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Research Article

The Impact Of Total Quality Management On Sustainable Tourism Development In The Chengdu-Chongqing Urban Agglomeration

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ABSTRACT

Sustainable tourism development (STD) is a crucial component of the circular economy. However, prevailing research focuses on tourism resources protection, rather than management methodologies. An innovative structural equation model (SEM) for STD and total quality management (TQM) was constructed. Empirical analysis revealed: (1) No evidence of collinearity among the scales of sample data, which exhibit high reliability and validity, indicating broad applicability. (2) The SEM model of TQM and STD demonstrated high goodnessof-fit ($\chi^2/df = 1.29$, IFI > 0.9), validating initial assumptions and indicating that extending TQM can optimize STD management. (3) Analysis indicates a positive impact and facilitative role of TQM on STD, which comprises full participation (FP, 0.343), whole process management (WPM, 0.283), and comprehensive management (CM, 0.261). FP directly contributes 55.1% of the impact on STD. WPM and CM indirectly influence STD through tourism benefits and overall tourist perception. These findings provide important guidance for improving STD.

Keywords: Total quality management, Sustainable tourism development, Structural equation model, Chengdu-Chongqing urban agglomeration.

1. Introduction

In 2021, China proposed the establishment of an economic system of green and low-carbon circular development by 2025, which includes the domains of digital tourism and sustainable tourism. In 2022, the State Council issued the "Tourism Development Plan for the 14th Five-Year Plan," explicitly emphasizing the need to promote sustainable tourism development (STD). In 2023, the Development and Reform Commissions of Sichuan Province and Chongqing Municipality jointly issued the "Construction Plan for the Bashu Cultural Tourism Corridor," which underscores the importance of enhancing both sustainable tourism development and the sustainable use of tourism resources through improved management efficiency and resource utilization. It is evident that both the national and local governments place significant emphasis on STD. Furthermore, 9.3% of the GDP in the Chengdu-Chongqing urban agglomeration (CCUA) was contributed by the tourism industry in 2023. Thus, the promotion of sustainable development in the tourism sector holds crucial value for regional economic sustainability and growth.

As an important part of the circular economy (Gabor et al., 2024), STD has attracted the attention of scholars (Figure 1) in recent years (Chiwaridzo, 2023; Bahamonde et al., 2024; Zhang et al., 2022). Several scholars have employed SEM to research STD, examining topics such as the impact of tourism poverty alleviation in ethnic regions on sustainability (Yang et al., 2020), the promotion of benign development through tourist behavior (López et al., 2021) and community participation (Tong et al., 2024), as well as the influence of tourist satisfaction (Basak et al., 2021), local residents' support (Gautam & Bhalla, 2024), and the economic development level of tourist destinations (Han et al., 2023) on sustainable tourism development.

Simultaneously, scholars have employed survey-based research to analyze the constraining factors influencing STD. Through these studies, it has been observed that the main factors impeding STD include: the intensity of policy implementation (Fernandez-Abila et al., 2024), online promotion and educational levels (Marchi et al., 2023; Maziliauske et al., 2024), social engagement (Diallo et al., 2022) and socio-cultural aspects (Stojanović et al., 2024), green development concepts (Penjišević et al., 2024), as well as environmental and social factors (de Bruyn et al., 2023). Additionally, several case studies have focused on the paths to achieve sustainable tourism development using a multi-perspective approach, e.g., improving performance appraisal levels (Wu & Yang, 2023), changing energy utilization methods (Wu et al., 2023), reducing carbon emission levels (Peeters et al., 2024), and improving the comprehensive benefits of tourism (Tian et al., 2022), etc.

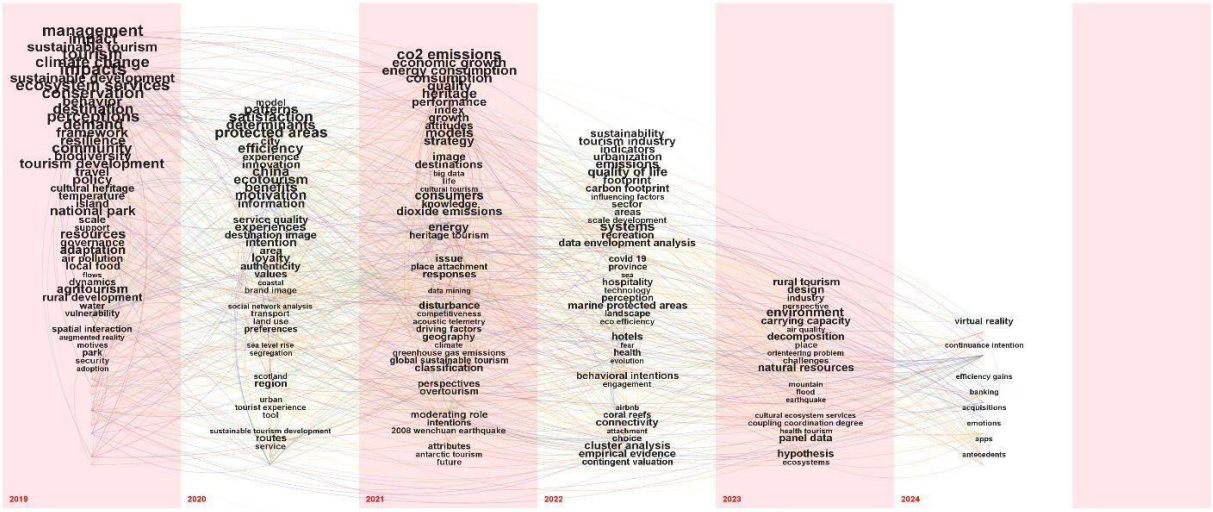

Figure 1 Bibliometric Analysis of Literature on the Development of Scales in the Field of Sustainable Tourism Development

Total quality management (TQM), as an important management approach (Witt & Muhlemann, 1994), has been widely applied in traffic management (Akhmatova et al., 2022), construction quality management (Othman et al., 2020), corporate performance management (Anil et al., 2016; Singh et al., 2018), and innovation management (Honarpour et al., 2012). In recent years, TQM has gradually begun to be applied in sustainable development research, such as environmental sustainability (Jum'a et al., 2023; Akhmatova et al., 2022), renewable energy management (Hussain et al., 2023), and sustainability opportunity research (Isaksson et al., 2023). However, there is currently limited literature on the application of TQM in sustainable tourism development (Bhuiyan et al., 2018).

In this context, this study is grounded in the TQM philosophy and employs an SEM to investigate STD in CCUA. Specifically, we establish hypotheses related to the impact of TQM's three dimensions, full participation (FP), whole process management (WPM), and comprehensive management (CM), on STD. Through a combination of questionnaire surveys and interviews, sample data was collected from tourism sites within the Chengdu-Chongqing urban agglomeration, and the diagnostics for collinearity, assessment of the reliability and validity of the sample data, and construction of an SEM model for fitting and path analysis were performed. This enabled us to ascertain the extent of the influence of TQM's three dimensions on STD. Based on these findings, scientific recommendations and management strategies for STD in the CCUA are proposed.

2. Research questions and hypotheses

2.1 Research Questions (RQ)

TQM includes three dimensions: full participation (FP), whole process management (WPM), and comprehensive management (CM). The primary focus of this study is to investigate the impact of these three dimensions, along with the introduction of two mediating variables—tourism benefits (TB) and overall perception (OP)—on STD. Thus, the research questions are as follows:

RQ 1. How does FP influence sustainable tourism development?
RQ 2. How does WPM influence sustainable tourism development?
RQ 3. How does CM influence sustainable tourism development?

2.2 Hypotheses

In addressing the aforementioned three issues and two mediating variables, and in alignment with the research objectives of this study, we propose the following twelve hypotheses (Figure 2).

H1: Tourism benefits have a positive effect on sustainable tourism development.
H2: Overall perception has a positive effect on sustainable tourism development.

H3: Full participation has a positive effect on tourism benefits.
H4: The whole process management has a positive effect on tourism benefits.
H5: Comprehensive management has a positive effect on tourism benefits.
H6: Full participation has a positive effect on the overall perception of tourists.
H7: The whole process management has a positive effect on the overall perception of tourists.
H8: Comprehensive management has a positive effect on the overall perception of tourists.
H9: Full participation has a positive effect on sustainable tourism development.
H10: The whole process management has a positive effect on sustainable tourism development.
H11: Comprehensive management has a positive effect on sustainable tourism development.
H12: Tourism benefits have a positive effect on the overall perception of tourists.

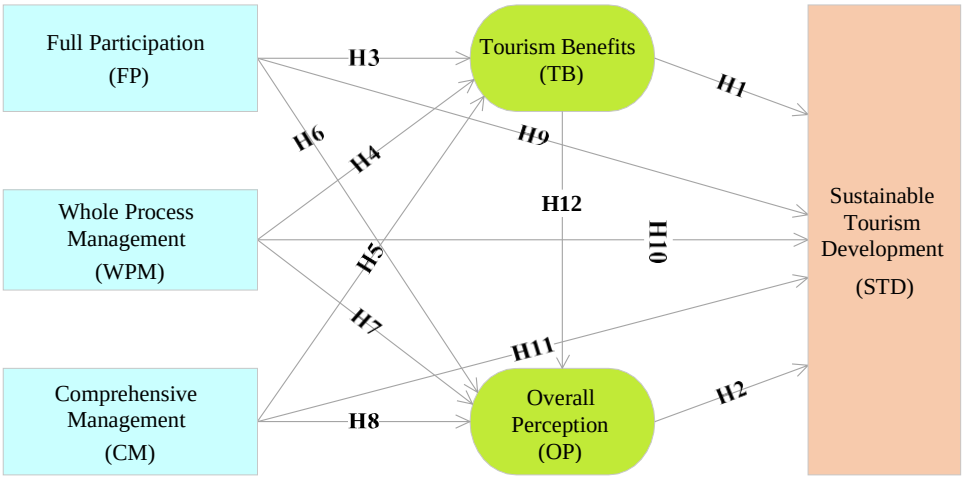

Figure 2 Conceptual framework of the research hypotheses

3. Materials and methods

3.1 Data collection

3.1.1 Sampling

The Chengdu-Chongqing urban agglomeration (Figure 3), centered around Chongqing and Chengdu, serves as a crucial platform for the development of China's western regions. It plays a strategic role in the Yangtze River economic belt and is a key demonstration area for the national promotion of new-type urbanization (Wang et al., 2023), covering a total area of 185,000 km². The urban agglomeration boasts 1,083 tourist attractions rated A-level or above, including 27 5A-level attractions. These 5A-level attractions, characterized by abundant resources and rich cultural value, are well-suited for research on STD. In selecting sample attractions for this study, we adhered to four fundamental principles: representativeness, even distribution, coverage of both natural and cultural landscapes, and high visitor volume. The sample attractions were chosen using a stratified sampling method, and the results are presented in Table 1.

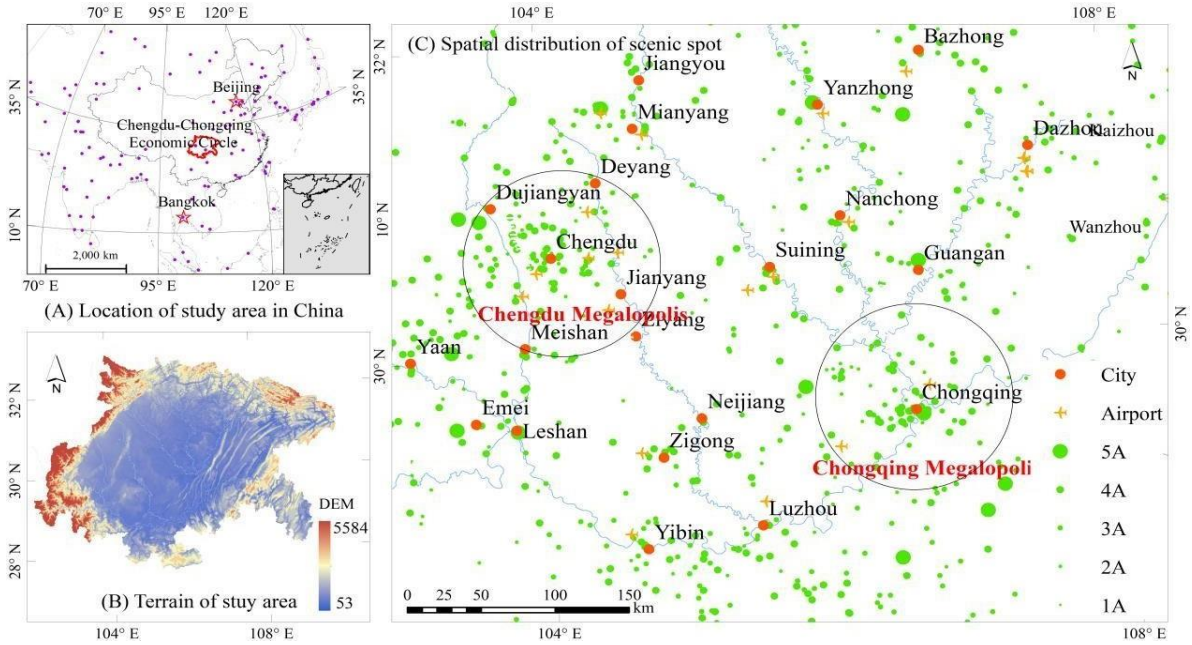

Figure 3 Location of the study area and the spatial distribution of the scenic spots

Table 1 Survey sample information in the study area

ID	Name	Level	Location	Sample type	Panoramic View
1	Golden Buddha Mountain	5A	Chongqing	Culture & Nature	
2	Dazu Rock Carvings	5A		Culture	
3	Four-sided Mountain	5A		Nature	
4	Black Valley	5A		Nature	
5	Qingcheng Mountain	5A	Chengdu	Culture & Nature	
6	Emei Mountain	5A	Leshan	Culture & Nature	
7	Beichuan Qiang	5A	Mianyang	Culture	
8	Deng Xiaoping's hometown	5A	Guangan	Culture	
9	Langzhong Ancient City	5A	Nanchong	Cultural landscape	
10	Jianmen Shudao	5A	Guangyuan	Cultural & Natural	
11	Bifeng Gorge	5A	Yaan	Natural	
12	Guangwu Mountain	5A	Bazhong	Natural	
13	Lizhuang Ancient Town	4A	Yibin	Cultural	

3.1.2 Datasets

Based on the three dimensions of TQM, the survey questionnaire for the sample area was designed with six latent variables. Drawing on the relevant literature (Tarí et al., 2020), multiple measurement items were established for each latent variable. Each item was assessed using a Likert 5-point scale (Memmedova et al., 2024). The questionnaire underwent Item-Objective Congruence (IOC) validity testing by 10 experts. The results revealed balanced IOC values exceeding 0.81 for all six themes, meeting the criteria for conducting the survey (Ismail, 2022). With the assistance of the tourism management authorities of the surveyed scenic areas, both online and on-site questionnaire surveys were conducted, followed by the retrieval and preprocessing of the survey questionnaires. A total of 700 questionnaires were distributed, with 643 collected. After removing 11 questionnaires with excessively short response times and identical answers, 632 valid questionnaires were obtained (Table 2), resulting in an response rate of 90.2%. Through characteristic statistical analysis of the questionnaire data, the average scores of the respondents ranged from 3.42 to 4.04, indicating a diverse range of perspectives and manifesting significant variations (Akca et al., 2024). The skewness and kurtosis values fell within the acceptable range of -2 to +2, adhering to the normal distribution patterns, making the data suitable for subsequent analysis (Nunnally, 1975).

Table 2 Respondents' demographic profile data

Survey items	Responses	Frequency	%
Gender	Male	231	36.6
	Female	401	63.4
Age	Under 18 years	46	7.3
	18–30 years	344	54.5
	31–40 years	118	18.7
	41–50 years	103	16.3
	More than 50 years	21	3.3
Respondents identities	Local residents	30	4.7
	Tourists	343	54.3
	Scenic spot managers	129	20.4
	Scenic area staff	90	14.2
	Government management staff	40	6.3
Education level	High school students and below	140	22.2
	Junior college students	315	49.8
	Undergraduates	146	23.1
	Master's degree students and above	31	4.9
Per capita household income/month	2,000 RMB and below	109	17.2
	2,000–5,000 RMB	134	21.2
	5,000–10,000 RMB	156	24.7
	10,000–20,000 RMB	152	24.1
	More than 20,000 RMB	81	12.8
Place of residence	Sichuan Province	303	47.9
	Chongqing municipality	295	46.7
	Other	34	5.4
Number of times you have traveled	1	27	4.3
	2	23	3.6
	3	225	35.6
	More than 3 times	357	56.5

3.2 Methods

The SEM model was employed, utilizing a large sample dataset, to investigate the impact of TQM on STD based on our research hypotheses. The entire research comprises three main sections: Item development, scale development and validation, and empirical investigation (Figure 4).

The structural equation model (SEM) is a statistical model that integrates factor analysis and path analysis (Bollen K, 1989; Kline, 2016; Wright et al., 2024). The general form of a structural equation model includes measurement equations and structural equations.

(1) The measurement equation reflects the relationships between the latent variables and observed variables and is formulated as follows:

$$x = A_x\xi+\delta,\ y = A_y\eta+\varepsilon,\ (1)$$

where x is the indicator variable for the independent variable, A_x is the factor loading, and δ is the measurement error, y is the indicator variable for the dependent variable, A_y is the factor loading, and ε is the measurement error.

(2) The structural equation reflects the relationships between the latent variables and is formulated as follows:

$$\eta = B\eta+\Gamma\xi+\zeta, \quad (2)$$

where η is the dependent variable, ξ is the independent variable, B is the coefficient matrix reflecting the relationships between dependent variables, Γ is the coefficient matrix reflecting the relationships between the independent and dependent variables, and ζ is the estimation error representing the segment of the dependent variables that cannot be explained by the independent variables.

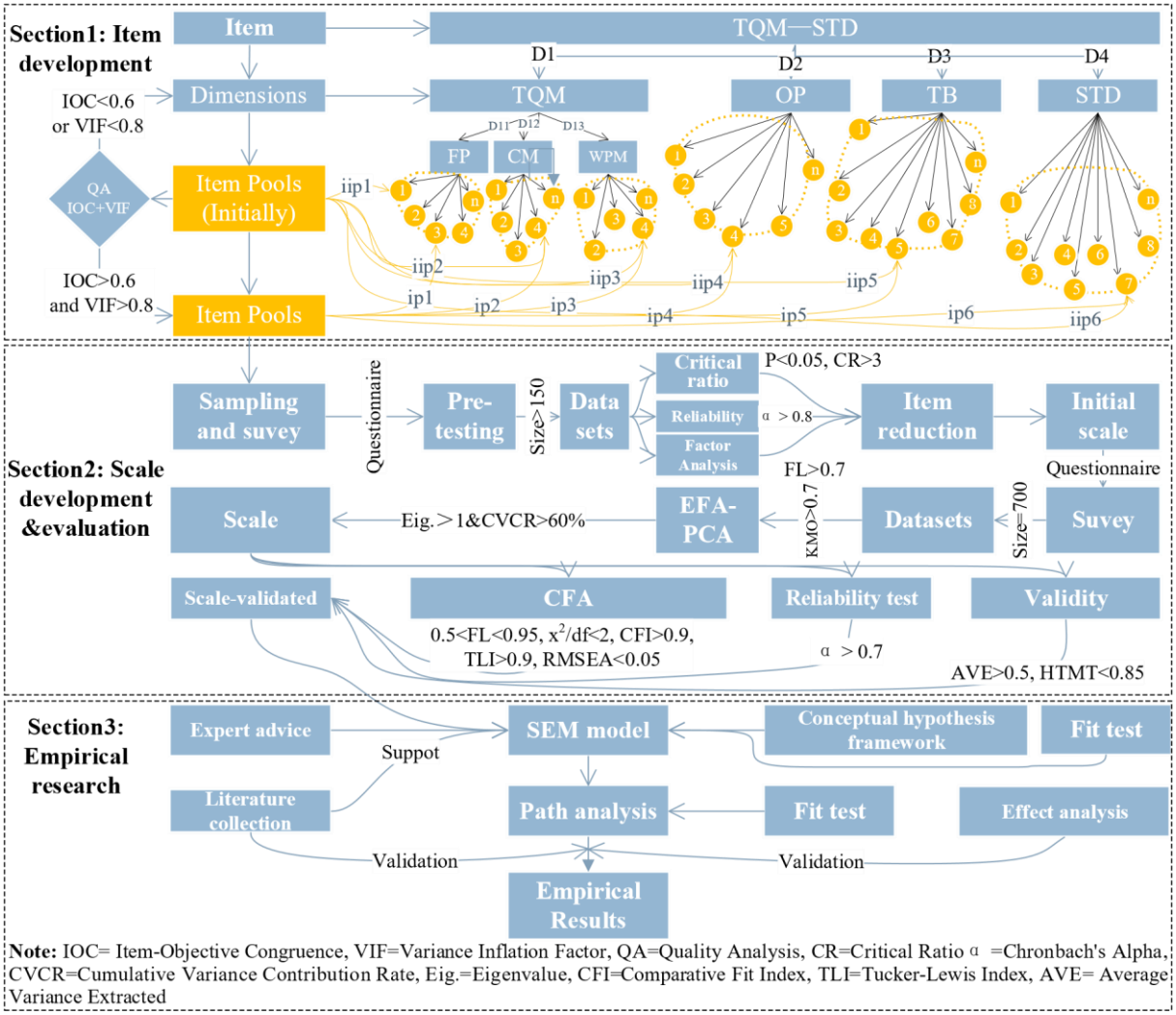

Figure 4 Framework of the study

4. Empirical analysis

4.1 Reliability and validity analysis

Reliability and validity are crucial indicators for assessing the quality of a scale, forming the basis for analyzing the relationship between the independent variable TQM and the dependent variable STD. If the reliability and validity do not meet the requirements, the scale cannot be used for constructing structural equations and path analysis. Reliability refers to the consistency of measurement results and is an indicator reflecting the magnitude of random measurement errors. Through a diagnostic examination of the collinearity among items in the scale, the results indicate that the variance inflation factor (VIF) is less than 5 and that there is no highly correlated collinearity between the items. Based on this, internal consistency reliability is employed in this study for assessing the reliability of the scale.

Internal consistency reliability is typically evaluated using Cronbach's alpha coefficient, and the reliability assessment results for the scale are presented in Table 3. The α values for FP, WPM, CM, OP, TB, and STD are 0.890, 0.885, 0.889, 0.898, 0.925, and 0.925, respectively. All α values exceed 0.80, indicating that the reliability of the questionnaire scale used in this study is ideal (Hair et al., 2010). Validity refers to the extent to which a test or scale can measure the psychological traits it aims to assess. We conducted assessments on the scale using structural validity, convergent validity, and discriminant validity. Structural validity was evaluated using confirmatory factor analysis (CFA), as shown in Table 3. The standardized factor loadings for all items were greater than 0.7. The goodness-of-fit test results for the CFA model evaluation (Table 4) indicated that X^2/df was equal to 1.284, which is less than 3. Additionally, CFI = 0.987, GFI = 0.923, AGFI = 0.926, IFI = 0.987, TLI = 0.986, all exceeding 0.6, and RMSEA = 0.021, less than 0.08. All these indices meet the criteria for fit indices (Fornell & Larcker, 1981), indicating that the CFA model passed the goodness-of-fit test.

The results of the convergent validity assessment (Table 3) show that the standardized factor loadings for all items are greater than 0.7 (Hair et al., 2021). The average variance extracted (AVE) for FP, WPM, CM, OP, TB, and STD is 0.618, 0.617, 0.606, 0.596, 0.582, and 0.580, respectively. These values are all higher than the recommended threshold of 0.50 (Kline, 2023), and the composite reliability (CR) for all constructs exceeds 0.7 (Hu et al., 1999), indicating satisfactory convergent validity. The analysis of reliability and validity reveals that

each item in the scale meets the requirements, indicating that the data is scientifically sound and suitable for structural model construction and analysis.

Table 3 Constructs, questions, diagnosis, and reliability

Constructs	Question setting principles	Question Code	VIF	Variables Loadings	α	CR	AVE
Full Participation (FP)	Full participation of all personnel in the scenic area, collection of opinions and suggestions from all staff, and encouragement of employee involvement in decision-making.	FP1	2.250	0.761	0.890	0.890	0.618
		FP2	2.189	0.786			
		FP3	2.033	0.799			
		FP4	2.165	0.796			
		FP5	2.254	0.787			
Whole Process Management (WPM)	Significant improvement in the operational effectiveness of the scenic area, effective resolution of issues, and continuous improvement in the management of the scenic area.	WPM1	2.140	0.771	0.885	0.890	0.617
		WPM2	1.935	0.774			
		WPM3	2.182	0.828			
		WPM4	2.215	0.776			
		WPM5	2.106	0.778			
Comprehensive Management (CM)	A clean and tidy scenic area with distinct product features and a clear theme, providing high-quality tourism services to meet the high standards.	CM1	2.118	0.792	0.889	0.885	0.606
		CM2	2.127	0.797			
		CM3	2.074	0.780			
		CM4	2.097	0.783			
		CM5	2.438	0.740			
Overall Perception (OP)	Enhancement of a positive tourism experience, increased tourist satisfaction, and spontaneous promotion of tourism.	OP1	2.009	0.779	0.898	0.899	0.596
		OP2	1.977	0.753			
		OP3	2.196	0.814			
		OP4	2.039	0.795			
		OP5	2.443	0.750			
		OP6	2.323	0.740			
Tourism Benefits (TB)	Ecological benefits, social benefits, and environmental benefits.	TB1	1.973	0.770	0.925	0.926	0.582
		TB2	2.111	0.752			
		TB3	2.268	0.717			
		TB4	2.137	0.726			
		TB5	1.932	0.754			
		TB6	1.963	0.841			
		TB7	2.129	0.728			
		TB8	3.028	0.746			
		TB9	2.848	0.824			
Sustainable Tourism Development (STD)	Fair development and improvement in the quality of life for the local residents, and sustainable utilization of resources and the environment.	STD1	1.808	0.710	0.925	0.925	0.580
		STD2	1.948	0.804			
		STD3	1.913	0.793			
		STD4	2.483	0.786			
		STD5	2.387	0.764			
		STD6	2.353	0.798			
		STD7	2.165	0.686			
		STD8	2.463	0.718			
		STD9	2.341	0.785			

Note: VIF, α, CR, and AVE represent the variance inflation factor, Cronbach's coefficient, composite reliability, and average variance extracted, respectively.

We employed the method of comparing the square root of AVE with the correlation coefficients between variables for discriminant validity assessment. As shown in Table 5, the square root of the AVE for each variable is greater than the coefficients outside the standardized correlation diagonal. Moreover, we used the more stringent HTMT method for discriminant validity assessment. The results (Table 6) indicate that the values of HTMT are all below 0.85, confirming that the scale has good discriminant validity (Leguina, 2015).

Table 4 Fit test of the CFA model

Indicators	X^2/df	CFI	GFI	RMSEA	AGFI	IFI	TLI
Recommended value	< 3	> 0.9	> 0.9	< 0.08	> 0.9	> 0.9	> 0.9
Actual value	1.284	0.987	0.923	0.021	0.926	0.987	0.986

Table 5 Validity Analysis

Variable	FP	WPM	CM	OP	TB	STD
FP	0.786					
WPM	0.227***	0.778				
CM	0.169***	0.229***	0.786			
OP	0.433***	0.468***	0.426***	0.772		
TB	0.415***	0.443***	0.437***	0.439***	0.763	
STD	0.452***	0.420***	0.384***	0.522***	0.580***	0.762

Note: Blank represents p < 0.05, ** is p < 0.01, *** means p < 0.001, and the diagonal represents the square root of AVE.

Table 6 Two-dimensional correlation matrix and HTMT for the TQM-STD scale system

N	FP	WPM	CM	TB	OP
FP	fp 1 2 3 4 5 6 2 0.59 3 0.59 0.62 4 0.64 0.61 0.59 5 0.65 0.63 0.59 0.61 6	0.226	0.173	0.420	0.435
WPM	0.201**	wp 1 2 4 6 7 2 0.54 4 0.63 0.60 6 0.62 0.61 0.61 7 0.62 0.56 0.61 0.62	0.233	0.449	0.468
CM	0.153**	0.207**	cm 1 2 3 4 5 2 0.57 3 0.60 0.60 4 0.61 0.61 0.59 5 0.65 0.65 0.63 0.62	0.444	0.428
TB	0.381**	0.407**	0.403**	tb 1 2 3 4 5 6 7 8 9 2 0.53 3 0.58 0.54 4 0.56 0.54 0.56 5 0.51 0.54 0.55 0.50 6 0.52 0.55 0.54 0.54 0.52 7 0.54 0.54 0.56 0.59 0.55 0.54 8 0.62 0.60 0.66 0.65 0.60 0.62 0.65 9 0.60 0.64 0.66 0.63 0.62 0.62 0.62 0.64	0.448
OP	0.389**	0.417**	0.383**	0.408**	op 1 2 4 5 7 8 2 0.52 4 0.59 0.55 5 0.57 0.55 0.55 7 0.62 0.62 0.64 0.62 8 0.58 0.61 0.64 0.61 0.60

Note: ** indicates p < 0.01, HTMT and Pearson correlation coefficients are located respectively on the diagonal and below.

4.2 SEM model construction and fitness test

Under the conceptual framework of the research hypotheses (Figure 2) and the scale data that has undergone reliability and validity analysis, we used the AMOS 24.0 tool to construct an SEM for the factors influencing the impact of TQM on STD (Figure 5). The standardized factor loadings (SFLs) for the five items of FP ranged from 0.792 to 0.798, for WPM's five items, the SFLs ranged from 0.743 to 0.801; for CM's five items, the SFL ranged from 0.775 to 0.826; for OP's six items, the SFLs ranged from 0.740 to 0.807; and for STD's nine items, the SFLs ranged from 0.685 to 0.804, while for TB's nine items, the SFLs ranged from 0.717 to 0.838. After the analysis, the SFLs of the 39 observed variables were found to all be greater than 0.6. In addition, the goodness-of-fit parameters of the SEM model are at an ideal level, with X^2/df equal to 1.284 and less than 3, CFI = 0.987, GFI = 0.935, AGFI = 0.926, IFI = 0.987, TLI = 0.986, all greater than 0.6. The RMSEA is 0.021, which is less than 0.08. Therefore, through the construction of the structural equation model and the goodnessof-fit test, the SEM model shows a good fit.

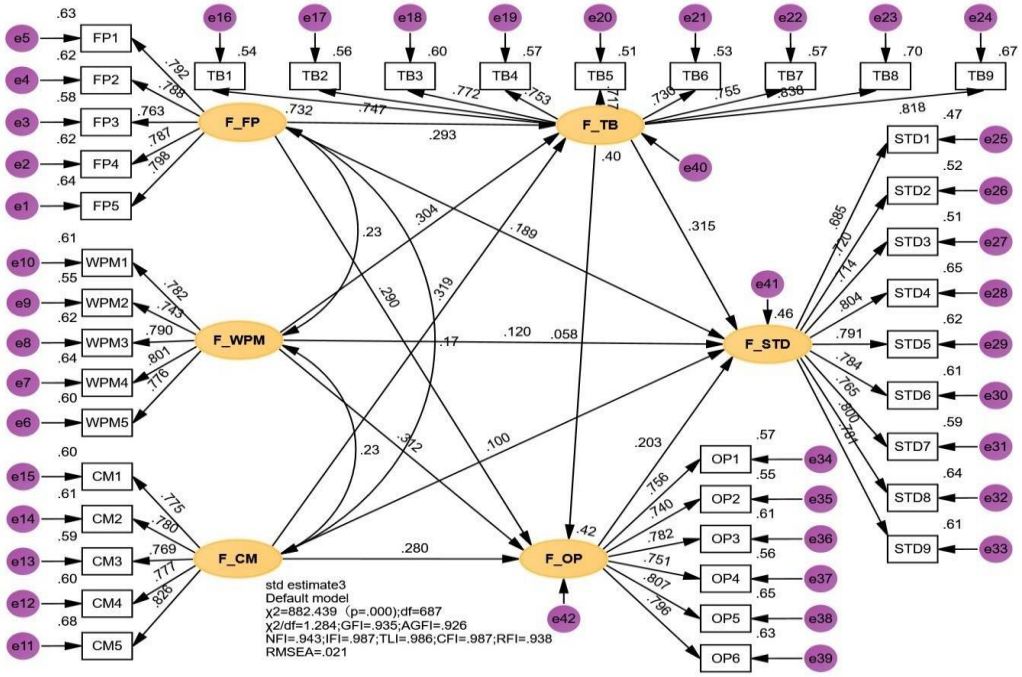

Figure 5 SEM model of TQM's influencing factors on STD

4.3 Path analysis and testing

The goodness-of-fit of the SEM model indicates the rationality of the model construction. However, to further understand the relationships between the latent variables and the degree of mutual influence, it was necessary to conduct a path analysis on the SEM model. Utilizing the AMOS tool and the data from the 632 valid samples, the results of the analysis and tests (Figure 5; Table 7) reveal that, except for the influence of TB on OP, which is not significant with a p-value greater than 0.05, all other hypothesized relationships in the structural equation model are significant ($p < 0.05$). This indicates that the research hypotheses are correct. The three independent variables, FP, WPM, and CM, have positive direct effects on the dependent variable STD, with path coefficients of 0.189 ($p \leq 0.001$), 0.120 ($p \leq 0.05$), and 0.10 ($p \leq 0.05$), respectively. This indicates that the three dimensions of TQM have a positive impact on STD. Among them, FP has the highest level of influence on STD. The three independent variables influence the dependent variable through the mediating variables, with CM-TB-STD showing the highest impact, having an average path coefficient of 0.317 ($p \leq 0.001$). Following this, WPM-TB-STD has an average path coefficient of 0.309 ($p \leq 0.001$), and finally, FP-TB-STD has an average path coefficient of 0.304 ($p \leq 0.001$). It can be observed that TQM primarily influences STD indirectly by affecting tourism benefits. In comparison, the extent to which TQM indirectly affects STD by influencing tourism perceptions is relatively lower. The most significant influencing path in this regard is FPOP-STD, with an average path coefficient of 0.257 ($p \leq 0.001$). Through path analysis, it is evident that TQM influences STD to a greater extent indirectly by impacting tourism benefits (0.282) compared to its direct impact on STD (0.136).

Table 7 SEM path analysis and testing results of TQM's impact on STD

Path	Hypothesis	Estimate(S)	Estimate	S.E.	C.R.	Yes/No	p-value
FP → TB	H3	0.293	0.276	0.037	7.371	Yes	***
WPM CM → TB TB	H4H5	0.3040.319	0.2970.272	0.0400.034	7.4707.983	YesYes	******
FP → OP	H6	0.290	0.278	0.041	6.842	Yes	***
WPM → OP	H7	0.312	0.310	0.043	7.136	Yes	***
CM → OP	H8	0.280	0.243	0.037	6.569	Yes	***
TB → OP	H12	0.058	0.166	0.048	1.210	No	0.226
FP → STD	H9	0.189	0.166	0.037	4.525	Yes	***
WPM → STD	H10	0.120	0.109	0.038	2.840	Yes	0.005
CM → STD	H11	0.100	0.080	0.033	2.432	Yes	0.015
TB → STD	H1	0.315	0.294	0.045	6.599	Yes	***
OP → STD	H2	0.203	0.186	0.044	4.266	Yes	***

Note: p indicates significance, *** means $p < 0.001$.

5. Discussion and conclusions

5.1 Discussion

The results of the path analysis confirm that the research hypotheses are valid. It can be observed that the three dimensions of TQM (FP, WPM, CM) have direct positive effects on STD. Specifically, FP exhibits the highest impact on STD, with a path coefficient of 0.189 ($p < 0.001$). Additionally, TQM's three dimensions exert indirect effects on STD through the mediating variables OP and TB, as indicated by the average path coefficients. However, all of these analysis results were obtained using a single platform and tool. To ensure the reliability of the research findings, we introduced the bootstrapping algorithm (Edwards et al., 2007) to validate the above analysis results. Based on all the sample data, we conducted 5,000 rounds of bootstrap sampling and set the confidence level to 95% to verify the direct and indirect effects of TQM on STD. The verification results are shown in Table 8.

The effect values in the direct effects (Table 8) are consistent with the path coefficients in AMOS. The VAF values in the indirect effects range from 20% to 80%, indicating partial mediation. This suggests that the three dimensions of TQM, through the mediating variables TB and OP, indirectly promote the development of STD. Additionally, the three dimensions of TQM also have a direct impact on STD. The effect values for the paths CM-TB-STD, WPM-TB-STD, and FP-TB-STD are 0.100, 0.096, and 0.092, respectively ($p < 0.001$), indicating that TQM influences STD to a greater extent through TB than through OP. This aligns with the results of the path analysis. Furthermore, it was observed that the overall effects of the three TQM dimensions on STD are ranked as FP-STD (0.343), WPM-STD (0.283), and CM-STD (0.261).

Table 8 Bootstrapping algorithm verification results

Effect	Path	S.E.	Effect value	95% CI		p	Effect proportion
				Lower	Upper		
Direct effect	FP → STD	0.041	0.189	0.105	0.270	0.000	55.1%
	WPM → STD	0.042	0.120	0.038	0.200	0.005	42.4%
	CM → STD	0.048	0.100	0.016	0.178	0.019	38.3%
Indirect effect	FP → TB → STD	0.018	0.092	0.060	0.132	0.000	26.8%
	WPM → TB → STD	0.018	0.096	0.065	0.135	0.000	33.9%
	CM → TB → STD	0.017	0.100	0.070	0.136	0.000	38.3%
	FP → OP → STD	0.017	0.059	0.030	0.097	0.000	17.2%
	WPM → OP → STD	0.017	0.063	0.033	0.101	0.000	22.3%
	CM → OP → STD	0.016	0.057	0.030	0.094	0.000	21.8%
	FP → TB → OP → STD	0.003	0.003	-0.002	0.011	0.184	0.9%
	WPM → TB → OP → STD	0.003	0.004	-0.002	0.012	0.188	1.4%
	CM → TB → OP → STD	0.004	0.004	-0.002	0.012	0.189	1.5%
Total effect	FP → STD	0.040	0.343	0.262	0.420	0.000	/
	WPM → STD	0.037	0.283	0.211	0.355	0.000	/
	CM → STD	0.037	0.261	0.183	0.331	0.001	/

Note: VAF = Variance accounted for, CI = the confidence interval.

Additionally, to validate the impact of the three dimensions of TQM on STD, we analyzed and compared previous research findings, especially those highly correlated with the Chengdu-Chongqing urban agglomeration, to verify the scientific and rational nature of our analysis results. The first dimension of TQM, FP, requires the full participation of all employees in scenic areas, travel-related companies, government agencies, and local residents in tourism planning and development. The results of our study show that the direct impact path coefficient of FP on STD is positive, indicating that optimizing FP can directly bring about improvements in STD. This is consistent with existing findings (Yang et al., 2023; He et al., 2021), and our research results indicate a specific degree of influence (0.343, $p < 0.001$). STD involves various aspects, including the planning, implementation, monitoring, and evaluation stages. The second dimension of TQM, WPM, emphasizes the management of the entire lifecycle. Analyzing the effects reveals that WPM significantly influences STD with an effect value of 0.283 ($p < 0.001$). Tourism planning and implementation play a crucial role in promoting sustainable development, particularly in green management (Dangi et al., 2021; Yamagishi et al., 2022). Moreover, the entire tourism planning process can be comprehensively integrated into the framework of TQM (Xiaorong et al., 2022). Therefore, the positive impact of WPM on STD is evident and reasonable. Promoting STD can be achieved through human resource management (Andrlić et al., 2022), comprehensive performance management (Al-Hazmi et al., 2020), and safety evaluation management (Jin et al., 2022). TQM's CM, with its core content encompassing these three aspects, involves a broader spectrum. The research results indicate that CM has a direct impact on STD. Moreover, CM can exert a positive indirect influence on STD through the mediation of TB and OP, with an impact level of 0.261 ($p < 0.001$). In summary, this study affirms the directional impact of TQM on STD as supported by previous findings. Additionally, the quantitative results of this research contribute valuable insights for the sustainable development of tourism in the Chengdu-Chongqing urban agglomeration.

5.2 Conclusions

Innovative thinking and perspectives were used to construct an SEM for the impact of TQM on STD based on 632 questionnaire responses. The hypotheses regarding the influence of TQM on STD were validated, and the bootstrapping algorithm was employed for verification. After analysis and validation, the results indicate the accuracy of the sample data structure, model construction, and analysis outcomes, leading to the following three conclusions:

(1) Efficient large-sample data from the study area can be obtained through online and on-site questionnaires (IOC = 0.81). There is no issue of collinearity among the questionnaire data sets (VIF < 5). The questionnaire exhibits high reliability and validity (α > 0.8, VL > 0.7, AVE > 0.5, CR > 0.7). The structure of the questionnaire and the survey method are scientifically reasonable, demonstrating broad applicability.

(2) Based on the conceptual model, an SEM incorporating the three dimensions of TQM and two mediating variables with STD was constructed. Variables loadings for FP, WPM, CM, OP, TB, and STD were all greater than 0.7. The SEM model thus exhibited good fitness, supporting the hypotheses. Therefore, TQM can be extended to the field of STD.

(3) The results of the SEM path and effect analysis indicate that TQM has a positive impact on STD, contributing to the promotion of sustainable tourism development. At a confidence level of $p < 0.001$, the order of the impact of the three dimensions on STD is FP (0.343), WPM (0.283), and CM (0.261). FP typically has a direct impact on sustainable tourism development (55.1%), while WPM (42.4%) and CM (38.3%) exert more indirect influence on STD through tourism benefits and overall perceptions. These findings hold significant guiding value for the management of STD.

Competing interests

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

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