Habits	BE1	0.867	0.86	0.609

Factor	Title	Factor loading	CR	AVE
Behavioral Intentions	BE2	0.718	0.902	0.605
	BE3	0.807		
	BE4	0.729		
	BI1	0.743		
	BI2	0.817		
	BI3	0.782		
	BI4	0.79		
	BI5	0.713		
	BI6	0.746		

The test of discriminant validity is generally done by comparing the square root of AVE with the value of the correlation coefficient; if the square root of AVE is greater than the correlation coefficient of this latent variable and other latent variables, then the discriminant validity is good. The data on the diagonal line in Table 6 are the square root of AVE, which is used to indicate the strength of the correlation within the factor, and the values on the diagonal line are greater than the other data in the same column, indicating that the discriminant validity is valid.

Table 6 Results of Discriminant Validity

Foctors	ATT	SN	PBC	RP	RH	BI
ATT	0.718					
SN	0.363	0.755				
PBC	0.383	0.372	0.76			
RP	-0.184	-0.142	-0.276	0.768		
RH	0.42	0.312	0.398	-0.228	0.78	
BI	0.472	0.363	0.442	-0.397	0.492	0.778

Note: The diagonal number is the root value of this factor AVE

4 STRUCTURAL EQUATION MODELING OF MOBILE PHONE USE BEHAVIOR DURING E-BIKE RIDING

4.1 Model Construction

Based on the results of the validation factor analysis, the structural equation model (SEM) of cell phone usage behavior during e-bike riding was constructed. The structural path diagram of the model was finally obtained by continuously adjusting the model according to the correction index of the model, as shown in FIG 2.

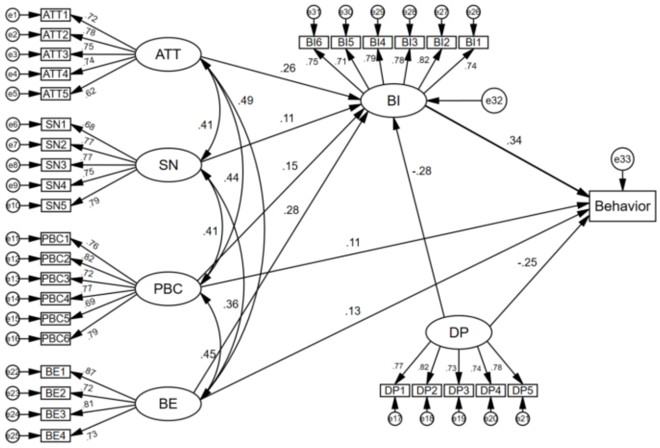

Figure 2 Structural equation modeling of mobile phone use behavior during e-bike riding

4.2 Model fitting effect judgment

T The modified structural equation model fit indexes are shown in Table 7 below, and comparing the fit indexes of the model with the evaluation criteria values shows that the modified model fits well and the data can fit well with the proposed fit.

Table 7 Results of the goodness of fit for the revised model.

Evaluation Indicators	Evaluation Criteria	Data
χ^2/df	1-3, good	1.27
RMESA	<0.08, good	0.027
GFI	＞0.90, good	0.917
AGFI	＞0.90, good	0.903
NFI	＞0.90, good	0.916
IFI	＞0.90, good	0.981
TLI	＞0.90, good	0.979
CFI	＞0.90, good	0.981
PGFI	＞0.50, good	0.782
PNFI	＞0.50, good	0.831

4.3 Model path analysis

According to Table 8, the standardized path coefficients between attitudes, subjective norms, perceived behavioral control, behavioral habits and behavioral intentions were 0.263, 0.108, 0.105, and P<05, in that order, assuming that H1, H2, and H3 hold. The standardized path coefficients between the extended variables riding habits, risk perception and behavioral intention were 0.284, -0.281, and P<0.001, in that order, assuming that H4, H5, and H6 hold. The path coefficients between perceived behavioral control, riding habits, risk perception and behavioral perception were 0.106, 0.126, -0.252, and P<0.05, in that order, assuming that H6, H7, and H8 hold. The path coefficient of behavioral intention and cell phone use behavior was 0.344 and P<0.001, and hypothesis H9 held. Risk perception and riding habits were significant influencing factors for behavioral intention, and attitude and behavioral intention were significant influencing factors for cell phone use behavior during riding.

Table 8 Extended TPB path analysis results

Path Relationships	Path factor	S.E.	C.R.	P-value
AT→ BI	0.263	0.066	4.262	***
SN→ BI	0.108	0.059	1.993	*
PBC→ BI	0.150	0.051	2.661	**
RH→ BI	0.284	0.049	4.821	***
RP→ BI	-0.251	0.048	-5.848	***
PBC→ Behavior	0.106	0.068	1.976	*
RH→ Behavior	0.126	0.068	2.168	*
RP → Behavior	-0.252	0.070	-5.084	***
BI → Behavior	0.344	0.088	5.472	***

Note: * P<0.05, ** P<0.01, *** P<0.001

In order to reveal the decision-making mechanism of cyclists' mobile phone use behavior more comprehensively and deeply, this study will further explain the model by analyzing the influence of variables in depth in three aspects: direct influence effect, indirect influence effect and total influence effect, and the results are shown in Table 9. Risk perception, behavioral intention and cycling habit have the most significant effects on pedestrians' mobile phone use behavior across the street, with total influence effects reaching -0.347, 0.344 and 0.224, respectively; followed by perceptual behavioral control and attitude, with total influence effects reaching 0.158, and 0.090, respectively: while subjective norms have the lowest influence effects, with total influence effects of only 0.037.

Table 9 direct, indirect, and total effects of the psychological factors on target behavior

Paths	Direct effect	Direct effect	Direct effect
ATT →Behavior	0.00	0.090	0.090
SN →Behavior	0.00	0.037	0.037
PBC →Behavior	0.106	0.052	0.158
RP →Behavior	-0.252	-0.095	-0.347
RH→Behavior	0.126	0.098	0.224
BI→Behavior	0.344	0.00	0.344

4.4 Discussion

Based on the extended TPB model, this paper explores the relationship of various factors on the influence of mobile phones during cycling, such as attitude, subjective behavioral norms, perceptual behavioral control, cycling habits, and risk perception on cyclists' intention to use mobile phones to explore whether cyclists would use mobile phones during cycling.

The results of the study showed that attitude, subjective behavioral norms, and perceptual behavioral control all had significant effects on behavioral intention, with attitude having a greater effect on behavioral intention, indicating that more positive attitudes toward mobile phone use behaviors produced a greater intention to use a mobile phone during riding, and subjective norms had less effect on wearing a helmet during riding. The additional extended variables of riding habits, risk perception, and behavioral intention all had a greater effect. The results showed that the richer the riding habits and the lower the risk prediction of mobile phone use behavior, the more likely the behavioral intention to use a mobile phone while riding.

Behavioral intention has a significant effect on mobile phone use behavior during cycling. The greater the intention to use a mobile phone during cycling, the more frequent the mobile phone use behavior during cycling will be. In addition, risk perception is one of the strongest influences on mobile phone use behavior during cycling. Those cyclists who perceived a higher risk of distraction from mobile phone use were less likely to use their mobile phones while riding an e-bike. Therefore, interventions should focus primarily on enhancing cyclists' perceived risk of mobile phone use. Safety campaigns to inform the public about the risks associated with mobile phone use and e-bike riding are necessary to remind people that smartphone use can be a distraction from traffic activities.

This study helps to understand the reasons for the occurrence of mobile phone use behavior during e-bike riding, and these findings help to develop corresponding countermeasures. The traffic police need to strengthen the penalties for mobile phone use during riding, so as to strengthen the public's awareness of compliance with the law; the media should publish typical cases of traffic accidents caused by mobile phone use and analyze the causes of accidents in depth to strengthen the public's awareness of traffic safety; for occupations such as online delivery workers who need to use mobile phones frequently during riding, companies should emphasize the hazards of mobile phone use during riding during induction business training, so as to change riders' riding habits and correctly understand mobile phone use during riding. The hazards of mobile phone use during cycling are emphasized during the induction training, and the cycling habits of riders are changed to correctly understand the behavior of mobile phone use during cycling.

5 CONCLUDING REMARKS

This paper analyzes the influencing factors of cell phone use behavior during e-bike riding from a social psychological perspective using an extended theory of planned behavior. The results show that only risk perception and cell phone use behavior during e-bike riding are negatively related, and risk perception is the main determinant of cell phone use behavior during e-bike riding. Behavioral intention is the secondary determinant of cell phone use behavior during e-bike riding, and subjective norm has the least total influence on cell phone use behavior during riding. The extended structural equation model constructed in this study has strong explanatory and predictive power for cell phone use behavior during riding. The results of the study can provide a basis for traffic management departments to conduct more effective traffic safety education and develop monitoring and management measures. However, this study still has some limitations, and some other factors, such as moral norms and group norms, may also have some influence on the behavior of cell phone use during cycling. Further research can be conducted in the future.

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