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Quantitative Evaluation of the Impact of Sustainable Eco-Tourism Policy on Tourism Environmental Capacity in Dali City

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Abstract

The sustainable eco-tourism policies of Dali City represent a pivotal foundation for fostering the harmonious integration of local ecology and tourism. To appraise the effectiveness of these policies, this study formulates an evaluation framework utilizing the PMC index model. The analysis encompasses 16 sustainable ecotourism policies and their associated environmental indicators in Dali City, subsequently constructing an evaluation system that integrates the PMC index with tourism environmental capacity. Evaluation proceeds via the PMC index and its surface map representation. The results reveal a commendable average PMC index of 6.176 for the 16 policies, indicating a generally high level of performance. This underscores Dali City's substantial commitment to the conjoined development of ecology and tourism, as evidenced by the preliminary establishment of a comprehensive policy system and operational network spanning the entire city. Incorporating the tourism environmental capacity model, the policies pertaining to facilities and ecological environment indicators score 5.440 and 5.638 respectively, falling below the average benchmark for similar-level assessments. These findings suggest that while the overarching design of Dali City's sustainable ecotourism policies is sound, there is scope for enhancement in focusing policy efforts on ecological and facility environment capacity. Future policy formulations should prioritize advancements in policy timeliness, scope, incentives, and constraints, fostering interdepartmental collaboration for coordinated governance. Furthermore, enhancing the comprehensiveness and efficacy of policies will contribute to fostering eco-tourism in Dali City and fostering a mutually beneficial relationship between ecological preservation and economic prosperity.

Keywords: tourism environmental capacity, Eco-tourism policy, PMC index, Dali City tourism

1. Introduction

With the economic progress and heightened living standards, tourism has emerged as a prominent global industry, significantly contributing to the economic growth of nations and regions. Notably, China, a country abundant in cultural and natural resources, has witnessed exponential growth in its tourism sector amidst the ongoing urbanization process, which is an inevitable facet of economic and societal advancement. As a pivotal strategy in realizing the vision of a new socialist countryside, sustainable ecological tourism has gradually gained prominence in the global tourism landscape, driven by heightened environmental consciousness and the quest for quality tourism experiences. This form of tourism underscores the importance of safeguarding the natural environment and cultural heritage while fostering tourism-led economic development and social progress. In recent times, the Chinese government has prioritized support for the southwest ethnic regions, recognizing their rich natural resources, agricultural endowments, distinctive historical sites, and profound ethnic cultures. This support has imparted new dimensions and opportunities to rural tourism. Nevertheless, while tourism development fosters local growth, its unchecked expansion has also emerged as a primary contributor to environmental degradation and, in some cases, outright destruction. Thus, a balanced approach that prioritizes sustainability and responsible tourism practices is imperative to ensure long-term benefits for both the environment and local communities.

Sustainable ecotourism policy encompasses a comprehensive set of measures aimed at fostering the sustainable development of this tourism sector. Since the turn of the 21st century, amidst growing concerns for tourism quality and environmental conservation, sustainable ecotourism policies have gradually evolved. The significance of sustainable ecotourism development has garnered widespread recognition from nations and international bodies, such as the World Tourism Organization and the Green Tourism Association, which have championed the concept of "sustainable tourism." Consequently, governments worldwide have enacted various laws and policies related to eco-tourism, including the Guiding Principles of Eco-Tourism Development and Measures for the Management of Eco-tourism in Protected Natural Areas. These policies seek to regulate eco-tourism activities, safeguard natural ecological resources, and foster harmonious growth between local economies and eco-tourism. Scholarly research on sustainable ecotourism policies has flourished, exploring their development from both macro and micro perspectives. At the macro level,(Russell 1997) 's analysis of eco-tourism policy evolution in the United States underscores the need to balance economic gains with ecological and sociocultural impacts. (Xie 2020), from a regional policy angle, traces the historical development and evolutionary features of eco-tourism policy, identifying distinct stages. Micro-level studies, like (Hou, Xia et al. 2021)'s examination of grassland eco-tourism protection policies, employ the Logistic model to investigate how ecological policies differentially affect local tourism stakeholders' enthusiasm and advocate for region-specific improvements to eco-tourism subsidy policies.(Girma and Beyene 2012) delve into the interplay between regional economic interests and eco-tourism policies, advocating for strategic allocation of policy tools and management models to achieve ecological and economic harmony. From a collaborative governance perspective, (Tsang and Kolk 2010) emphasize the necessity of establishing eco-tourism collaborative policies to balance tourism development and environmental protection. Research into policy implementation effects has also gained traction. (Zhao, Gu et al. 2022) 's textual analysis of eco-tourism development policies in the Yangtze River region highlights the need for stronger policy synergy and advocates for cross-regional cooperation and harmonized management standards. (Luo, Luo et al. 2019)utilizing the coupling coordination degree model, assesses the synergy between eco-tourism protection and policy implementation capacity in the Yangtze River Economic Belt, revealing disparities in local governments' overall policy implementation capabilities.

The significance of studying tourism environmental capacity is underscored by pressing issues such as overcrowding at tourist destinations, excessive load on scenic areas, and tourism-induced pollution. Tourism environmental capacity pertains to the threshold number of visitors a region can sustain without detrimental impacts on the natural environment and without compromising the quality of the tourism experience(UNWTO 1981). Despite China's relatively late inception in this field of research,(Song Lu et al. 2005) the prominence of environmental capacity challenges stemming from the unique characteristics of tourism development necessitates urgent and intensified exploration. Employing a systematic analytical framework, this study delves into tourism environmental capacity, introducing the limiting factor and minimum quantity law concepts. Furthermore, it presents a mathematical model and evaluation methodology, laying a theoretical groundwork for quantitative assessments. (Wu Xiaohao 2010) have exemplified their research by focusing on specific tourism areas, analyzing the environmental capacity of Longmen Grottoes, conducting a multi-dimensional quantitative analysis of Jiuzhaigou Scenic Spot(Wang Yong 2007), calculating the capacity of Dragon Palace Scenic Spot(Yang shixiong et al. 2014), and examining local perceptions of sustainable tourism in Mount Olympus, Greece. Additionally, an in-depth examination of the social carrying capacity of the Grazelema Natural Park in Spain (Kostopoulou and Kyritsis 2003)underscores the importance of environmental quality and visitor experience. (Huang Qian et al. 2021) underscore the necessity for government and the tourism industry to invest in strengthening the weaker links of carrying capacity for harmonious tourism development in Shangrao City. Research by (Wei Ningning et al. 2019) centers on the application of tourism carrying capacity in beach tourism management, emphasizing the distinction between physical and social-psychological carrying capacities and suggesting their utilization in infrastructure management, tourist spatial distribution, and tour timing. Collectively, the preponderance of research underscores the imperative of integrating environmental capacity considerations into tourism and recreation planning to foster sustainable development and mitigate adverse impacts on the environment and local communities (Li 2016). While research has broadened its scope to encompass spatial, economic, social, and psychological dimensions, it predominantly concentrates on quantitative and qualitative analyses of scenic spots, with limited literature examining the causal nexus between eco-tourism environmental capacity and local policies. Thus, the structural dimension of policy design remains underexplored in the internal composition of tourism environmental capacity.

Drawing upon 16 national policies spanning the period from 2016 to 2022, this study formulates a Policy Measurement and Classification (PMC) indicator model utilizing text mining methodologies to conduct a rigorous quantitative evaluation. Through a comprehensive literature review, this paper delves into the concept, current state of development, challenges, and potential avenues for future progress in sustainable ecotourism, integrating insights from the tourism environmental capacity index. The objective is to assess the quality of extant ecological protection policies, identify the issues and shortcomings inherent in the design of current ecological protection compensation policies, and propose optimized policy frameworks. By establishing the PMC index model rooted in the tourism environmental capacity index, this research innovates the policy evaluation paradigm, thereby laying a theoretical foundation and benchmark for future policy formulation, refinement, and implementation.

2. Materials and Methods

2.1 Research Area

Dali City, nestled in the western reaches of Yunnan Province and the heart of Dali Prefecture, stands as a pivotal tourist destination in China. Spanning longitudes 99°58' to 100°27'E and latitudes 25°25' to 25°58'N, the city encompasses a total area of 1815 km², with mountainous terrain accounting for 70.5% of its landmass, followed by dams at 15.8%, and Erhai Lake contributing a water area of 13.7%. By the conclusion of 2023, Dali's population approximated 771,100 individuals, predominantly comprising the Bai ethnic minority, which constitutes approximately 68% of the total populace. In 2023, Dali City's gross regional product amounted to approximately 546 billion yuan, with tourism revenue constituting a significant 38.69% of the gross domestic product, totaling 108.528 billion yuan. Historically, Dali has served as the political, economic, and cultural nexus of southwestern China and has now emerged as a strategic juncture along the Bangladesh-China-India-Myanmar economic and trade corridor under the Belt and Road Initiative. It is renowned globally as a premier tourist and leisure destination and boasts the title of China's second-largest comprehensive transportation hub. Nestled in Dali's northeast, Shuanglang Town, which was incorporated into Dali City's administrative jurisdiction in 2004, has been designated as a provincial historical and cultural town in Yunnan Province and acclaimed as "the premier town for scenic vistas." Spanning 218 square kilometers, Shuanglang Town oversees seven administrative villages, four of which fringe Erhai Lake, while the remaining three are perched atop the mountains. Its proximity to Erhai Lake, coupled with its idyllic landscapes, abundant forest resources, and lush vegetation, endows the town with exceptional advantages for fostering ecological tourism.

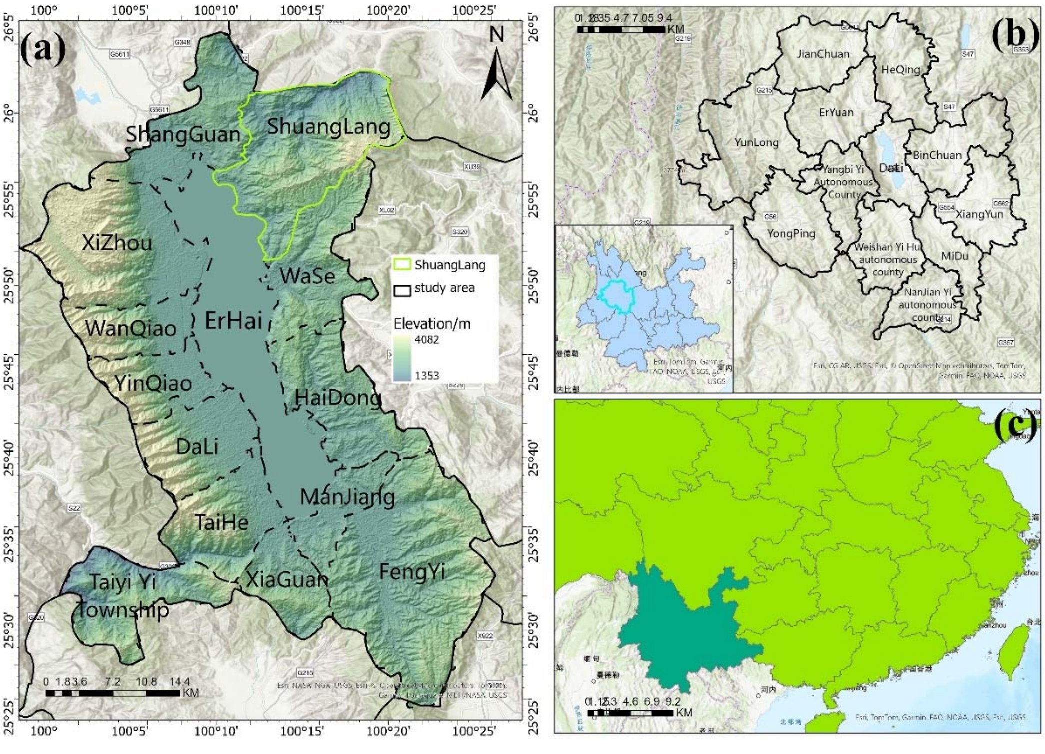

Figure 1. study area (a)，location of Dali Bai Autonomous Prefecture (b), location of Dali City (c), and Location of Yunnan, China (a).

2.2 Data Source

Through a meticulous examination of policy documents and targeted searches utilizing keywords such as ecology, tourism, and sustainable development, this research delves into policies pertaining to the ecological environment of Dali City and sustainable tourism initiatives promulgated by diverse policy entities, encompassing central, provincial, and municipal governments, along with their respective functional departments. Drawing from over 1,300 pertinent prevention and control documents, the study selectively analyzed policies and regulations related to ecology and tourism development issued by 16 national ministries and commissions, as well as local governments (Table 1). The governance framework adopted herein encompasses four key dimensions: ecological environment, facility environment, space environment, and social environment management. To ensure the authenticity and authority of the analysis, 16 representative ecological and environmental policies were meticulously selected, and their policy texts were extracted directly from official government documents. The study's data on tourism environmental capacity and related sources were primarily gathered through a comprehensive approach, which included conducting field questionnaire surveys, querying yearbook data, and conducting interviews with scenic spot managers. Specifically, the ecological environmental capacity, resource spatial capacity, resident-tourist psychological capacity, and tourism economic capacity of Shuanglang Town were quantitatively assessed using established mathematical statistical models (Hu Bingqing 1995, Yu et al. 2008, Huang Xiao et al. 2020).Adhering to the principle of identifying the minimum capacity and employing a weight assignment methodology, the study derived a reasonable estimate of the tourism environment capacity. The research data corpus comprises primarily tourist questionnaire data and government statistics, generously provided by local tourism bureaus, environmental protection bureaus, and meteorological bureaus, thereby ensuring the robustness and reliability of the findings.

Table 1. Summary of sustainable ecotourism policies

Serial number	Policy Name	Document number	Release date
P1	Implementation Opinions on Promoting the integrated development of the primary, secondary and tertiary industries in rural areas	Dazheng Changfa [2016] No. 99	2016/12/28
P2	Notice on issuing the implementation plan of the most stringent water resources Management system assessment during the "13th Five-Year Plan" period in Dali Prefecture	Big Government Office Tong [2017] No. 3	2017/12/19
P3	Notice on issuing implementation plan of Pollutant Discharge Control permit System in Dali Prefecture	Grand Government Office issued [2018] No. 9	2018/1/24
P4	Notice on the issuance of the three-year Action Plan (2018-2020) of Dali Prefecture to Promote the Tourism Revolution and Accelerate the Improvement of the Quality of Global Tourism	Grand Government Office issued [2018] No. 61	2018/8/15
P5	Notice on the issuance of Dali Prefecture solid waste pollution prevention and control battle plan	Big Government Office Tong [2019] No. 48	2019/3/28
P6	Notice on the issuance of Dali Prefecture's illegal encroachment of forest land, tea planting and deforestation of forest resources and other violations of the special rectification work program	Grand Government Office Letter [2020] No. 16	2020/6/3
P7	Notice on the issuance of the "Erhai Lake Protection and Management of the relevant departments at all levels of the Main Work Responsibilities"	Grand Administration Office issue [2020]42	2020/10/13
P8	Notice on the issuance of "Dali City Municipal Solid Waste Classification Management Measures (Trial)"	Grand Municipal Regulation [2021] 1	2021/3/23
P9	Notice on the implementation of Regulations on Protection and Management of Erhai Lake in Dali Bai Autonomous Prefecture, Yunnan Province	No. 3 of Daejeon [2021]	2021/4/2
P10	Opinions and guidance on Promoting Sustainable Development of characteristic Industries in poverty-stricken areas	No. 3 [2021]	2021/4/7
P11	Notice on the issuance of "Dali City Homestay Inn Management Measures"	Grand Municipal Regulation (2021) No. 5	2021/8/3

Serial number	Policy Name	Document number	Release date
P12	Notice on the issuance of Dali Bai Autonomous Prefecture to create a national culture and tourism consumption pilot city implementation plan	Grand Administration Office issued [2021] No. 39	2021/9/13
P13	Notice on the issuance of management measures for the repair and reinforcement or demolition and reconstruction of rural housing in Erhai Secondary Protection Area	Major Construction Plan [2021] No. 1	2021/10/29
P14	Implementation opinions on the third level protection area of Erhai Protection and management in Dali City and the approval and construction of rural housing outside the basin	City Administration [2021]19	2021/11/24
P15	Notice on the issuance of Dali Enterprise Technology Center identification management measures	Dagong Letter Regulation [2022] No. 1	2022/5/5
P16	Notice on the issuance of the Action Plan for Protection and Governance of Erhai Lake in Yunnan Province (2021-2025)	Grand Government Office issue No. 39 [2022]	2022/8/22

2.3 Construction of PMC Index Model

The PMC index model, also recognized as the policy and review model, constitutes an evaluation framework rooted in text mining methodologies. It is primarily employed to assess the coherence and efficacy of policies. This model is grounded in the "Omnia Mobilis" hypothesis proposed by (Ruiz Estrada 2011), which posits that all entities in the world are in perpetual motion and interconnected, necessitating the comprehensive consideration of all pertinent variables during model formulation, with none being omitted. In the context of this study, the PMC index model has been chosen to evaluate the sustainable eco-tourism protection policy. The specific steps involved in constructing the PMC-index model for evaluation purposes are outlined below: ① Classification of policy variables and parameter identification. ② Construct multiple input and output tables; ③ Measurement and evaluation of PMC index. ④PMC surface drawing and conclusion induction.

2.3.1 Variable Classification and Parameter Setting

On the basis of ROSTCM6.0 research and summary of the high frequency words of sustainable ecotourism in Dali City, the sustainable ecotourism policy rating index system is constructed (Table 1). The index system consists of 14 first-level variables and 49 second-level variables, among which the first-level variables are: Policy nature (X1), policy function (X2), policy timeliness (X3), policy area (X4), policy social benefit (X5), policy object (X6), policy incentive and constraint (X7), policy guarantee (X8), policy evaluation (X9) and policy disclosure (X10).

Drawing upon the definitions provided in Table 1, we employ a binary algorithmic approach to assign values to the respective policies. By convention, the weights of all secondary variables are presumed to be equivalent, and we allocate values to 49 such variables based on the presence of keywords within each policy text. Specifically, if the content of a policy aligns with the corresponding keywords of a secondary variable, a value of 1 is assigned; conversely, a value of 0 is assigned in the absence of such alignment. Given the unique context of sustainable ecotourism in Dali City, this study constructs a multivariate design (outlined in Table 2) and an input-output table (presented in Table 3), adhering to the aforementioned methodology.

Table 2. Variable design of PMC model

Primary indicator	Primary Indicator Name	Minor Indicator	Minor Indicator Name	Primary indicator	Primary Indicator Name	Minor Indicator	Minor Indicator Name
X1	Nature of policy	X1.1	stipulate	X6	Policy object	X6.1	Exchequer
		X1.2	item			X6.2	Ministry of Environmental Protection

Primary indicator	Primary Indicator Name	Minor Indicator	Minor Indicator Name	Primary indicator	Primary Indicator Name	Minor Indicator	Minor Indicator Name
		X1.3	idea			X6.3	National Development and Reform Commission
		X1.4	notification			X6.4	Ministry of Water Resources
		X1.5	decide			X6.5	Ministry of Science and Technology
		X1.6	project			X6.6	Ministry of Transport
		X1.7	method			X6.7	Forestry bureau
X2	Policy function	X2.1	Normative guidance			X6.8	Other relevant departments
		X2.2	Classification supervision	X7	Policy incentive and constraint	X7.1	Economic incentive
		X2.3	Cooperative management			X7.2	Tax incentives
		X2.4	Overall coordination			X7.3	Financial subsidy
X3	Timeliness of policy	X3.1	short-term			X7.4	Convenient service
		X3.2	metaphase			X7.5	Administrative punishment
		X3.3	long-term			X7.6	Capital investment
X4	Policy domain	X4.1	economy	X8	Policy guarantee	X8.1	evaluate
		X4.2	Social service			X8.2	Publicity and guidance
		X4.3	political			X8.3	self-regulation
		X4.4	Science and technology			X8.4	Government supervision
		X4.5	ecology			X8.5	Rule of law
X5	Social benefit of policy	X5.1	Environmental protection			X8.6	Policy support
		X5.2	sustainability			X8.7	Social supervision
		X5.3	Sound mechanism			X8.8	Technological innovation
		X5.4	Win-win cooperation	X9	Policy evaluation	X9.1	Clear goal
						X9.2	Basis enrichment
						X9.3	Detailed planning

Primary indicator	Primary Indicator Name	Minor Indicator	Minor Indicator Name	Primary indicator	Primary Indicator Name	Minor Indicator	Minor Indicator Name
X10	Policy disclosure					X9.4	Scheme science

Table 3. Multi - input /output

X1	X2
X1.1，X1.2，X1.3，X1.4，X1.5，X1.6，X1.7	X2.1，X2.2.X2.3.X2.4
X3	X4
X3.1，X3.2，X3.3	X4.1，X4.2，X4.3，X4.4，X4.5
X5	X6
X5.1，X5.2，X5.3，X5.4	X6.1，X6.2，X6.3，X6.4，X6.5，X6.6，X6.7，X6.8
X7	X8
X7.1，X7.2，X7.3，X7.4，X7.5，X7.6	X8.1，X8.2，X8.3，X8.4，X8.5，X8.6，X8.7，X8.8
X9 X9.1，X9.2.X9.3.X9.4	X10

2.3.2 PMC Index Calculation and Evaluation Grade Division

The calculation steps of PMC index model are as follows: First, the variables are constructed according to the policy text, and the primary variables and secondary variables are assigned to the multi-input output table by binary method according to formula (1) and (2); Then, the formula (3) is used to combine the assignment of the secondary variable to calculate and obtain the value of the primary variable, " j " represents the primary variable, " i " represents the secondary variable; Finally, the data is imported into formula (4) to generate the PMC index value of the strategy to be evaluated.

$$X \sim N[0,1] \tag{1}$$

$$X = \{XR: [0 \sim 1]\} \tag{2}$$

$$X_t\left(\sum_{j=1}^{n} \frac{X_j}{n}\right) = 1,2,\ldots,\infty \tag{3}$$

$$PMC = \begin{bmatrix} X_1\left(\sum_{k=1}^{7} \frac{X_{1k}}{7}\right) + & X_2\left(\sum_{l=1}^{4} \frac{X_{2l}}{4}\right) & +X_3\left(\sum_{m=1}^{3} \frac{X_{3m}}{3}\right) \\ X_4\left(\sum_{n=1}^{5} \frac{X_{4n}}{5}\right) + & X_5\left(\sum_{o=1}^{4} \frac{X_{5o}}{4}\right) & +X_6\left(\sum_{p=1}^{8} \frac{X_{6p}}{8}\right) \\ X_7\left(\sum_{q=1}^{6} \frac{X_{7q}}{6}\right) + & X_8\left(\sum_{r=1}^{8} \frac{X_{8r}}{8}\right) & +X_9\left(\sum_{s=1}^{4} \frac{X_{9s}}{4}\right) \end{bmatrix} \tag{4}$$

Upon calculating the PMC index for 16 sustainable ecotourism policies, a quantitative evaluation of each policy was conducted, drawing upon the specific values reported in previous studies (Yongan and Zhe, Kerja 2007, Chao and Sijing 2015, Chen 2020, Kuang, Han et al. 2020, Peng, Chen et al. 2020, Fan and Zhang 2021, Li, He et al. 2021, Wei, Hu et al. 2021, Li and Guo 2022, Mogstad, Torgovitsky et al. 2024) The PMC index of these sustainable ecotourism policies was categorized into four distinct grade standards, as outlined in Table 4. Specifically, a PMC result falling within the range of (7.920，10] signifies the highest level of domain perfection, indicative of exceptional performance. Conversely, results falling into (5.549, 7.127] are classified as excellent domain perfection, while those within (3.969, 5.548] represent good domain perfection. Lastly, a PMC index falling below 3.968, within the range of [0,3.968], denotes that the domain completeness does not meet the required standard, suggesting room for improvement.

Table 4. Hierarchy classification of Sustainable ecotourism policy

PMC index	**0-3.968**	**3.969-5.548**	**5.549~7.127**	**7.128-7.920**
level	no pass	pass	good	excellent

2.3.3 PMC Surface Structure

The PMC index is transformed into PMC-Surface map and visualized in the form of stereoscopic images, which can visually display the evaluation results of policies [16] and help analyze the advantages and weaknesses of sustainable ecotourism policies. Considering the equilibrium of the matrix, X10 is eliminated to form a 3x3 third-order matrix. The raised part of the surface indicates that the policy to be evaluated has a high score on this indicator level; A concave part indicates that the strategy to be evaluated has a low score on that indicator level. Formula (5) is used for PMC surface calculation.

$$PMC = \begin{bmatrix} X_1 & X_2 & X_3 \\ X_4 & X_5 & X_6 \\ X_7 & X_8 & X_9 \end{bmatrix} \tag{5}$$

3. Tourism Environmental Capacity under Sustainable Tourism Policy

3.1 Calculation of Tourism Environmental Capacity Index

Tourism environmental capacity pertains to the quantifiable limit and intensity of tourism activities that a destination can sustainably accommodate. This metric encompasses the consumption patterns, loading capacities, and resilience of environmental resources, along with the safeguarding of both natural and cultural environments(Shi Lei et al. 2016, Tsang Hongkai 2022). Tourism environmental capacity can be categorized into three dimensions: physical, economic, and social. Physical capacity relates to the maximum number of tourists that the destination's environment and resources can sustainably host. Economic capacity considers the economic implications of tourism on the local economy. Social capacity, on the other hand, emphasizes the dynamics of interaction and adaptability between tourists and local residents. As a prerequisite for sustainable tourism development, the assessment of tourism environmental capacity is paramount. According to the formula of tourism environmental capacity index in Table 5，this study primarily evaluates and analyzes the tourism environmental capacity of Shuanglang Town in Dali City, focusing on four key aspects: tourism eco-environmental capacity, tourism resource spatial capacity, tourism environmental facility capacity, and tourism social environmental capacity. These dimensions offer a comprehensive understanding of the destination's ability to balance tourism growth with environmental preservation.

Table 5. Tourism environmental capacity index calculation formula

Primary index	Secondary index	formula	
Ecological environmental capacity	Water environmental capacity	$WEC = {W_0}/{W_1}$	(5)
	Atmospheric environmental capacity	$AEC = {WA_0}/{A_1}$	(6)
	Solid waste capacity	$SEC = {S_0}/{S_1}$	(7)
Ecological environmental capacity Q(e)	$Q(e) = Min(WEC, AEC, SEC)$		(8)

Primary index	Secondary index	formula	
Space environment capacity	Area calculation formula	$TRSC = {(S \times T)}/{s \times t}$	(9)
Space environment capacity Q(r)		$Q(r) = \sum_{i}^{7}\{TRSC_i\}$	(10)
Facility environment capacity	Traffic facility capacity	$TFC = {D_f}/{K}$	(11)
	Hotel facility capacity	$HFC = {H_0}/{H_1}$	(12)
	Main and non-staple food facilities capacity	$DFC = {D_f}/{L}$	(13)
Facility environment capacity Q(f)		$Q(r) = \sum_{i}^{7}\{TRSC_i\}$	(14)
Social environmental capacity	Tourist psychological environment capacity	$TPC = ({S}/{a}) \times ({T}/{t})$	(15)
Social environmental capacity Q(s)		$Q(s) = TPC$	(16)

3.2 Calculation of the PMC Index for the Tourism Environment Capacity Subsystem

Drawing upon the categorization of first-level indicators pertaining to tourism environmental capacity and the analysis of policy high-frequency words, this study has selected 16 sustainable ecotourism policies that encompass four distinct aspects: ecological environmental capacity, tourism resource spatial capacity, tourism environmental facility capacity, and tourism social environmental capacity (Table 6). (Kuang, Han et al. 2020, Fan, Chu et al. 2023, Song, Liu et al. 2024)The chosen positive policies and norms comprehensively cover all secondary indicators of tourism environmental capacity, ensuring a holistic assessment of the subsystem's performance.

Table 6. Sustainable eco-tourism policy corresponding to tourism environmental capacity index

Tourism environmental capacity index	**Policy serial number**
Ecological environmental capacity	P3、P5、P8、P14
Space environment capacity	P6、P7、P9、P16
Facility environment capacity	P2、P4、P11、P13
Social environmental capacity	P1、P10、P12、P15

4. Results and Analysis

4.1 Analysis of 16 Policy Indicators

Based on the constructed sustainable ecotourism policy evaluation system, this study employs text mining technology to formulate a multi-input and output table for each variable. Subsequently, the PMC index of each policy is calculated, and the policy level is determined based on the PMC index values. As depicted in Table 7, the PMC indices of the 16 sustainable ecotourism policies range from 5 to 8, with an average score of 6.176, suggesting that the policy texts are generally of good quality. The ranking of the policies, in descending order of their scores, is as follows: P10 > P15 > P16 > P12 > P9 > P1 > P7 > P4 > P6 > P5 = P8 > P2 > P3 > P14 > P13 > P11. Notably, Policy 10, titled "Opinions and Guidance on Promoting the Sustainable Development of

Characteristic Industries in Poverty-Stricken Areas," achieved the highest score of 7.280, categorizing it as excellent and ranking first. Conversely, Policy 11, concerning the issuance of "Dali City Homestays Management Measures," received the lowest score of 4.980, placing it in the qualified level and highlighting a disparity in policy quality.According to the evaluation criteria outlined in Table 6 under the tourism environmental capacity index, the 16 policies can be categorized into four groups for further analysis. The first group comprises policies of excellent quality, including P1, P2, P5, P7, and P9. The second group, categorized as acceptable, consists of P3, P4, P6, P8, and P10.

Table 7. PMC index values of Sustainable eco-tourism policy

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	PMC index	rank	level
P1	0.43	0.75	0.33	0.6	0.75	0.63	0.67	0.75	0.75	1	6.654	6	good
P2	0.57	0.5	0.33	0.4	0.75	0.50	0.33	0.5	0.75	1	5.638	12	good
P3	0.57	0.5	0.33	0.4	0.75	0.38	0.33	0.5	0.75	1	5.513	13	Pass
P4	0.57	0.5	0.33	0.6	0.75	0.50	0.50	0.625	0.75	1	6.130	8	good
P5	0.57	0.5	0.33	0.4	0.75	0.38	0.33	0.625	1	1	5.888	10	good
P6	0.43	0.75	0.33	0.6	0.75	0.50	0.33	0.625	0.75	1	6.070	9	good
P7	0.57	0.75	0.33	0.6	0.75	0.63	0.67	0.5	0.75	1	6.546	7	good
P8	0.57	0.5	0.33	0.4	0.75	0.38	0.33	0.625	1	1	5.888	10	good
P9	0.71	0.75	0.33	0.6	0.75	0.63	0.67	0.625	0.75	1	6.814	5	good
P10	0.57	0.75	0.33	1	0.75	0.75	0.50	0.875	0.75	1	7.280	1	Excellent
P11	0.57	0.5	0.33	0.2	0.5	0.38	0.50	0.5	0.5	1	4.980	16	Pass
P12	0.43	0.75	0.33	1	0.75	0.63	0.83	0.75	0.5	1	6.970	4	good
P13	0.57	0.5	0.33	0.4	0.5	0.38	0.33	0.5	0.5	1	5.013	15	Pass
P14	0.57	0.25	0.33	0.4	0.75	0.50	0.33	0.375	0.75	1	5.263	14	Pass
P15	0.71	0.75	0.33	0.8	0.5	0.63	0.67	0.75	1	1	7.139	2	Excellent
P16	0.57	0.75	0.33	1	1	0.63	0.50	0.75	0.5	1	7.030	3	good
Mean	0.563	0.609	0.333	0.588	0.719	0.523	0.490	0.617	0.734	1	6.176		

In a vertical comparison, the domain of sustainable ecotourism exhibits exceptional performance across four primary variables: policy function (X2), policy social benefit (X5), policy guarantee (X8), and policy evaluation (X9). The average scores for these variables surpass 0.6, reflecting a clarity of objectives coupled with scientific and comprehensive planning schemes, robust foundations, and innovative methodologies to facilitate goal attainment. Furthermore, a seamless alignment exists across various policy levels, from national ministries to municipal governments, with corresponding policies issued or endorsed, thereby fostering optimal policy implementation and future enforceability. Since the inception of the rural revitalization policy, government agencies across sectors have proactively formulated relevant policies to align with the objectives and prerequisites of the implementation plan, yielding a commendably high level of policy coverage. However, three variables—policy prescription (X3), policy object (X6), and policy incentive constraint (X7)—manifest significantly lower scores of 0.333, 0.523, and 0.490, respectively, when compared to the average of other indices. This indicates that upon policy introduction, the timeframe for policy efficacy remains vague, and specific goals or behaviors within stipulated timelines lack clarity. Moreover, individual policies often encompass a limited scope of beneficiaries, spanning merely economic, social, political, environmental, and technological domains. Furthermore, the incentive and safeguard mechanisms within various policies are relatively underdeveloped, potentially impeding the efficiency and effectiveness of policy implementation.

4.2 PMC Surface Diagram of Representative Policy Indicators

This section presents a PMC surface analysis of 16 representative policies related to sustainable eco-tourism in Dali City. The scores of the variables at each policy level were input into the data analysis software in a 3x3 matrix format, enabling the generation of three-dimensional color-mapped PMC surface maps for each policy. These maps are depicted in Figure 2, offering a visual representation of the performance of the 16 policies. The varying colors in the graph signify the policy's score on the respective first-level indicators. The elevated portions indicate higher scores on the corresponding indicators, whereas the depressed areas signify lower scores. The overall position of the surface serves as a proxy for the policy's overall quality, while the degree of surface fluctuation reflects the level of internal consistency within the policy (Xiong, Zhang et al. 2023).Examining Figure 2, it becomes evident that policies P10 and P11 occupy the first and 16th positions, respectively, in the PMC index ranking. The PMC surface map of policy P10 exhibits a higher overall position, relatively stable fluctuations, and a pronounced bulge, indicative of its superior overall quality and high scores across the first-level indicators in the policy field. This policy effectively integrates and reflects the aspects of economy, social service, politics, science and technology, and ecology in its formulation and implementation. In contrast, the PMC surface map of policy P11 displays a higher overall position but with a noticeable depression, suggesting a lower overall quality and subpar scores in the policy field indicators. Furthermore, this policy's connectivity with other domains, such as economy and social service, appears to be inadequate and requires improvement.

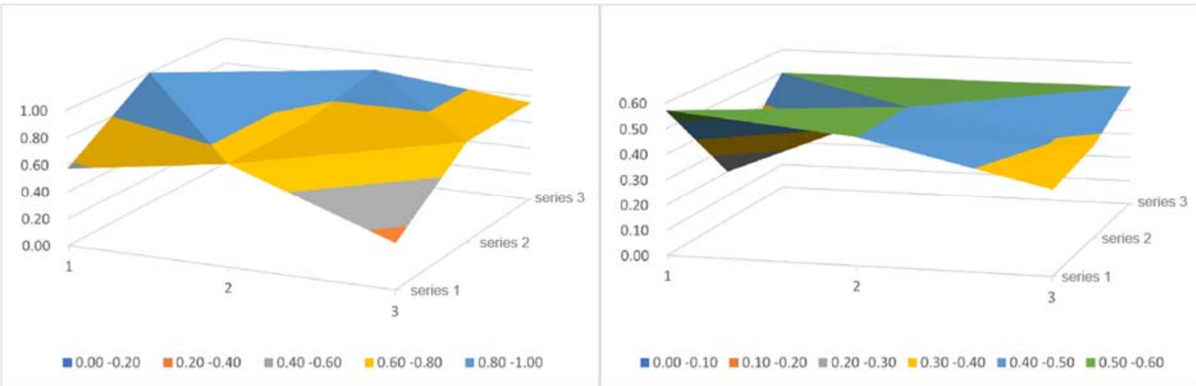

Figure 2. PMC surface diagram of representative policy

4.3 Tourism Environmental Capacity under Sustainable Eco-Tourism

4.3.1 Ecological Environment Capacity

The scenic area of Shuanglang Town in Dali City encompasses ancient towns, cultural islands, and diverse landscapes. This study assesses the environmental capacity of these scenic spots from three perspectives: atmospheric, water, and solid waste capacities. The Erhai River basin boasts a robust sewage treatment infrastructure, including 19 urban sewage treatment plants, 125 decentralized rural facilities, and the Shuanglang sunken reclaimed water plant, which commenced operations in 2016 and covers the entire town(Zhao, Gu et al. 2022, Zhao, Jiang et al. 2023). Currently, the sewage treatment capacity stands at 5,000 t/d, with an additional 3,097 t/d of spare capacity, based on the projected sewage generation from the town's 19,822 residents in 2023, assuming an 80% sewage discharge rate and an average tourist sewage discharge of 0.24 t/d. Applying Equation (5), the domestic sewage environmental capacity is estimated to be 12,904 persons/day. Air quality in Shuanglang Town is excellent, with most quarters experiencing 100% days of good air quality, as per the "Ambient Air Quality Standard" (GB3095-2012). Particulate matter levels are within permissible limits set by the Comprehensive Emission Standard for Air Pollutants (GB16297-1996), indicating minimal impact on tourist experience and thus not considered further. Solid waste management in Dali has achieved a 100% disposal rate since 2019. The daily waste disposal capacity of the town's garbage transfer station is 50 t/d, while the per capita waste generation among residents and tourists is 1.2 kg/d and 0.4 kg/d, respectively. Using Equation (7), the solid waste environmental capacity is calculated to be 65,535 persons/day.

4.3.2 Facility Environment Capacity

The capacity of tourism infrastructure in Shuanglang Town is gauged by the availability of food, accommodation, and transportation services. Water and electricity supplies are abundant, with a total water supply capacity of

289,000 t/d, far exceeding domestic consumption, and an annual power supply exceeding 10 billion kilowatts, rendering these factors negligible in capacity constraints. Transportation capacity is primarily determined by the Shuanglang Passenger Transport Center and self-drive options, with estimated daily passenger capacities ranging from 780 to 1,643 persons/day, depending on the origin. Parking facilities accommodate approximately 6,650 vehicles daily. Applying Equation (11), the traffic environmental capacity (TFC) of Shuanglang Ancient Town in 2023 is estimated to be 16,708 persons/day. Accommodation facilities comprise 660 hotels and inns with 11,479 rooms, capable of hosting 22,958 overnight visitors. Assuming a 60% overnight to transit tourist ratio, the daily tourist capacity of accommodation facilities is projected to be 38,263 persons/day. Dining facilities encompass 40 restaurants with over 100 seating capacities, 131 restaurants with 50-100 capacities, and 237 smaller establishments, collectively accommodating at least 20,935 diners simultaneously. Using Equation (13), the restaurant capacity (DFC) is estimated to be approximately 26,168 persons/day.

4.3.3 Space and Social Environment Capacity

Given the compact and widespread layout of scenic spots in Shuanglang Town, the spatial capacity is assessed using the area method (Equations 9 and 15), as detailed in Table 3. Social environmental capacity in tourism research often focuses on the psychological capacity of residents and tourists, religious beliefs, population composition, and other factors (Shi Lei et al. 2016). As Shuanglang Town is predominantly inhabited by Bai and Yi ethnic minorities with no specific religious beliefs, this study focuses solely on the psychological capacity of tourists within the destination. The tourism space capacity and tourist psychological capacity of Shuanglang Town are shown in Table 8.

Table 8. Tourism space capacity and tourist psychological capacity in Shuanglang Town

Scenic spot name	Tourist area m^2/ Route length m	Valid opening hours (h)	Optimal activity density m^2/ distance m	Tour Time (h)	Daily visitor capacity TRSC (Person-time)
Shuanglang ancient town	883 000	16	200	2	35 320
Nanzhao style island	63 000	10	400	1	1 575
Okgil	22 000	24	200	0.5	5 280
Kuixing Tower	900	10	100	0.1	900
Shima Yibang fishing village	23 000	24	200	0.5	5 520
Erhai Wetland Park	1 200	24	200	0.2	720
Coastal highway	19 000	16	20	1.5	10 133
Scenic spot name	Tourist area m^2/ Route length m	Valid opening hours (h)	Reasonable mental activity density m^2/ distance m	Average visit time (h)	Tourist Psychological capacity TPC (Person-time)
Shuanglang ancient town	2 870	16	5	2	4592
Nanzhao style island	1 600	10	5	1	3200
Okgil	220	24	5	0.5	2112
Kuixing Tower	900	10	400	0.1	225
Shima Yibang fishing village	190	24	5	0.5	1824
Erhai Wetland Park	240	24	5	0.2	5760
Coastal highway	19 000	16	30	1.5	6755.6

4.3.4 Evaluation of Tourism Environmental Capacity

The comprehensive assessment of tourism environmental capacity (TEC) is rooted in the individual evaluation of its constituent components. This study delves into the measurement of the four sub-systems of TEC, each of which is evaluated separately. By applying the formulas (8, 10, 14, 16), the subsequent analysis reveals the secondary indicators of TEC for Shuanglang Town in the year 2023, as presented in Table 9. This approach ensures a systematic and rigorous examination of the TEC, fostering clarity and conciseness in the interpretation of the results.

Table 9. Results of secondary indicators of tourism environmental capacity in 2023

Tourist environment capacity indicator	Person/day
Ecological environmental capacity $Q(e)$	12 904
Space environment capacity $Q(r)$	59 448
Facility environment capacity $Q(f)$	16 708
Social environmental capacity $Q(s)$	24 468

4.4 Tourism Environmental Capacity Under Sustainable Eco-Tourism

To evaluate the efficacy of sustainable eco-tourism policies, the first-order variable score of the policy under consideration is benchmarked against the average score. Additionally, the gap between the policy and an ideal "perfect policy" is assessed using sag index analysis, which facilitates the identification of areas requiring improvement, or "weak links." In this study, (Table 10) our strategies—P(e) (ecological environment), P(r) (spatial environment), P(f) (facility environment), and P(s) (social environment)—are selected for horizontal comparison, and their PMC index surface plot is depicted in Figure 3. The average scores, in descending order, are 7.011, 6.615, 5.638, and 5.440, respectively, indicating that policies related to ecological, spatial, and social environments emerge as the most favorable strategies for evaluation, while the facility environment policy is deemed acceptable.

Table 10. PMC index values of tourism environmental capacity secondary index policy

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	PMC index	rank	level
P(e)	0.571	0.438	0.333	0.400	0.750	0.406	0.333	0.531	0.875	1	5.638	3	good
P(r)	0.571	0.750	0.333	0.700	0.813	0.594	0.542	0.625	0.688	1	6.615	2	good
P(f)	0.571	0.500	0.333	0.400	0.625	0.438	0.417	0.531	0.625	1	5.440	4	pass
P(s)	0.536	0.750	0.333	0.850	0.688	0.656	0.667	0.781	0.750	1	7.011	1	good

The overall average PMC index of 16 sustainable eco-tourism policies in Dali City stands at 6.176, reflecting the city's commitment to integrating ecological and tourism development. Over time, supporting policies and measures have been refined, culminating in a policy system and operational network that spans the entire city. Analysis of the PMC index across various dimensions reveals that the policy nature (X1) mean score of 0.563 suggests a focus on descriptive, suggestive, and predictive elements, with room for enhancement in regulatory and directive aspects. The policy function (X2) mean score of 0.609 underscores the policies' effectiveness in normative guidance, classified supervision, coordinated management, and overall coordination, showcasing the government's governance prowess. However, policy timeliness (X3) lags behind, with an average PMC index of 0.33, pointing to the simplicity of development goals set by sustainable eco-tourism policies and the lack of comprehensive long-, medium-, and short-term planning. In the policy field (X4), the average PMC index of 0.588 highlights a preponderance of policies addressing systems, environments, and policies, with minimal emphasis on economic and cultural aspects. From a policy content perspective, the aim is to foster high-quality tourism development through ecological civilization construction.The policy social benefit (X5) mean PMC index of 0.719 demonstrates a well-conceived approach that prioritizes social welfare, suggesting that future policy improvements could further emphasize this aspect. The policy target (X6), which pertains to stakeholders affected by policies and requiring corresponding measures, has an average PMC index of 0.523, suggesting an opportunity to strengthen collaboration among implementing departments. Policy incentive and constraint (X7), crucial for motivating stakeholders and ensuring policy effectiveness, lags with an average PMC index of 0.490, emphasizing the need for enhanced incentive and constraint mechanisms. The policy guarantee (X8) mean PMC index of 0.617 indicates that policies not only emphasize assessment supervision and institutional guarantees but also comprehensively consider personnel training, capital investment, organizational leadership, and legal protection. Lastly, the policy evaluation (X9) dimension ranks highest, with an average PMC index of 0.734, reflecting the coherence of policy formulation that incorporates clear objectives, solid foundations, detailed planning, and scientific programs.

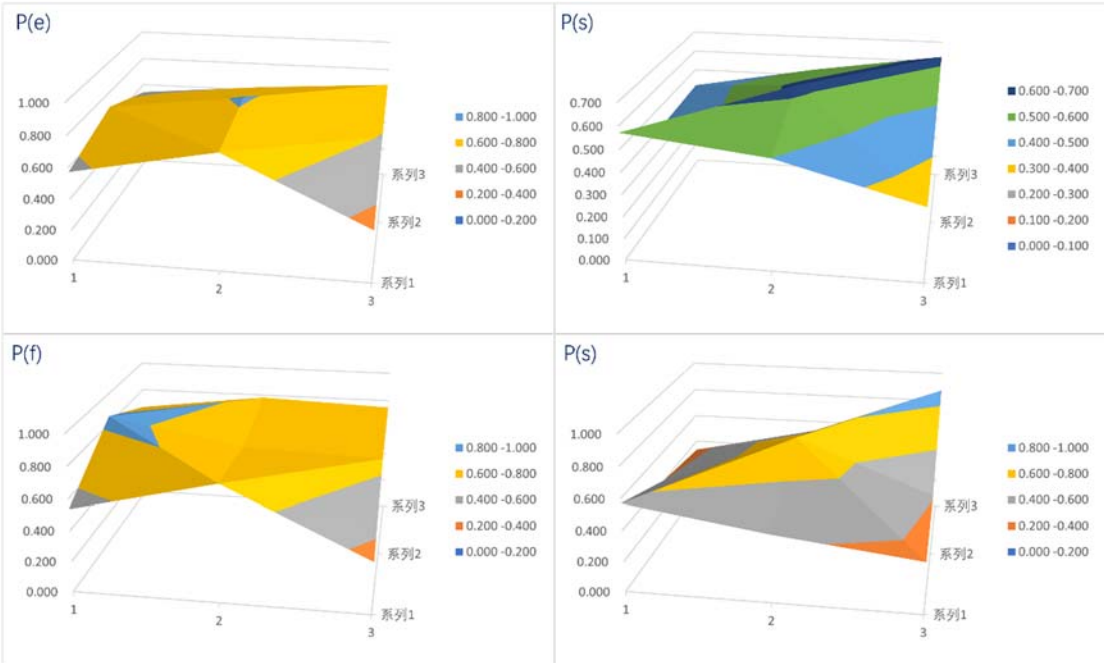

Figure 3. Tourism environmental capacity secondary index policy PMC surface map

As depicted in Figure 4, Policy P(e) pertaining to ecological and environmental indicators encompasses a multifaceted approach aimed at mitigating industrial pollution's impact on the environment through the implementation of an emission permit system, safeguarding vital ecological elements like water and air, committing to effective solid waste management, minimizing garbage-induced ecological damage, preserving soil and natural landscapes, and fostering urban solid waste classification. This policy also encompasses measures to reduce garbage pollution, enhance resource recycling rates, protect the environment, standardize rural housing construction, and safeguard the ecology of Erhai Lake and its vicinity. Notably, Policy P(e) exhibits prominence in the X5 (policy social benefit), X8 (policy guarantee), and X9 (policy evaluation index) dimensions, with a high PMC index average of 5.638 points, ranking third. Specifically, X1 (policy nature), X5, X8, and X9 variables surpass their respective peer averages, whereas X2 (policy function), X3 (policy timeliness), X4 (policy field), X6 (policy object), and X7 (policy incentive and constraint) indices lag below 0.5, indicating room for improvement in policy design's scientificity, rationality, and comprehensiveness. Future enhancements should prioritize enhancing X3's timeliness, clarifying policy functions and objects, and strengthening incentives and constraints to better achieve ecological protection goals. Considering Dali Shuangong Town's estimated ecological environmental capacity of 12,904 persons/day, the most restrictive tourism environmental capacity index, underscores the need for stricter ecological protection policies, pollutant discharge control, solid waste prevention, and forest resource conservation. Clarifying policy objectives and targets, ensuring precise focus on ecological protection's key aspects, and incentivizing tourism enterprises and visitors through eco-tourism certification and green tourism incentives can bolster enthusiasm and effectiveness.

Policy P(r), addressing space environment indicators, emphasizes forest resource protection, natural space integrity maintenance, tourism space resource augmentation, Erhai Lake protection and management responsibilities clarification, surrounding space rational planning, space utilization efficiency enhancement, and standardized development. This policy aims to facilitate orderly tourism development, formulate long-term Erhai Lake protection plans, optimize spatial layouts, and boost spatial environmental capacity. With a PMC index average of

6.615 points, ranking second, Policy P(r) demonstrates substantial overall value, albeit with notable X3 timeliness shortcomings. Notably, X2, X4, X5, and X8 indices exceed 0.7, indicating Dali's tourism environmental space policies effectively guide, supervise, collaborate, and coordinate. These policies are well-conceived, spanning politics, economy, social services, science and technology, and ecology, with a strong emphasis on social benefits, showcasing effective governance. X9 and other variables outperform their peers, while X1, X6, X7, X8, and X9 indices, though above 0.5, suggest room for improvement. Policy P(r) is comprehensive, involving multiple dimensions, detailed planning, and effective incentives for actors' responsibilities fulfillment. It integrates assessment, supervision, system guarantees, talent training, capital investment, organizational leadership, and legal protection. However, X3's low score highlights the need for more comprehensive long-, medium-, and short-term development planning. Given Dali Shuanglang Town's spatial environmental capacity of 59,448 people/day, the highest among environmental capacity indicators, relevant policies effectively leverage spatial capacity, scientifically plan attractions, allocate resources, correct illegal encroachment, and ensure scientific and rational space planning through robust policy safeguards, evaluation, and supervision.

Policy P(r), which focuses on environmental indicators for tourism facilities, encompasses various aspects such as reinforcing water resource management, ensuring water demand for tourism amenities, fostering sustainability in tourism services, promoting facility construction and upgrades, augmenting tourist reception capacity, catering to tourist needs, regulating bed and breakfast establishments, and enhancing the quality and quantity of accommodation facilities. Additionally, it addresses providing diverse accommodation options, rationalizing rural housing development, and mitigating impacts on tourism infrastructure. The policy's overall performance is average, with a modest PMC index of 5.440, placing it at the bottom of the policy evaluation ranking and classified as acceptable. Notably, indices for policy timeliness (X3), areas (X4), objects (X6), and incentive constraints (X7) are below 0.5, highlighting insufficient comprehensiveness in developmental timelines, normative guidance dimensions, classified supervision, collaborative management, and goal-oriented incentive policies. While the policy's nature (X1), function (X2), and average policy guarantee index (X8) are middling, indicating room for improvement in scientific, rational, and holistic policy description, recommendation, prediction, supervision, guidance, and standard guidance, further efforts are required to bolster social benefits, objectives, foundations, planning, and scientific programs. Specifically, enhancements in policy functions, fields, incentives, and constraints are vital to improve policy coherence and efficacy. Notably, Shuangong Town in Dali City's facility environmental capacity is estimated at 16,708 persons daily, the lowest among tourism environmental capacity indicators, suggesting the need for enhanced policies on facility construction, quality, and quantity, along with stricter management and standardization of tourism facilities, including homestays and rural housing.

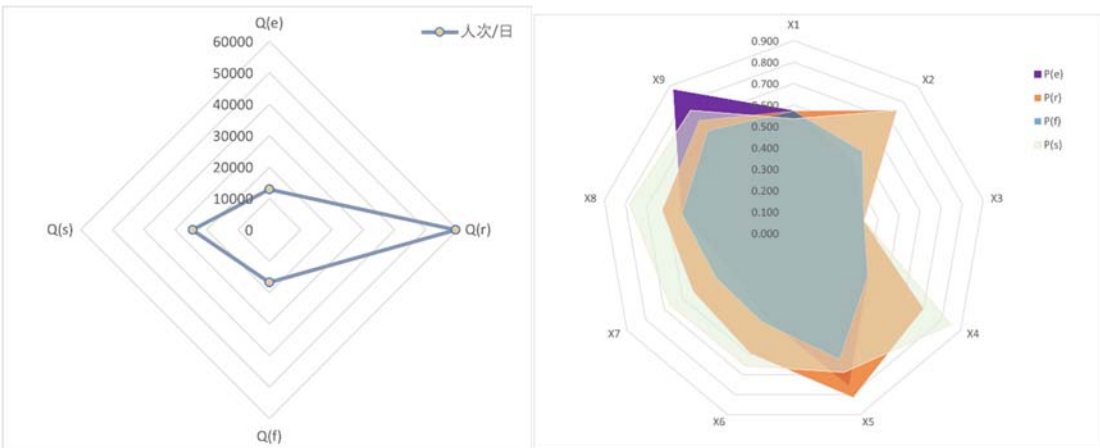

Figure 4. Tourism environmental capacity radar map and index corresponding policy PMC index radar map

Policy P(s), pertaining to tourism's social and environmental indicators, aims to propel rural economic growth, elevate local incomes, strengthen societal support for tourism, foster characteristic industries in impoverished regions, boost employment, enhance quality of life, and promote social harmony. It also enhances the tourism consumption environment, enriches tourism culture, improves tourist satisfaction and loyalty, encourages enterprise technological innovation, and fortifies the tourism industry's competitiveness. Despite an average overall image, the policy boasts a substantial PMC index average of 7.011, topping the policy evaluation ranking.

While the policy's timeliness (X3) indicator lags below 0.5, reflecting limited comprehensiveness in long-term, medium-term, and short-term planning, other indices are high, demonstrating robust consistency in standardized guidance, classified supervision, coordinated management, and overall coordination, as well as scientific, rational, and comprehensive design in supervision, guidance, guarantee, maintenance, and standardized guidance, classified supervision, coordinated management, and overall coordination. This policy set on the social environment can leverage its strengths while refining policy nature and enhancing pertinence and sustainability in managing social environmental capacity. Shuanglang Town in Dali City boasts a social environmental capacity of 24,468 persons daily, second in the tourism environmental capacity index, attesting to the city's success in implementing social environmental capacity management policies and maintaining a favorable social and cultural environment. Further leveraging these advantages can foster tourism-culture integration, strengthen policy safeguards for social environmental capacity management, intensify publicity, guidance, and social oversight, and promote tourism civilization and environmental protection to elevate tourists' and residents' environmental awareness and civilized behavior. Additionally, fostering social oversight and encouraging public participation in tourism environmental management is crucial.

5. Conclusion

As ecological protection awareness intensifies and tourism modernization progresses, the level of tourism development in our country has been steadily escalating. Policies pertaining to tourism ecological protection have played a pivotal role in safeguarding this development over time. However, disparities in tourism sustainability status across different levels and external developmental environments necessitate varied evaluations of tourism-related secondary indicator policy sets. Sustainable ecotourism protection constitutes a multifaceted, systematic endeavor encompassing economic, political, and social dimensions. Specific tourism policies address diverse issues, ranging from optimizing spatial layouts to reserving ample space for tourism development, enhancing tourism quality, and fostering ecological governance. These policies vary in their themes, priorities, innovations, and implementation strategies, with some focusing on micro-level execution while others offering macro-level guidance. Furthermore, as socio-economic advancements unfold, the concepts, technologies, and methodologies of ecotourism continue to evolve. Dali City, for instance, employs policies as pilot directives, subjecting them to real-world tests before revising and implementing them citywide. The coherence and integrity of policy texts significantly impact the achievement of policy objectives (Hu et al., 2020).To evaluate sustainable eco-tourism policies in Dali City, we constructed an evaluation index system and selected 16 representative central and local policies related to ecological environment protection since 2016. These policies were quantitatively assessed using the PMC index. Subsequently, we proposed a targeted optimization pathway for the ecological and facility environments in Dali Shuanglang Town, drawing upon existing tourism environmental capacity indicators and the town's tourism status quo and policy characteristics. This provides valuable insights for refining existing policies and formulating new ones.

Our findings reveal that Dali City's overall sustainable ecotourism policy design is relatively scientific and rational, contributing significantly to the integrated management of tourism development and ecological protection. Of the 16 policies evaluated, ten were rated "good," two "perfect," and four "adequate," with an average PMC index of 6.176, indicating the Dali government's strong commitment to sustainable ecotourism. However, there is room for improvement in Dali City's ecological and facility environment governance and implementation policies. Specifically, Shuanglang Town's estimated ecological and facility environment capacities (12,904 and 16,708 people/day, respectively) fall short of their corresponding index values. The PMC index rankings for these two policy sets are low, with scores of 5.638 and 5.440, respectively. Micro-level analysis of secondary policy indicators reveals that X3 (policy timeliness), X4 (policy areas), X6 (policy objects), and X7 (policy incentives and constraints) have values below 0.5 and low scores, indicating a need for policy design enhancements. Firstly, there is an imbalance in the combination of policy tools for China's ecological and facility environments, with inadequate coverage of policy priorities. Achieving a favorable ecological environment and well-equipped facilities necessitates the scientific selection and efficient utilization of policy tools. However, issues such as overreliance on administrative orders in ecological environment policies and mismatches between construction and management policies in facility environments persist. Secondly, the policy perspectives for China's ecological and facility environments are relatively simplistic, necessitating further refinement of relevant programs and planning. The PMC index model and text analysis reveal a high proportion of mandatory administrative order policy tools in ecological and environmental policies, with insufficient economic incentives and technological innovation policy tools. In facility environments, emphasis is often placed on short-term construction, neglecting effective policy support for long-term maintenance and renewal. These issues are not confined to specific policies but represent "pain points" that must be addressed in policymaking for these domains.

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