Keywords: campus in cold region; slow traffic system; evaluation system; travel satisfaction; Bayesian-structural equation model

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EVALUATION AND IMPROVEMENT OF A SLOW TRAFFIC SYSTEM IN A COLD REGIONAL CAMPUS BASED ON TRAVEL SATISFACTION

Summary. This study establishes a Bayesian-structural equation model based on the travel satisfaction survey at the Boda Campus of Xinjiang University to construct and optimize the slow traffic system of campus in cold regions. Moreover, relevant indicators are selected to construct the evaluation system of the campus's slow traffic system in cold regions. Then, strategies are proposed to optimize the campus's slow traffic system according to the key elements highlighted by the evaluation system. The results show that subjective emotion and perceived time have a great influence on travel satisfaction. The connectivity and density of the walking and cycling network, anti-skid performance of the road surface, canopy amount, and parking/pick-up convenience of shared bicycle sites substantially influence the construction of campuses' slow traffic systems in cold regions. The score of the optimized campus's slow traffic system increased by 72.10% compared with that of the pre-optimized system.

1. INTRODUCTION

With the rapid development of the social economy, colleges, and universities continue to optimize the education environment and gather talents in the process of the social economy. One of the main performances of this progress is the continuous growth of the enrollment scale of colleges and universities, leading to the emergence of new construction and expansion projects on campuses. As a result, there is a growing demand from faculty and students for fast, secure, and convenient passage on the extensive campus. Therefore, there is an urgent need to construct a traffic environment that accommodates slow traffic on college campuses.

At present, the slow traffic system on campuses typically involves traffic modes of walking, shared bicycles. The research on slow traffic systems on college campuses usually focuses on planning campus slow traffic routes [1-4] and optimizing parking points for shared bicycles [5-9]. In general, the research on slow campus traffic predominantly concentrates on planning and managing a single traffic mode. Nevertheless, the advancement of slow traffic constitutes a comprehensive undertaking that demands the strategic planning of physical infrastructure and improvements in the slow traffic environment concerning safety and comfort. Furthermore, the extant research has mainly focused on developing slow traffic systems in colleges and universities located in regions with mild climates. For example, Tan et

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al. took universities in temperate regions as an example to build a satisfaction evaluation system and proposed optimization measures such as human-vehicle separation and dynamic right-of-way allocation [10]. Pan used universities in hot and humid areas as an example to explore the heat dissipation effect of shade degree and road surface materials on the slow running system of colleges and universities in hot and humid areas [11]. Research on slow traffic systems at colleges and universities in cold regions is relatively scarce [12, 13].

Compared with temperate regions, colleges and universities in cold regions have a unique climate environment characterized by, for example, a long snow season, low temperatures, and high wind speeds. Taking the Boda Campus of Xinjiang University as an example, the city where the university is located has a typical northern climate, with a snow season that lasts from October to March every year, with an average temperature of -15.2°C. In winter, walking and cycling paths are covered with snow; this, along with icy roads, cold winds, and other problems, brings safety risks to winter travel.

Hence, the study of slow traffic system development for campuses in cold regions is a critical aspect of ongoing research on slow traffic systems within college campuses, which needs attention and improvement. This article analyzes the slow traffic system at a campus in a cold region from the perspective of travel satisfaction by combining it with the slow traffic characteristics and traffic demand. Specifically, the study explores the factors and mechanisms that influence travel satisfaction and establishes an evaluation system for the slow traffic system of campus in a cold region that incorporates environmental factors. The existing slow traffic system can then be assessed to develop design strategies for improving the slow traffic system on campus. It is of great practical significance for constructing a suitable dynamic and static traffic system for travel at a campus in a cold region.

2. CONSTRUCTION OF A CAMPUS SLOW TRAVEL SATISFACTION MODEL OF COLLEGE STUDENTS IN A COLD REGION

Slow travel satisfaction of college students in cold regions is closely related to psychological factors such as safety and comfort. In order to deeply explore the factors and the mechanisms that influence travel satisfaction, this study applies the satisfaction theory, utilizes established scales for quantifying travel satisfaction, and employs a structural equation model to analyze the relationship between psychological factors and travel satisfaction. Based on five types of variables—travel attribute, subjective emotion, perceived quality, travel satisfaction, and perceived time—a campus travel satisfaction questionnaire of college students in cold regions with 16 measurement items was created. A total of 411 questionnaires were issued and collected through offline investigation, of which 398 were valid, with an effective rate of 96%. The sample statistical results are shown in Table 1, which are mostly consistent with the actual distribution of students at Xinjiang University. The representativeness of the sample data can be used to explore the factors influencing college students' on-campus travel satisfaction in cold regions.

Reliability and validity analyses were conducted on the scale data in order to ensure the effectiveness of subsequent modeling. Reliability was assessed using Cronbach's alpha, and validity was evaluated using the Kaiser-Meyer-Olkin (KMO) value to test variable correlations. As shown in Table 2, the Cronbach's alpha value for each latent variable was greater than 0.8, and the KMO value exceeded 0.6. Thus, the requirements for reliability and validity were met, and the data could be used for modeling and analysis.

Structural equation models usually require complete data and a sufficient sample size, and it is assumed that random observations are independently and equally distributed in a multivariate normal distribution. Moreover, the generalized least square method and maximum likelihood method are used to estimate the model parameters, and the analysis results depend on the asymptotic distribution of the sample covariance matrix [14, 15]. However, the reality is complex, and many practical problems cannot meet the required assumptions.

Bayesian methods allow prior knowledge to be incorporated into the model (i.e., prior distributions of parameters can be set using existing expertise). When estimating model parameters, they are all regarded as random variables, and the prior distribution and data are used to update the posterior distribution of these variables rather than relying on the sample covariance matrix so that data uncertainty can be handled more effectively. Moreover, Bayesian methods can deal with non-normal distribution, missing data, or complex model structures, such as nonlinear models, hierarchical models, and multi-level data structures. In addition, although the Bayes method relies less on asymptotic theory, it makes more accurate estimates through prior information and posterior inference and can obtain reliable results even in the case of small samples [16]. Therefore, the structural equation model based on Bayesian estimation is adopted in this study to analyze satisfaction.

Table 1

Statistical results of questionnaire survey data at Xinjiang University

Category		Frequency	Proportion	Category		Frequency	Proportion
Age	Male	205	51.5%	Dormitory	North	170	42.7%
	Female	193	48.5%		South	115	28.9%
Grade	Freshman	51	12.8%		West	113	28.4%
	Sophomore	66	16.6%	Monthly living expenses (yuan)	⩽1000	48	12.1%
	Junior	164	41.2%		1001–1500	197	49.5%
	Senior	37	9.3%		1501–2000	88	22.1%
	Graduate student	80	20.1%		>2000	65	16.3%

Table 2

Test results of reliability and validity

Latent variable	Perceived time	Subjective emotion	Perceived quality	Satisfaction
Cronbach's alpha	0.853	0.897	0.853	0.927
KMO	0.728	0.740	0.691	0.764

2.1. Modeling principles

The structural equation model comprises two components: the measurement model and the structural model. The measurement model is primarily used to investigate the relationship between latent variables and observed variables, while the structural model focuses on analyzing the causal effects among latent variables.

This study investigates the relationship between latent variables and their corresponding observed variables using a measurement model to evaluate the psychological perceptions of college students during campus travel in cold regions, as depicted in Equations (1) and (2):

$$X = \boldsymbol{\Lambda_X}\xi + \delta \tag{1}$$

$$Y = \boldsymbol{\Lambda_Y}\eta + \varepsilon \quad , \tag{2}$$

where X and Y are exogenous and endogenous observed variables, respectively, ξ and η are exogenous and endogenous latent variables, Λ_X and Λ_Y are factor loading matrices, and δ and ε are error terms.

This study explores the relationship between latent variables through the structural model to analyze the formation mechanism of college students' satisfaction during campus travel in cold regions, as depicted in Equation (3):

$$\eta = \boldsymbol{B}\eta + \boldsymbol{\Gamma}\xi + \zeta \quad . \tag{3}$$

where B and Γ are the path coefficient matrices of endogenous and exogenous latent variables, respectively, and ζ is the residual term.

2.2. Model assumptions

When using the structural equation model to investigate college students' satisfaction during campus travel in cold regions, it is crucial to put forward hypothetical paths between variables in advance and validate them to analyze the interaction mechanism. This paper formulates hypotheses about the influence paths between variables by summarizing existing research results (refer to Table 3).

Table 3

Description of hypothetical variable relationships

Hypothesis	Source	Hypothetical content
H1	Literature [17]	Travel attributes have a positive effect on perceived quality
H2	Literature [17]	Travel attributes have a positive effect on subjective emotion
H3	Literature [17]	Travel attributes have a positive effect on travel satisfaction
H4	Literature [18]	Perceived time has a positive effect on subjective emotion
H5	Literature [18]	Perceived time has a positive effect on perceived quality
H6	Literature [19]	Perceived quality has a positive effect on subjective emotion
H7	Literature [19]	Perceived quality has a positive effect on travel satisfaction
H8	Literature [17]	Subjective emotion has a positive effect on travel satisfaction

2.3. Variable assignment

According to the description of influence paths among latent variables, traveler's travel attribute and perceived time are exogenous variables, perceived quality and subjective emotion are mediating variables, and travel satisfaction is an endogenous variable. The types of variables of each observed variable are shown in Table 4.

Table 4

Variable assignments of structural equation model

Variable category	Variable name	Banding level	Indicators	Assignment
Exogenous variable	Travel duration	＞20 min	X1	1
		10 min~20 min		2
		<10 min		3
	Travel purpose	Attendance and study	X2	1
		Routine		2
		Leisure and entertainment		3
	Travel companion	Someone to go with	X3	0
		Alone		1
	Travel mode	Walking	X4	0
		Cycling		1
Exogenous variable	Perceived time	-	T1/T2/T3	-4~4
Mediating variable	Subjective emotion	-	P1/P2/P3	-4~4
Mediating variable	Perceived quality	-	Q1/Q2/Q3	1~5
Endogenous variable	Travel satisfaction	-	S1/S2/S3	-4~4

2.4. Model parameter estimation and result analysis

The ratio of the chi-square statistic was chosen for the respective degrees of freedom (*CMIN/DF*), root mean square error of approximation (*RMSEA*), goodness of fit index (*GFI*), comparative fit index (*CFI*), and incremental fit index (*IFI*, to carry out the fitting test of SEM. Each test index meets the standard, indicating that the overall fit of the model is good and that the model can be used for subsequent analysis.

When estimating the structural equation model using the Bayesian method, it is necessary to provide prior information for the unknown parameters. In this study, the conjugate prior distribution, as demonstrated in Equation (4), was selected based on findings from related research, where *I* represents the unit matrix of the corresponding dimension.

$$\begin{aligned} &\Phi^{-1^D} = W_4\left[B,10\right]; \Psi_{\varepsilon k}^{-1^D} = Gamma\left[6,10\right]; \Lambda_k^D = N\left[0.8, 4\Psi_{\varepsilon} I\right] \\ &\Psi_{\delta k}^{-1^D} = Gamma\left[6,10\right]; \Gamma^D = N\left[M, \Psi_{\delta} I\right] \end{aligned} \quad . \tag{4}$$

After 79,956 iterations, the convergence index (*CS*) was calculated to be 1.0006, which is below the standard value of 1.002, indicating that the model has reached the desired state. Additionally, the trajectory of the parameter y_1 for the observed variable *T1* does not display any noticeable upward or downward trends or stochastic drift phenomena. Hence, it can be concluded that the Bayes-SEM has successfully been converged.

Upon analyzing the model's fitness, the posterior predictive *p*-value *(PPp)* was determined to be 0.55, indicating that the model is well-fitted. Furthermore, the deviance information criterion (*DIC*) value was 313>10, indicating that Bayes-structural equation model is significantly different from the traditional SEM, highlighting the superior fit of the Bayes-structural equation model over the traditional counterpart.

The estimated factor load of the measurement model is shown in Table 5, and the standardized load coefficients show the relative weight of each observed variable to the latent variable it measures.

Table 5

Factor load estimates for variables

Latent variable	Observed variable	Standardized coefficient	Latent variable	Observed variable	Standardized coefficient
Travel attribute	X1	0.942	Perceived quality	Q2	0.868
	X2	0.349		Q3	0.741
	X3	0.114	Subjective emotion	P1	0.850
	X4	0.913		P2	0.852
Perceived time	T1	0.868		P3	0.864
	T2	0.777	Travel satisfaction	S1	0.891
	T3	0.767		S2	0.915
Perceived quality	Q1	0.721		S3	0.897

For the travel attributes, the load coefficients of items *X*1 and *X*4 are greater than 0.9, indicating that the travel duration and travel mode were the main factors influencing travel attributes, which aligns with the actual travel conditions. The load factors of the measurement items *T*1~*T*3, *Q*1~*Q*3, *P*1~*P*3, and *S*1~*S*3 were all greater than 0.7, indicating that the measurement items selected in this paper can effectively measure the relevant latent variables. *T*1 (feeling time pressure during a particular trip <—> feeling no time pressure) had the highest weight in the perceived time dimension. *Q*2 (ease of choosing a certain mode of travel) had the highest weight in the perceived quality dimension, indicating that time pressure and travel convenience had a strong impact on travel psychological perception.

The standardized coefficients between latent variables in the structural model are shown in Table 6.

Table 6

Standardized estimation parameters between variables

Acting latent variable	Action path	Being acting latent variable	Standardized coefficient
Travel attribute	——>	Perceived quality	0.152
Travel attribute	——>	Travel satisfaction	0.139
Perceived time	——>	Subjective emotion	0.963
Perceived time	——>	Perceived quality	0.181
Perceived quality	——>	Subjective emotion	0.205
Perceived quality	——>	Travel satisfaction	0.147
Subjective emotion	——>	Travel satisfaction	0.887

As shown in Table 6, subjective emotion exerts a direct positive impact on travel satisfaction, indicating that the more positive travelers' psychological perception, the higher their overall travel satisfaction. Travel attribute has a direct positive impact on travel satisfaction and an indirect impact on travel satisfaction through perceived quality, indicating that the length of travel time and the convenience of the travel mode have a strong impact on satisfaction. Thus, the more positive the evaluation, the higher the traveler's satisfaction. The perceived time attribute indirectly affects satisfaction through subjective emotion and perceived quality, indicating that a traveler's positive perception of time during the travel process enhances their overall travel experience and increases their satisfaction. Perceived quality directly and indirectly affects satisfaction through subjective emotion, indicating that higher levels of safety, convenience, and comfort experienced during the travel process lead to a more positive psychological perception of the traveler and increase their overall satisfaction.

Further, according to the path structure and coefficient of each latent variable, subjective emotion is the dominant factor influencing satisfaction, and perceived time exerts the most substantial influence on subjective emotion, suggesting that emotions stemming from travel time significantly affect travel satisfaction degree in college campus travel.

3. EVALUATION SYSTEM CONSTRUCTION OF A SLOW TRAFFIC SYSTEM IN COLD REGIONAL CAMPUS

3.1. Selection of evaluation indicators

Based on a summary of existing research results [12, 20-24], the factors affecting the travel satisfaction of college students in cold regions and the operation of the slow traffic system at the Boda Campus of Xinjiang University are combined. This study evaluates a slow traffic system at a campus in a cold region by selecting 12 second-level indicators related to four first-level indicators, namely slow traffic facilities, slow traffic network, slow traffic environment, and slow traffic system operating level.

In view of the perceived quality (safety, convenience, and comfort) that greatly impacts travel satisfaction, three indicators were selected: barrier-free facilities, anti-skid performance of road surface, and canopy amount of shared bicycle site, as the second-level evaluation indicators. For the indicator of a slow traffic network, in view of the great influence of perceived time on travel satisfaction, the density of the walking and cycling network and the connectivity degree of the walking and cycling network were selected as the second-level evaluation indicators. As for the indicator of a slow traffic environment, given that subjective emotion has the greatest impact on travel satisfaction, shade degree of walking path, richness of snow and ice landscape, proportion of evergreen plants, and rationality of leisure facilities were selected. For the indicator of slow traffic system operating level, travel cost, travel time, and parking and pick-up convenience related to travel attributes and perceived quality were selected as the second-level evaluation indicators.

3.2. Determination of index weight

A questionnaire on the mutual comparison of the importance of evaluation indicators, which adopts the nine-scaled scoring method to improve accuracy, was issued in order to construct the evaluation system of a slow traffic system on campus in cold regions. The weights and rankings of the first- and second-level indicators in the evaluation system of slow traffic system on campus in cold regions are shown in Table 7.

Table 7

Evaluation index weights and rankings of slow traffic system at a campus in a cold region

First-level indicator	Second-level indicator	Tiered weight	Overall weight	Ranking
Slow traffic facilities 25.523%	Barrier-free facilities	30.089%	7.67%	8
	Anti-skid performance of road surface	35.695%	9.10%	3
	Canopy amount of shared bicycle site	34.216%	8.72%	4
Slow traffic network 25.137%	Density of walking and cycling network	48.658%	12.03%	2
	Connectivity degree of walking and cycling network	51.342%	12.70%	1
Slow traffic environment 23.973%	Shade degree of walking path	25.952%	6.47%	10
	Richness of the snow and ice landscape	22.855%	5.69%	12
	Proportion of evergreen plants	24.530%	6.11%	11
	Rationality of leisure facilities	26.663%	6.64%	9
Slow traffic system operating level 25.368%	Travel cost	31.870%	7.92%	7
	Travel time	33.291%	8.28%	6
	Parking and pick-up convenience	34.838%	8.66%	5

As shown in Table 5, among the first-level indicators, weight of slow traffic facilities > weight of slow traffic system operating level > weight of slow traffic network > weight of slow traffic environment. However, the difference in the weights of the four first-level indicators is very small and nearly equally important, reflecting that students are equally concerned about slow traffic facilities, slow traffic system operating level, slow traffic network, and slow traffic environment.

Regarding the second-level indicators, the connectivity degree of the walking and cycling network and the density of the walking and cycling network were ranked in the top two, followed by the anti-skid performance road surface. In contrast, students have the lowest demand for a snow and ice landscape, probably because the large scale of the campus and snow-covered roads in winter at a campus in a cold region affect the travel experience. Given that practical indicators are not guaranteed, ornamental indicators such as the snow and ice landscape appear to be insignificant. The indicators ranking fourth and fifth in weight are closely related to shared bicycles. The construction of the evaluation system of the slow traffic system on campus in cold regions provides a basis for improving the slow traffic system on campus in cold regions.

4. SLOW TRAFFIC SYSTEM IMPROVEMENTS ON A CAMPUS IN A COLD REGION

Based on the characteristics and weights of the indicators in the evaluation system of slow traffic system on campus in cold regions and the correlation between the indicators. This study gives specific optimization suggestions from the site selection of shared bicycle sites to improve the accessibility, convenience, and comfort of travel on campus in cold regions.

4.1. Shared bicycle site selection optimization

Based on a summary of existing research results, the site selection scheme of shared bicycle sites is determined by building a site selection evaluation system. The evaluation system includes five indicators: vehicle requirement, road gradient, distance from entrances and exits, cycling detour distance, and impact on neighboring traffic. The following weights of the indicators were obtained according to the questionnaire survey data: 20.50%, 21.21%, 18.65%, 21.06%, and 18.57%.

Twenty-four shared bicycle sites at the Boda Campus of Xinjiang University were evaluated using the constructed shared bicycle site selection evaluation system. The results are shown in Table 8.

Table 8

Evaluation results of shared bicycle sites before optimization

Site	Score	Site	Score	Site	Score
Dormitories 9 and 11	69.32	University activity center	79.04	Heavy Equipment Laboratory	28.34
Dormitories 10 and 12	77.21	Administration building, He Yuan Restaurant	60.57	Dormitory 1 and 2	65.46
North district canteen	57.42	Dormitory 7	58.31	Dormitory 3 and 4	63.13
College of geological and mining engineering	38.76	Dormitory 6	47.90	College of Chemistry	57.65
College of civil engineering and architecture	47.08	First teaching building	63.79	College of Ecology and Environment	57.18
West district canteen	73.97	South district canteen	65.85	College of Chemical Engineering	39.54
Second teaching building	67.04	School infirmary	72.22	College of Life Sciences and Technology	39.08
Library	52.25	Engineering research center	43.74	College of Textiles and Clothing	51.64
Average score	55.20				

Table 8 shows that five sites (the College of Geology and Mining Engineering, the Engineering Training Center, the Heavy Equipment Laboratory, the College of Chemical Engineering, and the College of Life Sciences and Technology) have low scores and can be removed. At the same time, field research indicates that locations on campus have a significant demand for shared bicycles but do not have shared bicycle sites. Therefore, the constructed shared bicycle site selection evaluation system was used to add six sites: South Gate, South Playground, the College of Physical Science and Technology, the College of Mechanical Engineering, West Gate, and Tuxi Supermarket. The overall score after optimization was 65.74. The layout of before and improved shared bicycle sites at the Boda Campus of Xinjiang University is shown in Fig. 1. Red indicates removed sites, blue indicates new sites, and purple indicates unchanged sites.

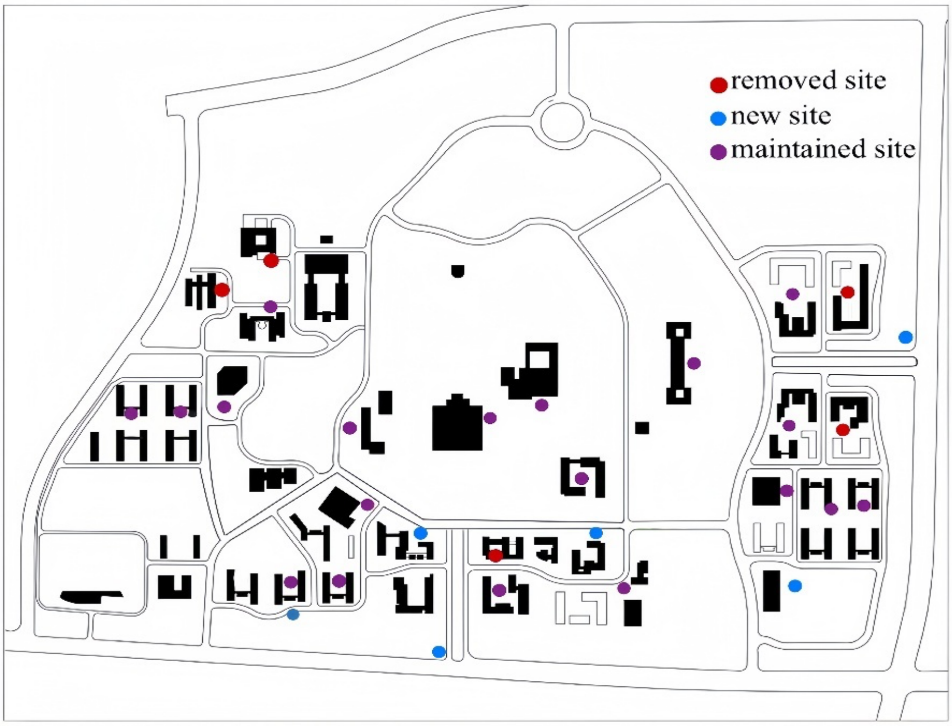

Fig. 1. The improved shared bicycle sites at the Boda Campus of Xinjiang University

4.2. Analysis of improvement effects

According to the evaluation of the slow traffic system at a campus in a cold region in the previous section, the system can be improved by improving the anti-skid performance of road surface, adding canopies for shared bicycle sites, setting up ice and snow landscapes, adding evergreen plants, adding resting facilities, and optimizing the shared bicycle sites. The comparison of the evaluation results before and after improvement is shown in Table 9.

This study of the slow travel system mainly focused on optimizing the construction and layout of travel facilities to improve the convenience and safety of travel. Universities in special climate areas need to fully consider the impact of climate factors on travel experience to ensure basic travel facilities. Taking a tropical area as an example, the design of the slow walking system on the campus pays particular attention to heat protection and shade. In cold areas, anti-slip and snowstorms need to be considered in addition to improving the quality of travel facilities and special climatic conditions, such as cold weather, to optimize the slow travel system.

Based on the unique cold climate of colleges and universities in cold regions, the optimization measures of colleges and universities' slow travel systems are designed from four perspectives: slow travel facilities, slow travel network, slow travel environment, and running level. As can be seen in Table 12, the overall score before the improvement of the slow traffic system at the Boda Campus of Xinjiang University was 35.34, and after the improvement, the overall score was 60.82, representing an increase of 72.10%. The functionality and sense of the experience of the campus's slow traffic system can be significantly improved through systematic optimization, effectively improving the satisfaction of teachers and students on campus travel, thus promoting the sustainable development of the campus environment and enhancing the overall travel experience of teachers and students.

Table 9

Comparison of evaluation results of the slow traffic system at the Boda Campus of Xinjiang University

	Value before	Normalized value before	Indicator score	Value after	Normalized value after	Indicator score
Barrier-free facilities	1.00	1.00	7.67	1.00	1.00	7.67
Anti-skid performance of road surface	53.39	0.67	6.10	65.00	1.00	9.10
Canopy amount of shared bicycle site	0.00	0.00	0.00	19.00	1.00	8.72
Density of walking and cycling network	5.29	0.31	3.73	5.29	0.31	3.73
Connectivity degree of walking and cycling network	1.03	0.02	0.25	1.03	0.02	0.25
Shade degree of walking path	0.36	0.61	3.95	0.36	0.61	3.95
Richness of the snow and ice landscape	0.00	0.00	0.00	1.00	1.00	5.69
Proportion of evergreen plants	0.00	0.00	0.00	0.50	0.50	3.06
Rationality of leisure facilities	0.00	0.00	0.00	13.00	0.65	4.32
Travel cost	2.83	0.39	3.09	2.83	0.39	3.09
Travel time	40.00	0.70	5.80	40.00	0.70	5.80
Parking and pick-up convenience	55.20	0.55	4.76	62.50	0.63	5.46
Overall score	35.34			60.82		

5. CONCLUSIONS

From the perspective of college students' satisfaction with slow travel on campus in cold regions, an evaluation system of slow traffic on campus in cold regions was constructed to evaluate and optimize the existing slow traffic system. This was done by combining the environmental evaluation indicators of the campus's slow traffic characteristics, slow traffic demand, and slow traffic system operating status, as well as by comprehensively considering the walking and shared bicycle traffic modes. The main research conclusions are as follows:

1. Based on the questionnaire survey of college students at the Boda Campus of Xinjiang University, a Bayesian structural equation model was constructed to determine the influencing factors and the influencing mechanisms of slow travel satisfaction of campuses in cold regions. Subjective emotion, perceived quality, and travel attributes directly affect travel satisfaction, with subjective emotion having the greatest influence on travel satisfaction. Perceived time and perceived quality indirectly affect travel satisfaction by influencing subjective emotion, in which perceived time has the greatest influence.
2. Four first-level indicators and 12 second-level indicators were selected to construct the evaluation system of slow traffic system on campus in cold regions. The results show that the weights of connectivity of the walking and cycling network, the density of the walking and cycling network,

and the anti-skid performance of road surface ranked first through third among the second-level indicators, followed by the canopy amount of shared bicycle sites and the parking and pick-up convenience of shared bicycles. Through the further construction of a shared bicycle site selection evaluation system to optimize the campus's slow traffic system in cold regions, the optimized campus's slow traffic system score increased by 72.10%.

The constructed evaluation system of the slow traffic system based on travel satisfaction for a campus in a cold region aligns with the actual travel at campuses in cold regions. The optimization results are helpful in improving the serviceability and service level of slow traffic systems of campuses in cold regions. The current results can be generalized to other cold regions or campus types to some extent, especially when the climatic conditions, transportation needs, and the basic composition of slow traffic systems are similar. However, considering the possible differences between different campuses and regions, certain adjustments and localized designs must be made according to the specific environment when promoting the application.

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