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The Economic Value of Coral Reefs: The Case Study of Mu Ko Chang National Park, Trat Province, Thailand

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ABSTRACT

The past decade has witnessed a substantial rise in ecotourism, providing a major economic boost to many developing countries, including Thailand's second-largest island, Ko Chang in Trat Province. Protected areas like Mu Ko Chang National Park face critical challenges in reconciling economic development with conservation. This paper contributes to understanding the role of economic analysis in protected area management by estimating the recreational benefit (consumer surplus) of the coral reefs in Mu Ko Chang, Trat province, using the Individual Travel Cost Method (ITCM). Data were collected via direct interviews with 592 visitors. The results indicate that the recreational services of the park generate an estimated annual consumer surplus of 2,025.92 million Baht (USD 61.73 million), of which international visitors account for the largest share (1,298.13 million Baht). The present recreational value over 30 years is calculated to be 25,139.48 million Baht (USD 794.75 million) (using a 7% discount rate). Crucially, demand analysis revealed distinct market behaviors: Domestic demand aligns with a normal good and is inelastic to price, while international demand is negatively income elastic (indicating substitution as wealth rises) but strongly and positively driven by educational attainment. The findings demonstrate the substantial economic importance of coral reef ecosystems and support the implementation of a tiered entrance fee system and conservation funding mechanisms to enhance sustainable tourism management and long-term marine ecosystem conservation.

Keywords: individual travel cost method, coral reefs, consumer surplus, Mu Ko Chang, Thailand

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Background and Significance of the Research Problem

Thailand has a long coastline of approximately 3,219 km and large area of exclusive economic zone (EEZ) of approximately 320,000 sq.km. (Bradford and Herrmann, 2021; Chariyaphan, 2012; Gibbons et al., 2014). The major coastal resources of Thailand are marine resources, coral reefs, mangrove, and grass beds. These coastal and marine resources are rich diversity, providing ecosystem services and benefits for the people and the economy.

However, in the recent past these resources are threaten. In 2021, Department of Marine and Coastal Resources (DMCR) reported that coral reefs in the Andaman Sea were 54.8 % in good condition, 26.3 % moderately intact, and 18.9 % damaged. Closely, on the Gulf of Thailand side, the coral reefs were 49.7 % in good condition, 21.3 % moderately intact, and 29.0 % damaged (Department of Marine and Coastal Resources, 2022). Provinces with coral reef areas in good condition included Surat Thani Province, which was the healthiest, followed by Phang Nga Province. Contrary, Trat Province had the highest number of damaged coral reef areas. Overall, the coral reefs in the Andaman Sea are in better condition compared to those in the Gulf of Thailand.

Table 1 Status of Coral Reefs in Thailand, Year 2021

Province	Coral Reef Area (Rai)	Reefs at Risk (%)		
		Low	Medium	High
Eastern				
Trat	17,757.00	7.00	3.70	89.30
Chanthaburi	766.00	55.22	42.69	2.09
Rayong	3,151.00	25.20	55.82	18.98
Chonburi	6,478.00	74.81	6.38	18.82
Southern				
Prachuap Khiri Khan	1,421.00	87.19	3.17	9.64
Chumphon	9,143.00	93.00	7.00	0.00
Surat Thani	35,982.00	56.20	33.10	10.70
Nakhon Si Thammarat	412.00	39.56	15.78	44.66
Songkhla	167.00	41.92	36.53	21.56
Pattani	108.00	0.00	100.00	0.00
Narathiwat	41.00	0.00	100.00	0.00
Ranong	2,828.00	16.20	54.99	28.82
Phangnga	26,691.00	47.20	22.80	30.00
Phuket	13,757.00	42.36	40.99	16.65
Krabi	14,039.00	59.93	28.00	12.07
Trang	3,015.00	80.30	14.69	5.01
Satun	13,426.00	79.99	12.82	7.19
Total area	**149,182.00**	**78,687.08**	**35,966.63**	**36,128.29**
(%)		**(52.75)**	**(24.11)**	**(24.22)**

Source: Department of Marine and Coastal Resources (DMCR), 2022.

Table 1 shows that high-risk reefs generally experience severe ecological degradation, including coral bleaching, biodiversity loss, and reduced ecosystem resilience, which can diminish tourism attractiveness and ecosystem services. Medium-risk reefs exhibit moderate ecological stress, while low-risk reefs maintain healthier coral cover and stronger ecological resilience. Interestingly, in eastern Thailand—particularly in Trat Province—approximately 90% of coral reefs in this area are classified as high risk. Human activity impacts coral reefs in both direct and indirect ways, highlighting the extreme sensitivity of these environments (Roman et al., 2004). Notably, global climate change and its associated environmental alterations are significant drivers of coral reef degradation. While these initiatives promote industrial expansion, infrastructure development, and foreign investment, they also intensify pressures on marine and coastal ecosystems. Increased coastal modification, pollution, and resource exploitation associated with these developments have contributed to the degradation of marine environments and pose serious threats to coral reef ecosystems, particularly in Mu Ko Chang, Trat Province (Chamchoy et al., 2018). Ko Chang Island, located in Trat Province in the eastern Gulf of Thailand, is the second-largest island in Thailand (Englong et al., 2019; Thai National Parks, 2024) and was designated as a national park in 1982 (Department of National Parks Wildlife and Plant Conservation, 2025). Mu Ko Chang is provided with abundant coastal and marine resources (Thai National Parks, 2024), including (1) scenic island landscapes and largely pristine shorelines; (2) diverse marine ecosystems, such as coral reefs, mangrove forests, and seagrass beds; (3) exceptional opportunities for snorkeling and diving; and (4) the active involvement of small-scale fishers in local conservation efforts (Al Ismaili et al., 2024).

Figure 1 Geographical Location of Mu Ko Chang

Source: Google, 2024.

The island is a popular destination for both domestic and international tourists. According to the Department of National Parks, Wildlife and Plant Conservation (2025) as shown in Table 2, tourist arrivals increased significantly during the post–COVID-19 period from 2021 to 2025.

Table 2 Number of Visitors in Mu Ko Chang During 2021-2025

Fiscal Year	Thai	Foreign	Total
2021	86,408	6,537	92,945
2022	122,081	20,471	142,552
2023	105,856	68,881	174,737
2024	90,350	92,219	182,569
2025	99,457	115,985	215,442

Source: Department of National Parks Wildlife and Plant Conservation, 2025.

By the expansion of tourism sector, a thriving tourism industry can significantly boost a province's economy by creating jobs, generating revenue, and attracting foreign investment however, increased tourism can strain natural resources and infrastructure. Popular destinations may become overcrowded, leading to pollution, puts a strain on coral reefs. Activities like careless boat anchoring, touching coral, and excessive diving/snorkeling can damage the fragile coral structures (Tamayo et al., 2018; Van Beukering and Cesar, 2010).

Despite the ecological and economic importance of coral reef ecosystems in Mu Ko Chang National Park, empirical evidence regarding their recreational economic value remains limited. Existing marine ecosystem valuation studies in Thailand have predominantly focused on destinations in the Andaman Sea, while comparatively little attention has been given to coral reef ecosystems in the Eastern Gulf of Thailand. As a result, policymakers and park managers lack quantitative economic evidence to support conservation planning, tourism management, and sustainable financing strategies for Mu Ko Chang's marine ecosystems. This research gap is particularly important given the increasing tourism pressure and the high proportion of coral reefs in Trat Province classified as high risk. Therefore, there is need to adopt an economic tool which can enable the development of more inclusive strategies in decision-making for the management of critical ecosystems such as coral reefs (Fonner et al., 2020; Owuor et al., 2019). This paper uses economic modeling to estimate the value of coral reefs in Mu Ko Chang, serving as a management framework for protecting critical marine environments.

Research Objective

This study estimates the recreational value of coral reef ecosystems in Mu Ko Chang, Thailand, using the Travel Cost Method (TCM) to address a lack of empirical data for the region. By quantifying consumer surplus within the Total Economic Value (TEV) framework, the research will provide a basis for informed coastal management and the design of sustainable public financing strategies to mitigate anthropogenic pressures.

Scope of Research

The scope of this research is strictly focused on the economic valuation of recreational demand for Mu Ko Chang National Park using the Individual Travel Cost Method (ITCM). The study boundaries include domestic and international visitors surveyed between March and October 2025. Data were collected through on-site face-to-face interviews conducted at major tourism and marine recreation areas within Mu Ko Chang National Park, including popular snorkeling, diving, and beach destinations. To reduce temporal bias, surveys were administered across both weekdays and weekends throughout the study period. Spatially, the research centers on the recreational use of coral reef zones within the park's jurisdiction. Methodologically, the analysis is confined to revealed preference data, utilizing travel expenditures and trip frequency as proxies for the site's economic value. The scope specifically aims to calculate the consumer surplus per visit, providing a direct measure of the park's recreational value to inform tourism fee structures and site management.

Literature Reviews

Marine ecosystems such as coral reefs, seagrass beds, and mangrove forests provide important ecosystem services, including fisheries production, coastal protection, biodiversity conservation, carbon sequestration, and recreation (Hoegh-Guldberg et al., 2017; IPBES, 2019; Millennium Ecosystem Assessment, 2005). Among these services, tourism and recreation generate significant economic benefits for coastal economies, particularly in marine protected areas.

Economic valuation is widely used to estimate the benefits derived from environmental resources that are not traded in markets. Within the Total Economic Value (TEV) framework, recreational benefits are classified as direct use values (Bateman et al., 2002). One of the most commonly applied methods for estimating recreational use value is the Travel Cost Method (TCM).

The Travel Cost Method (TCM) is a revealed preference approach that estimates recreational value based on visitors' travel expenditures and visitation behavior (Clawson & Knetsch, 1966). The method assumes that travel costs represent the implicit price of accessing recreational sites. By estimating the relationship between visitation rates and travel costs, TCM can derive recreational demand functions and consumer surplus (Freeman et al., 2014).

TCM has been extensively applied to marine and coastal tourism studies. Zambrano-Monserrate et al. (2018) estimated the recreational value of a coastal recreation area in Ecuador at approximately USD 16.95 per visitor per trip using the Individual Travel Cost Method (ITCM). In Thailand, Seenprachawong (2016) estimated that coral reef tourism in the Phi Phi Islands generated recreational benefits of approximately 8.2 billion Baht annually, while Piriyapada and Wang (2015) found that visitors to Mu Ko Chang National Park exhibited a positive willingness to pay for beach conservation. These findings demonstrate the substantial economic contribution of marine tourism and the importance of ecosystem quality in supporting recreational demand. These findings demonstrate the substantial economic contribution of marine tourism and the importance of ecosystem quality in supporting recreational demand.

Recent studies further indicate that environmental degradation can significantly reduce tourism benefits. Fezzi et al. (2023) estimated that coral bleaching in Hawaii resulted in annual recreational losses of approximately USD 25 million, highlighting the economic importance of coral reef conservation.

Despite its strengths, TCM is limited to estimating recreational use values and cannot capture non-use values associated with ecosystem conservation (Bateman et al., 2002). In Thailand, studies applying TCM to marine protected areas remain limited, particularly in Mu Ko Chang National Park. Therefore, this study applies the Individual Travel Cost Method to estimate the recreational value of marine ecosystem services in Mu Ko Chang National Park and provide evidence to support sustainable tourism and conservation policy.

Research Methodology

This study utilized Travel Cost Method (TCM) to estimate value recreational uses of the Mu Ko Chang, Trat province. Travel cost model is a revealed preference approach that estimates recreational demand based on observed visitation behavior, where travel expenditures and travel time are treated as the implicit price of site access (Clawson and Knetsch, 1966; Freeman et al., 2014). The recreational demand function is specified:

$$V_i = f\left(TC_i, Y_i, S_i, Z_i\right) \quad (1)$$

Where V_i denotes the number of visits made per year by individual i ; TC_i represents travel cost, Y_i is income, S_i refer to socio-economic characteristics, and Z_i includes trip-related variables.

This study employs a double-log specification because it allows coefficients to be interpreted as elasticities, linearizes multiplicative relationships, and helps mitigate heteroskedasticity commonly found in travel cost data (Wooldridge, 2016). The empirical model is specified as:

$$\ln V_i = \beta_0 + \beta_1 \ln TC_i + \beta_2 \ln Y_i + \gamma \ln S_i + \delta \ln Z_i + \varepsilon_i \quad (2)$$

Where ε_i is the error term. The model is estimated using Ordinary Least Squares (OLS) with heteroskedasticity-robust standard errors.

Primary data were collected through face-to-face interviews with 592 visitors at Mu Ko Chang National Park during 2024 using a structured questionnaire. The survey collected information on visitation frequency, travel expenditures, travel characteristics, and socio-economic profiles. Incomplete questionnaires were excluded during data verification and screening.

For an individual i, the consumer surplus (CS) is the integral of the demand function V with respect to the price P between the lower bound P_{li} and the choke price or the upper bound P_{ui} . The choke price is the price at which demand equals zero. The indefinite integral of the demand function is:

$$\int vdp = e^{\alpha_0 + \sum_{c=1}^{l} \alpha_c D_{ci}} \cdot \prod^{k} X_j^{\beta_j} \cdot \frac{P^{b+1}}{b+1} \quad (3)$$

The integral between P_l and P_u is:

$$CS = \frac{e^{\alpha_0 + \sum_{c=1}^{l} \alpha_c D_{ci}}}{b+1} \cdot \prod^{k} X_j^{\beta_j} \cdot (p_u^{b+1} - p_l^{b+1}) \quad (4)$$

For each of individual the consumer surplus is computed by plugging into the above general formula the values for each individual dummy variable D_{ci} , the travel cost P_{li} , the choke price P_{ui} , and the value of the explanatory variables X_{ji} :

$$CS_i = \frac{e^{\alpha_0 + \sum_{c=1}^{l} \alpha_c D_{ci}}}{b+1} \cdot \prod^{k} X_j^{\beta_j} \cdot (p_{ui}^{b+1} - p_{li}^{b+1}) \quad (5)$$

The recreational demand curve was integrated between the observed travel cost and the choke price, where predicted visitation approaches zero. Following standard practice, the choke price was approximated using the 99^{th} percentile of the travel cost distribution. Sensitivity analysis was also conducted using the 95^{th} percentile and maximum observed travel cost to test the robustness of welfare estimates.

The annual consumer surplus per individual can be computed by summing up the consumer surplus estimates from all observed consumers (N) and dividing by N:

$$\text{CS per individual} = \frac{1}{N}\sum_{i=1}^{N} CS_i \qquad (6)$$

The annual consumer surplus per visit is calculated by dividing the annual consumer surplus per individual by the annual sample average number of visits:

$$\text{CS per visit} = \frac{\text{CS per individual}}{\text{Sample average visits per year}} \qquad (7)$$

The CS per visit is then multiplied by the total number of visitors to Mu Ko Chang during the year to obtain the annual total recreational value of Mu Ko Chang.

$$\text{Total recreational value (TR)=CS per visit} \times \text{Total visitors} \qquad (8)$$

The impact of losing the site extends far beyond the immediate loss of recreational opportunities. It's a long-term loss with lasting consequences, so the total future value of annual recreational values must be included. Assuming that the annual value of recreation is constant over time, the present value of the stream of future benefits can be calculated simply by the following formula:

$$PV = \sum_{t=1}^{T} \frac{TR}{(1+r)^t} \qquad (9)$$

Results

1. Socio-Demographic Characteristics

Between March and October 2025, 592 observations were collected, consisting of 330 domestic and 262 international visitors. Domestic tourism was predominantly regional, with 54.5% of visitors originating from the Eastern region (Chanthaburi, Rayong, Chonburi, and Trat), followed by Bangkok (14.5%), and the Central/Northeastern regions (10.9%). The residual groups consisted of visitors from the Northern (3.6%), Southern (3.0%), and Western (2.4%) regions. Regarding international arrivals, Europe constituted the largest market at 65.6%, followed by Asia (13.0%), the Americas (12.2%), and Australia (9.2%).

By observes about activities which visitors planned to do during stay at the site (Table 3) for clear understanding of behavioral intentions and preference structures of different visitor segments. The result found that coral reef snorkeling and diving emerged as the primary planned activities for both domestic (52.7%) and international (58.0%) visitors to Mu Ko Chang, highlighting the central role of marine resources in attracting tourism. However, notable differences are evident in secondary activity preferences. Domestic visitors demonstrated a significantly higher interest in general beach activities (21.2%) and fishing (15.8%). In contrast, international visitors showed greater planned participation in birdwatching and nature-based exploration (16.0%), indicating a stronger orientation toward ecotourism within this segment. The minimal interest in activities such as hiking and trekking and visits to local villages across both groups suggests potential opportunities for tourism product diversification and targeted promotional strategies.

Table 3 First 3 Planned Activities at Mu Ko Chang: A Comparison of Domestic and International Visitors

Activity	Domestic		Activity	International	
	Visitor(s)	%		Visitor(s)	%
Coral reef snorkeling/diving	174	52.7	Coral reef snorkeling/diving	152	58.0
Beach activities (e.g. swimming, kayaking)	70	21.2	Birdwatching and exploring nature	42	16.0
Fishing	52	15.8	Beach activities (e.g. swimming, kayaking)	24	9.2

Estimation of Benefits Based on the Individual Travel Cost Method

Next, the analysis examines travel expenditures and opportunity costs incurred by visitors as proxies for their willingness to pay for recreational experiences at Mu Ko Chang National Park. The following section presents the variables incorporated into the ITCM model, reports the estimated demand parameters, and derives consumer surplus estimates for both domestic and international visitor groups. Table 4 summarizes the variables used in the Travel Cost Model and their definitions. It should be noted that the occupational dummy variable (OCCU) was defined differently for domestic and international samples in order to reflect differences in employment structures and respondent characteristics between the two groups. In addition, income for international respondents was recorded in U.S. dollars, following respondents' original reporting, whereas travel expenditures (TRAV) were measured in Thai Baht because most tourism-related expenditures occurred within Thailand.

Table 4 Definition of Variables Used in Travel Cost Modeling and Consumer Surplus Calculations

Variable	Definition
REGI	Binary variable equal to 1 if the respondent resides in the Bangkok metropolitan region (domestic sample) or Europe (international sample), and 0 otherwise
TRAV	Round-trip travel expenditure incurred by the respondent
INCO	Respondent's self-reported monthly income, measured in Thai Baht for the domestic sample and in U.S. dollars for the international sample
NUMV	Number of visits made by the respondent per year
1SITE	Binary variable equal to 1 if the respondent traveled directly to Mu Ko Chang as a single-destination trip, and 0 if the trip involved multiple destinations
GEND	Binary variable equal to 1 if the respondent is male and 0 if female
SINGL	Binary variable equal to 1 if the respondent is single and 0 otherwise
AGE	Age of the respondent, measured in years
OCCU	Binary occupational indicator: for the domestic sample, equals 1 if the respondent is a business owner and 0 otherwise; for the international sample, equals 1 if the respondent is a student and 0 otherwise
NUFA	Household size of the respondent
NUMED	Total number of years of formal education completed by the respondent
MEMB	Binary variable equal to 1 if the respondent is a member of an environmental organization and 0 otherwise
OWNS	Binary variable equal to 1 if the respondent owns a residence and 0 otherwise

Table 5 shows the descriptive statistics of all variables used in modeling demand for Mu Ko Chang National Park, summarizes the mean, standard deviation (Std. Error), and range for each variable, providing foundational insight into the characteristics of both the domestic (n=330) and international (n=262) visitor samples. Generally, international visitors have higher round-trip travel expenditures and generate greater per-visit economic contributions than domestic visitors, while domestic visitors report slightly higher visitation frequency. The average age of visitors is quite similar across groups, with both group by middle-aged individuals. International visitors exhibit higher educational attainment and a greater proportion of male respondents, whereas domestic visitors tend to have larger household sizes and higher rates of property ownership. Single-site travel is more prevalent among domestic visitors, and membership in environmental organizations remains relatively low for both groups. Overall, the descriptive statistics highlight notable socioeconomic and behavioral differences between domestic and international visitors, underscoring the importance of segment-specific analysis in recreational demand modeling.

Table 5 Descriptive Statistics of Model Variables

Variable	Domestic Visitors (n=330)				International Visitors (n=262)			
	Min	Max	Mean	Std. Error	Min	Max	Mean	Std. Error
REGI	1.00	7.00	3.64	1.55	1.00	4	1.66	1.0191
TRAV	100	20,000	2,926.67	2,786.28	200	40,000	4,701.15	5,571.23
NUMV	1.00	14.0	2.47	2.13	1.00	10.00	1.98	1.3101
1SITE	0.00	1.00	0.23	0.42	0.00	1.00	0.12	0.3281
GEND	0.00	1.00	0.32	0.46	0.00	1.00	0.60	0.4918
SINGL	0.00	1.00	0.56	0.55	0.00	1.00	0.59	0.68
AGE	19	67	38.40	10.37	21	70	39.64	12.40
OCCU	0.00	1.00	0.11	0.39	0.00	1.00	0.09	0.28
NUFA	2.00	9.00	3.67	1.67	2.00	5.00	2.69	1.26
NUMED	6	22	15.92	2.04	12	22	16.17	1.81
INCO	5,000	300,000	40,293.94	27,255.35	500	8,000	3,678.44	1,554.49
MEMB	0	1	0.03	0.26	0.00	1.00	0.12	0.33
OWNS	0.00	1.00	0.88	0.32				

Following the descriptive statistics and variable characteristics, the model was estimated. Table 6 presents the estimation results, where the Log of Number of Visits (LNNUMV) is used as the dependent variable.

Table 6 ITCM Estimation of All Variables

Independent Variable	Dependent Variable: LNNUMV			
	Domestic n=330		International n=262	
	Coefficient	t-Stat	Coefficient	t-Stat
Constant	4.6079	(4.8564)***	-2.1918	(-2.0763)**
REGI	0.7333	(4.2894)**	0.0624	(0.5428)
LNTRAV	-0.1896	(-2.9779)***	-0.1355	(-2.3622)**
LNINCO	0.1074	(1.7890)*	-0.0864	(-1.0875)
1SITE	-0.2941	(-3.6887)***	-0.0402	(-0.3924)
GEND	0.0522	(0.7860)	-0.0278	(-0.4096)
SINGL	-0.0946	(-1.2030)	-0.0432	(-0.5555)
LNAGE	-0.2649	(-1.7640)*	0.2046	(1.5729)
OCCU	0.2609	(3.4518)***	0.3503	(2.6502)***
NUFA	-0.1502	(-2.3230)***	0.1895	(2.3282)***
LNNUMED	-0.4312	(-2.0173)**	1.0541	(3.3892)***
MEMB	0.1285	(1.0264)	-0.1648	(-1.6261)
OWNS	0.2366	(2.1827)**		
R^2	0.4225		0.1744	
Adjusted R^2	0.3910		0.1310	
F	13.4266		4.0140	

Note: *** significant at 0.01, ** significant at 0.05, * significant at 0.10

Table 6 presents the estimation results for two separate models: one for domestic visitors and one for international visitors. In both models, the dependent variable, Number of Visits, was

transformed using the natural logarithm (LNNUMV). Explanatory variables that were numeric—including round-trip travel expenditure (LNTRAV), respondent's income (LNINCO), respondent' age (LNAGE), and years of education (LNNUMED)—were also transformed using the natural logarithm; all other variables were maintained in their original scale.

Model 1: Determinants of Domestic Visitor Demand (LNNUMV)

The domestic visitor model for Mu Ko Chang National Park indicates that eleven variables have a statistically significant influence on visitation demand. The model produced an R^2value of 0.4225, indicating that approximately 42.25% of the variation in visitation behavior is explained by the independent variables included in the regression model. The adjusted R^2 value of 0.3910 further suggests that the model retains a moderate explanatory power after accounting for the number of predictors included in the estimation.

The results are generally consistent with economic theory. Travel cost (LNTRAV) and single-site itineraries (1SITE) are negatively associated with visitation demand, whereas income (LNINCO) and visitors with residential ownership (OWNS) exhibit positive and statistically significant effects. In addition, socio-demographic factors, including age, educational attainment, and region of residence (REGI), significantly influence visitation behavior, highlighting the multidimensional determinants of domestic tourism demand for Mu Ko Chang National Park.

Model 2: Determinants of International Visitor Demand (LNNUMV)

The second model, which focuses on international visitors to Mu Ko Chang National Park, indicates that travel cost (LNTRAV) has a statistically significant negative relationship with visitation demand, consistent with the Law of Demand. International visitation model produced an R^2 value of 0.1744 and an adjusted R^2 value of 0.1310, indicating relatively lower explanatory power and greater heterogeneity in international visitor behavior. In addition, student status (OCCU), educational attainment (LNNUMED), and smaller travel party size (NUFA) are found to significantly influence visitation demand. These findings suggest that international visitation is primarily associated with highly educated individuals and smaller travel groups, particularly students traveling during academic breaks.

To obtain consistent estimates of the model parameters, particularly the price elasticity of demand, a log-linear estimation approach is employed to estimate the recreational demand function. The re-estimated models used to derive the demand functions for visits to the recreational site are presented in Table 7 for domestic visitors and Table 8 for international visitors. Insignificant variables that did not improve model performance were excluded from the final specification to obtain a more parsimonious model.

Table 7 ITCM Re-Estimation of Double-Log Demand Function for Domestic Visitors

Dependent Variable: LNNUMV Domestic: n=330, R^2=40.91, F=13.5465

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	2.44272	0.899134	2.716747	0.0069
LNINC	0.296526	0.110313	2.688038	0.0076
LNTRA	-0.737896	0.217765	-3.388495	0.0008
LNAGE	0.2232	0.084004	2.657007	0.0083
1SITE	-0.330092	0.083435	-3.956258	0.0001

Table 7 presents the re-estimated parameters for the demand function of domestic visitors. The results from the final demand estimation for domestic visitors reveal that the demand for Mu Ko Chang is price inelastic (coefficient of LNTRA =--0.7379), suggesting that moderate price increases will not severely reduce visit numbers. Visits are confirmed to be a normal good (LNINC or income elasticity= 0.2965). The model highlights that the highest frequency of visits comes from older visitors and multi-destination travelers, pointing to the need to promote Ko Chang as part of broader regional travel packages. The results provide consistent estimates affirming that economic factors (price and income) are statistically significant determinants of domestic visitor demand for Ko Chang. The estimated demand is found to be inelastic with respect to both travel cost and income, indicating that changes in these variables lead to proportionally smaller changes in visitation demand. This inelastic response suggests that visitors' decisions to travel to Mu Ko Chang are relatively insensitive to moderate variations in travel expenses and income levels.

Table 8 ITCM Re-Estimation of Double-Log Demand Function for International Visitors

Dependent Variable: LNNUMV International: n=262, R^2=14.39, F=7.1180

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-4.730606	1.179288	-4.011407	0.0001
LNINC	-0.21617	0.068945	-3.135397	0.0019
LNNUMED	1.686935	0.316191	5.335175	0.0000
LNAGE	0.354438	0.130143	2.723458	0.0069
LNTRA	-0.112312	0.042497	-2.642847	0.0087

Table 8 presents the consistent estimates for the demand function of international visitors. This analysis focuses on key demographic and economic factors influencing the frequency of international visits (LNNUMV) to Mu Ko Chang.

The result found that visitation demand among international visitors to Mu Ko Chang is strongly influenced by educational attainment (elasticity = 1.6869) and age (age elasticity = 0.3544), suggesting a higher propensity to visit among more highly educated and older individuals, and indicating potential loyalty within these visitor segments. The results from the final demand estimation for international visitors reveal that the demand for Mu Ko Chang is price inelastic (coefficient of LNTRA= –0.1123), suggesting that moderate price increases will not severely reduce visit numbers. The finding of negative income elasticity (coefficient of LNINC= –0.21617) suggests that, as visitor income increases, there is a greater propensity for substitution toward higher-priced or more exclusive destinations, implying that Mu Ko Chang may currently function as a relatively budget-friendly or middle-market marine tourism destination for international visitors. This finding is consistent with tourism demand theory and recreational valuation studies suggesting that higher-income travelers may substitute toward premium tourism destinations as income rises (Freeman et al., 2014; Menegaki et al., 2020).

Consumer Surplus Estimation Methodology

The annual consumer surplus (CS) was calculated for each observation using the estimated double-log demand function. The choke price, defined as the upper bound of integration, was set at the 99th percentile of observed round-trip transportation costs. This threshold was set at 15,000 Baht (USD 457.07) for domestic visitors and 21,850 Baht (USD 665.79) for international visitors. The annual consumer surplus per individual was subsequently calculated using Equation (5). The estimated values amount to 9,740.02 baht (USD 296.79) for domestic visitors and 21,905.78 baht (USD 667.49) for international visitors. To derive consumer surplus per visit, the estimated annual consumer surplus values were normalized by the respective average annual visit frequencies. The mean visit frequency was 2.47 visits per year for domestic visitors and 1.98 visits per year for international visitors. This adjustment yields an estimated consumer surplus per visit of 3,948.66 baht (USD 120.32) for domestic visitors and 11,037.14 baht (USD 336.31) for international visitors.

The total annual recreational benefits of Mu Ko Chang National Park were estimated at approximately 727.79 million baht (USD 22.15 million) for domestic visitors and 1,298.13 million baht (USD 39.55 million) for international visitors. These estimates are based on 2023 visitation levels, with a total of 105,856 domestic visitors and 68,881 international visitors to Mu Ko Chang

National Park. When combined, these estimates yield a total annual recreational benefit of approximately 2,025.92 million baht (USD 61.73 million) for Mu Ko Chang National Park. Assuming that the real annual recreational value of Mu Ko Chang National Park—estimated at 2,025.92 million baht (USD 61.73 million)—remains constant over a 30-year period, and applying a social discount rate of 7% (Halaburka et al., 2013; Office of the National Economic and Social Development Council, 2024), the present value of recreational benefits is estimated at 25,139.48 million baht (USD 794.75 million).

Discussion

This study utilized the Individual Travel Cost Method (ITCM), and the results confirm that travel cost is a significant determinant of visitation demand, consistent with the expected downward-sloping demand curve, coinciding with the results of Fezzi et al. (2023); Zambrano-Monserrate et al. (2018). However, the price inelasticity observed in both visitor groups suggests that moderate increases in fees are unlikely to substantially reduce visitation, reflecting the high recreational value of Mu Ko Chang National Park.

The findings also reveal distinct behavioral patterns between domestic and international visitors. Domestic demand is primarily influenced by regional proximity, home ownership, and income, indicating localized and repeat visitation behavior. In contrast, international demand is strongly influenced by educational attainment and age. The high elasticity associated with education suggests that Mu Ko Chang attracts highly educated and environmentally conscious visitors who value marine ecosystem experiences.

The negative income elasticity among international visitors further suggests that Mu Ko Chang may function as a relatively lower-cost substitute destination within the international marine tourism market. As income rises, higher-income tourists may increasingly shift toward more exclusive destinations with superior environmental quality and tourism infrastructure. Consequently, continued coral reef degradation could reduce the park's competitiveness and increase dependence on lower-budget tourism segments.

Economically, international visitors generate substantially higher consumer surplus than domestic visitors, reflecting stronger preferences for marine recreational activities such as diving and snorkeling. From a policy perspective, the relatively high consumer surplus and inelastic demand support the implementation of conservation levies or differentiated pricing strategies, particularly for international tourists. However, maintaining coral reef quality remains essential for sustaining the park's long-term economic value and attractiveness.

Suggestions

Application

The findings from this study indicate that visitors to Mu Ko Chang National Park derive substantial benefits from coral reefs and exhibit a positive willingness to pay (WTP) for improvements in coral reefs quality. While the current entrance fee system generates revenue for general park management, it is not explicitly linked to marine ecosystem conservation outcomes. Therefore, this study proposes a complementary voluntary conservation contribution mechanism alongside the existing fee structure. Conservation fees could be implemented through digital ticketing systems, online booking platforms, or partnerships with local dive and tour operators. Following Bateman et al. (2002) and Freeman et al. (2014), revenue from these fees should be transparently earmarked for reef restoration and waste management to ensure public legitimacy.

Given the economic heterogeneity between segments, a tiered fee structure is recommended (Piriyapada and Wang, 2015). International visitors, who generate substantially higher consumer surplus and exhibit greater willingness to pay, may be charged higher conservation fees, while maintaining affordable access for domestic visitors. Given the relatively inelastic demand observed in both visitor segments, such measures are unlikely to substantially reduce visitation.

Ecosystem-Based Management: As snorkeling and diving are the primary demand drivers, management must prioritize coral reef protection through zoning and capacity controls (Roman et al., 2004; Seenprachawong, 2016). Simultaneously, the park should pursue tourism product diversification-promoting land-based activities-to alleviate pressure on sensitive marine ecosystems and distribute economic benefits to local communities.

The influence of education and age on demand indicates a market of environmentally aware tourists. Marketing should therefore emphasize ecological value over price. Ultimately, the high present value amounting to 25,139.48 million Baht over a 30-year period at a 7% discount rate of these recreational benefits confirms the park's status as a vital natural capital asset, which should be integrated into national budgeting and environmental impact assessments to ensure long-term conservation (Bateman et al., 2011).

Further Research

Future research could extend the present analysis by incorporating non-use values through stated preference methods, examining seasonal variations in visitation demand, or applying panel data techniques to assess changes in visitor behavior over time. Additionally, integrating ecological indicators with economic valuation would provide a more comprehensive assessment of sustainability outcomes.

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