Responsible tourist behaviour in Jashpur: A PLS-SEM and SHAP-based machine learning study of tribal ecotourism

Augustin Xaxa [1*]

[1] *Dr. C. V. Raman University, India*

**Corresponding author: xaxa.augustin@gmail.com*

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ABSTRACT

Sustainable ecotourism depends on responsible visitor behaviour, particularly in emerging destinations where regulation, interpretation, and visitor-management systems remain limited. The purpose of this study is to explain and predict responsible tourist behaviour among 425 tourists in Jashpur, an emerging tribal ecotourism destination in central India. Grounded in the Value-Attitude-Behavior (VAB) framework, the study applies Partial Least Squares Structural Equation Modelling (PLS-SEM), mediation analysis, and Importance-Performance Map Analysis (IPMA) to examine relationships among perceived value, tourist satisfaction, ecotourism intention, and responsible tourist behaviour. Machine-learning models and SHAP explainability are then used to assess predictive performance and rank behavioural and demographic predictors. PLS-SEM shows that ecotourism intention is the strongest direct predictor of responsible tourist behaviour, followed by perceived value, while tourist satisfaction has a weaker effect. The intention-mediated pathway is also stronger than the satisfaction-mediated pathway. Ridge Regression performs best, explaining 64.5% of responsible tourist behaviour variance, while SHAP independently identifies ecotourism intention and perceived value as the leading predictors. The findings identify intention-building and value-enhancing interventions as priorities for sustainable tribal ecotourism management.

1. INTRODUCTION

Ecotourism has emerged as a response to concerns that conventional mass tourism places increasing pressure on fragile ecological systems and local cultures, combining conservation, community participation, and interpretation to make tourist behaviour central to sustainability outcomes (Pham & Khanh, 2021; The International Ecotourism Society, 2015; Wondirad, 2019). In India, ecotourism is increasingly promoted as both a conservation strategy and a tool for regional development in biodiverse, culturally rich areas (Majeed et al., 2025; Singh et al., 2021). Yet the behavioural dimension of ecotourism remains underexplored in lesser-known destinations such as Jashpur District, Chhattisgarh, which possesses forests, waterfalls, and strong tribal-cultural appeal but limited formal tourism infrastructure,

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interpretation facilities, and visitor-management systems. In such settings, sustainability depends heavily on the choices tourists make while visiting, making the behavioural dimension of ecotourism at least as important as its infrastructural and regulatory dimensions (Indrianto et al., 2022).

This behavioural focus matters beyond Jashpur itself. Ecotourism is frequently positioned as a mechanism that can simultaneously fund conservation and generate livelihoods for host communities, but that dual promise only holds if visitors actually behave in ways that limit ecological and cultural damage; poorly managed visitor behaviour can erode the very resources on which conservation-linked tourism depends. Realising this promise typically depends on coordinated collaboration among government agencies, local communities, and private operators, since fragmented stakeholder involvement has been shown to weaken sustainable ecotourism outcomes even where ecological potential is high (Khusaini et al., 2024). Emerging, lightly regulated destinations such as Jashpur therefore represent a useful stress test for behavioural theory: because formal visitor-management systems are still developing, whatever drives responsible conduct here is more likely to reflect tourists' own psychological orientation than externally imposed rules, signage, or enforcement.

Although rules, signage, and interpretation centres can encourage sustainable conduct, they cannot substitute for tourists' conscious actions (Chiu et al., 2014; Han et al., 2018). The Value-Attitude-Behavior (VAB) framework proposes that values shape attitudes and, ultimately, behavioural outcomes (Homer & Kahle, 1988), and has been used in tourism research to explain environmentally responsible behaviour (Kiatkawsin & Han, 2017; Lee & Jan, 2019). Compared with attitude-centred models such as the Theory of Planned Behaviour, VAB places more explanatory weight on the value judgements that precede attitude formation, which makes it well suited to a setting like Jashpur where tourists' evaluation of what the destination is worth to them, rather than social norms or perceived control, is plausibly the more proximate driver of conduct. In this study, perceived value reflects tourists' evaluation of the benefits of the ecotourism experience relative to time, cost, and effort (Pandža Bajs, 2015; Zeithaml, 1988). Tourist satisfaction captures the affective response to the experience, consistent with evidence from hospitality and tourism settings that satisfaction is itself shaped by perceived value and experiential quality (Ali et al., 2023); and ecotourism intention reflects motivational readiness to act responsibly (Ajzen, 1991).

Prior research has produced mixed findings regarding whether satisfaction consistently translates into responsible behaviour and whether intentions are reliably enacted on-site (Kim et al., 2023), with an identified intention-behaviour gap linked to situational barriers and inadequate destination support (Poudel & Nyaupane, 2016; Wut et al., 2023). Earlier studies suggest perceived value can influence both satisfaction and intention, which in turn affect responsible behaviour (Duong et al., 2022; Lee et al., 2023; Oviedo-García et al., 2016),

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though the strength of these pathways may vary by destination context. Research on responsible tourist behaviour also remains concentrated in well-regulated settings such as national parks and developed destinations, leaving rural and tribal destinations with fragile environments comparatively underrepresented (Caber et al., 2020; K C et al., 2020), and there is limited integration of perceived value, satisfaction, intention, and responsible tourist behaviour within a single behavioural pathway in under-researched Indian ecotourism contexts (Huang et al., 2023; Majeed et al., 2025). Jashpur, with its ecological richness and limited formal infrastructure, provides a suitable context for addressing these gaps and for testing whether internal, psychological drivers can substitute for weak external regulatory cues (Regmi & Walter, 2017).

This gap has practical stakes as well as theoretical ones. Where visitor-management infrastructure is thin, destination authorities in India and comparable emerging markets often default to blanket restrictions or signage-heavy approaches transplanted from better-resourced national parks, without evidence on whether such measures actually move behaviour in a tribal, low-infrastructure context; policy analyses of tourism management in other under-resourced, multi-site destinations point to similar constraints around accessibility, coordination, and enforcement capacity (Andalecio, 2024). A study that identifies perceived value, satisfaction, and intention most strongly shapes conduct in a setting like Jashpur can help redirect limited resources toward interventions with the best evidential support.

The theoretical logic of the proposed model rests on two linked mechanisms within the VAB perspective. Perceived value represents the evaluative judgement that precedes downstream responses: when tourists perceive an ecotourism experience as worthwhile, meaningful, and consistent with environmental values, that evaluation can generate both an affective response (tourist satisfaction) and a motivational response (ecotourism intention) (Pandža Bajs, 2015; Zeithaml, 1988). These mechanisms are conceptually distinct. Satisfaction reflects a favourable evaluation of the completed experience, whereas intention is more proximal to subsequent responsible action and therefore may translate more directly into behaviour (Ajzen, 1991; Poudel & Nyaupane, 2016). Consistent with prior ecotourism research, perceived value may also retain a direct influence on responsible conduct while operating indirectly through satisfaction and intention (Duong et al., 2022; Oviedo-García et al., 2016). Infrastructure pathways therefore test whether responsible conduct in a low-

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infrastructure destination is driven more strongly by affective experience evaluation or by motivational commitment.

Grounded in the VAB framework, this study proposes that perceived value influences responsible tourist behaviour both directly and indirectly through ecotourism intention and tourist satisfaction (Figure 1):

H_1: Perceived value exerts a positive effect on ecotourism intention.

H_2: Perceived value exerts a positive effect on tourist satisfaction.

H_3: Ecotourism intention positively predicts responsible tourist behaviour.

H_4: Perceived value has a direct positive effect on responsible tourist behaviour.

H_5: Tourist satisfaction positively predicts responsible tourist behaviour.

H_6: Ecotourism intention mediates the relationship between perceived value and responsible tourist behaviour.

H_7: Tourist satisfaction mediates the relationship between perceived value and responsible tourist behaviour.

Most behavioural studies in ecotourism remain primarily explanatory in design; structural models such as PLS-SEM test hypothesised relationships but are less suited to identifying which variables contribute most strongly to prediction when behavioural and demographic variables are examined together. Growing interest in machine-learning applications for visitor profiling and destination decision support (López-Naranjo et al., 2025; Sancho Núñez et al., 2024; Schrader et al., 2025) motivates the use of Shapley Additive Explanations (SHAP), an explainable machine-learning technique that estimates each predictor's contribution to model output (Chen et al., 2025; Lundberg & Lee, 2017). Here, SHAP is used not as a substitute for theory testing but as a complementary predictive-explainability tool to examine whether the strongest predictors of responsible tourist behaviour align with the PLS-SEM results addressing:

RQ_1: Which behavioural and demographic variables most strongly predict responsible tourist behaviour when examined through machine-learning and SHAP-based explainability?

This study therefore examines how perceived value, tourist satisfaction, and ecotourism intention influence responsible tourist behaviour using PLS-SEM, mediation analysis, and IPMA, complemented by machine-learning prediction and SHAP-based explainability. It contributes empirical evidence from a tribal, under-researched ecotourism setting in India; combines explanatory modelling with predictive explainability, which remains rare in ecotourism behaviour research; and offers practical implications for improving responsible tourist behaviour in emerging ecotourism destinations by identifying both statistically significant behavioural pathways and the strongest predictive drivers of responsible conduct. Findings from Jashpur are also relevant to India's wider push to position community-based, nature-linked tourism as a livelihood strategy in biodiverse and tribal regions, where

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responsible visitor conduct directly affects both conservation outcomes and local economic benefit. More broadly, by pairing a confirmatory explanatory model with an independent predictive check, the study offers a template that other emerging, low-infrastructure destinations facing similar behavioural-management questions could adapt.

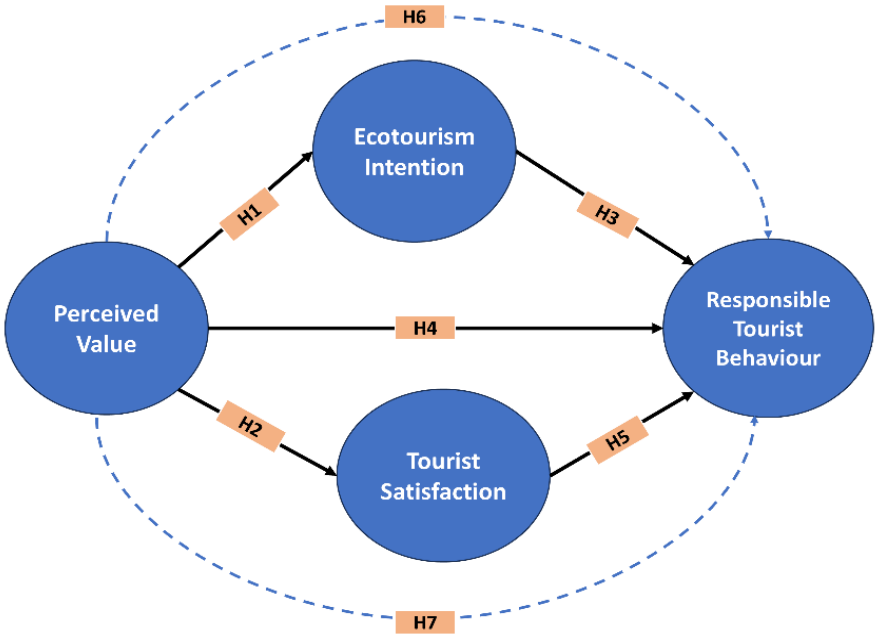


Figure 1. Conceptual Framework Based on the Value–Attitude–Behavior Model

2. METHODOLOGY

This study adopted a quantitative explanatory-predictive design combining PLS-SEM with machine-learning prediction. The explanatory stage, grounded in the VAB framework, was estimated to use PLS-SEM in SmartPLS 4.0, selected because the study involved multiple latent constructs, mediation paths, and an exploratory model in an under-researched setting (Ali et al., 2018; Hair et al., 2019). SmartPLS 4.0 was used to estimate the measurement model, structural model, direct and indirect effects, and IPMA. In the predictive stage, responsible tourist behaviour was the outcome variable, with perceived value, tourist satisfaction, ecotourism intention, and demographic variables as predictors. Machine-learning models were compared and SHAP was used to identify each variable's relative predictive contribution (Lundberg & Lee, 2017). Combining the two stages allowed the hypothesised behavioural pathways to be cross-checked against an independent, purely predictive ranking of drivers.

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Study Area and Sampling

The study was conducted in Jashpur District, north-eastern Chhattisgarh, characterised by forests, waterfalls, biodiversity, and a predominantly tribal population (Oraon, Munda, Kharia) whose cultural practices remain closely tied to the natural environment. Major attractions include Rani Dah and Dangari Waterfalls, Kailash Gupha, and Kotebira Eb River. Jashpur remains an emerging destination with limited interpretation facilities, trained guides, and waste-management arrangements, making it a useful low-infrastructure setting for examining tourist behaviour (Figure 2).



Figure 2. Geographical Location of Jashpur District in Chhattisgarh, India
Source: Author's Own Elaboration (2026)

A purposive sampling strategy recruited visitors who had spent at least one full day engaging in ecotourism activities in Jashpur. Data were collected through on-site paper-based questionnaires at major ecotourism locations, including waterfall and forest tourism sites. A total of 425 usable responses were obtained, adequate for PLS-SEM analysis (Hair et al., 2019). The sample was nearly gender-balanced (51.5% female), concentrated in the 18-35 age group (52.2%), and composed mainly of graduates or postgraduates (54.8%) (Table 1). The study protocol was reviewed by the relevant departmental research committee prior to data collection; the survey was anonymous, voluntary, and minimal risk in nature, informed consent was obtained, and no personally identifying information was collected. Care was taken to keep all questions non-sensitive and appropriate to the survey context. A small number of younger visitors encountered at the sites were included with adult accompaniment and assent, reflecting the actual visitor profile during fieldwork; as a purposive, on-site sample, results should be generalised to other destinations with appropriate caution.

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Table 1. Socio-Demographic Profile of Respondents (N = 425)

Variable	Category	Percentage
Sex	Female	51.53%
	Male	48.47%
Age	18–35	52.23%
	36–65	36.70%
	Below 18 / Above 65	11.06%
Education	Graduate or higher	54.83%
	12th pass or below	45.17%
Monthly Income	Below ₹25,000	48.71%
	Above ₹25,000	51.29%

Source: Author's Field Survey, Jashpur District (2025)

Measures

Four multi-item reflective constructs were measured on a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree): perceived value, tourist satisfaction, ecotourism intention, and responsible tourist behaviour, adapted from validated tourism and environmental-behaviour scales and contextualised to Jashpur (Table 2). The questionnaire was administered in English and Hindi with back-translation to maintain linguistic accuracy, and a pilot test with 30 tourists assessed clarity and cultural appropriateness, informing minor wording revisions.

Table 2. Operationalisation of Latent Constructs

Construct	Items Used	Measurement Type
Perceived Value	Worth the money, exceeded expectations, experiential quality	Reflective, 5-point Likert
Tourist Satisfaction	Enjoyment, learning, environmental appreciation, engagement	Reflective, 5-point Likert
Ecotourism Intention	Revisit intention, advocacy, sustainable travel alignment	Reflective, 5-point Likert
Responsible Tourist Behaviour	Waste minimisation, biodiversity care, cultural respect, local support	Reflective, 5-point Likert

Source: Adapted from Validated Tourism Behaviour Scales and Contextualised through the Author's Field Survey (2025)

Data Analysis

Data was analysed in two stages. First, the measurement model was assessed for internal consistency (Cronbach's Alpha, composite reliability), convergent validity (AVE), and discriminant validity (HTMT). The structural model was then evaluated using bootstrapping with 5,000 resamples to estimate path coefficients, t-values, and p-values, with explanatory and predictive power assessed via R^2, f^2, and Q^2, and model fit examined via SRMR and NFI. Mediation analysis tested the indirect effects of ecotourism intention and tourist satisfaction, and IPMA identified constructs combining high importance with lower performance, indicating priorities for destination management.

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Second, a machine-learning stage was conducted in Python (Pedregosa et al., 2011). Construct scores were computed as item means, with responsible tourist behaviour items excluded from predictors to avoid data leakage. The dataset was split 80:20 into training and testing subsets. Ridge Regression (Hoerl & Kennard, 1970), Random Forest Regressor (Breiman, 2001), and Gradient Boosting Regressor (Friedman, 2001) were compared using R^2, Mean Absolute Error, and Root Mean Square Error, with five-fold cross-validation assessing robustness across data partitions. SHAP analysis was then applied to the best-performing model to rank predictors by mean absolute SHAP value; these values were interpreted as predictive rather than causal contributions, distinct from the causal-style hypothesis testing performed in the PLS-SEM stage.

3. RESULTS AND DISCUSSION

Measurement and Structural Model

The measurement model showed satisfactory indicator reliability, with all outer loadings between 0.864 and 0.907, exceeding the 0.70 threshold. Item means were above 4.00 on the five-point Likert scale, indicating generally positive evaluations of Jashpur's ecotourism experience, and standard deviations ranged from 0.79 to 0.92, showing acceptable variation among respondents (Table 3). Composite reliability and Cronbach's Alpha ranged from 0.842 to 0.918, and AVE ranged from 0.760 to 0.802, confirming internal consistency and convergent validity (Table 4). All HTMT ratios were below the conservative 0.85 threshold (Henseler et al., 2016) (Table 5), and cross-loadings confirmed discriminant validity, indicating the four constructs were reliable, valid, and empirically distinct.

Table 3. Indicator Loadings and Item Statistics

Construct	Item Code	Measurement Item	Mean	SD	Loading
Ecotourism Intention	EI1	I intend to visit Jashpur for an ecotourism experience in the near future.	4.12	0.84	0.907
	EI2	I choose destinations like Jashpur that reflect my environmental values.	4.05	0.87	0.884
	EI3	I prioritise eco-friendly travel options when planning trips.	4.08	0.79	0.887
	EI4	I believe that visiting Jashpur promotes sustainable tourism practices.	4.15	0.80	0.903
Perceived Value	PV1	Visiting Jashpur was worth the money, time, and effort.	4.01	0.92	0.866
	PV2	The ecotourism experience in Jashpur exceeded my expectations.	4.07	0.85	0.881
	PV3	Visiting Jashpur left a positive impression on my social circle.	4.03	0.88	0.867
Tourist Satisfaction	SAT1	The ecological environment in Jashpur was well maintained.	4.10	0.86	0.890
	SAT2	I was satisfied with the knowledge and service of local tour guides.	4.06	0.83	0.888

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Construct	Item Code	Measurement Item	Mean	SD	Loading
	SAT3	The overall travel experience in Jashpur was enjoyable.	4.08	0.87	0.878
	SAT4	I appreciated the opportunity to observe wildlife and nature.	4.00	0.89	0.864
Responsible Tourist Behaviour	RTB1	I made efforts to protect the local environment during my visit.	4.11	0.81	0.884
	RTB2	I supported local businesses and artisans in Jashpur.	4.04	0.90	0.876
	RTB3	I managed my waste responsibly while travelling.	4.09	0.86	0.898
	RTB4	I avoided disturbing natural habitats during my tour.	4.13	0.84	0.900

Source: Author's Field Survey and SmartPLS 4 Output (2025); N = 425

Table 4. Construct Reliability and Convergent Validity

Construct	Composite Reliability (rhoA)	Cronbach's Alpha	AVE
Ecotourism Intention	0.918	0.918	0.802
Perceived Value	0.843	0.842	0.760
Tourist Satisfaction	0.903	0.903	0.774
Responsible Tourist Behaviour	0.912	0.912	0.791

Source: SmartPLS 4 Analysis, Jashpur Field Data (2025); N = 425

Table 5. HTMT Ratio Matrix for Discriminant Validity

Construct	EI	PV	SAT	RTB
Ecotourism Intention	-	0.789	0.590	0.780
Perceived Value	0.789	-	0.799	0.779
Tourist Satisfaction	0.590	0.799	-	0.602
Responsible Tourist Behaviour	0.780	0.779	0.602	-

Note: All Values Are below the Recommended Threshold of 0.85 (Henseler et al., 2016)
Source: Author's SmartPLS 4 Analysis, Jashpur Field Data (2025); N = 425.

The structural model was estimated with 5,000 bootstrap resamples (Table 6; Figure 3). Perceived value had significant positive effects on ecotourism intention (β = 0.694) and tourist satisfaction (β = 0.697), supporting H_1 and H_2. Ecotourism intention was the strongest direct predictor of responsible tourist behaviour (β = 0.455), supporting H_3, followed by perceived value (β = 0.304, H_4) and a weaker but significant effect of tourist satisfaction (β = 0.091, H_5). The model explained 59.6% of variance in responsible tourist behaviour (R^2 = 0.596), 48.2% in ecotourism intention, and 48.6% in tourist satisfaction. Effect sizes (Table 7) showed large effects of perceived value on intention and satisfaction, a medium effect of intention on responsible tourist behaviour, a small direct effect of perceived value on responsible tourist behaviour, and a negligible effect of satisfaction on responsible tourist behaviour despite its significant path coefficient. Q^2 values were positive for all endogenous constructs (0.304–0.372), and the SRMR and NFI model-fit indices were within recommended thresholds, indicating adequate predictive relevance and overall model fit.

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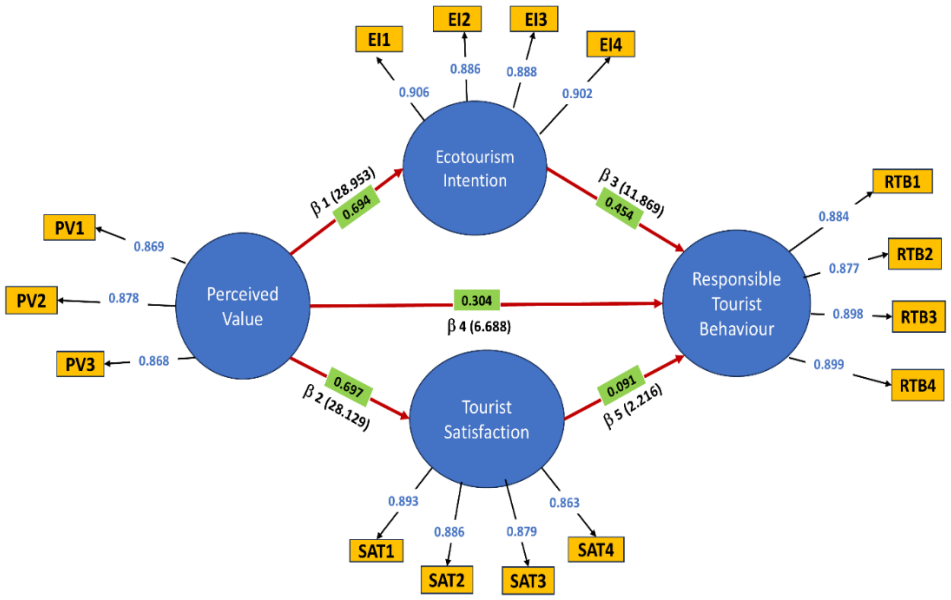


Figure 3. Structural Model Results Using PLS-SEM for the Jashpur Ecotourism Study
Note: The figure presents standardised path coefficients for the hypothesised PLS-SEM model.

Table 6. Structural Model Path Coefficients and Hypothesis Testing

Hypothesis	Relationship	β	t-value	p-value	Result
H_1	PV → EI	0.694	28.953	<0.001	Supported
H_2	PV → SAT	0.697	28.129	<0.001	Supported
H_3	EI → RTB	0.455	11.869	<0.001	Supported
H_4	PV → RTB	0.304	6.688	<0.001	Supported
H_5	SAT → RTB	0.091	2.216	0.027	Supported

Note: PV = Perceived Value; EI = Ecotourism Intention; SAT = Tourist Satisfaction; RTB = Responsible Tourist Behaviour
Source: SmartPLS 4 Structural Model Output, Jashpur Field Data (2025); N = 425

Table 7. Effect Size (f^2) for Structural Paths

Structural Path	f^2	Interpretation
PV → EI	0.928	Large
PV → SAT	0.942	Large
EI → RTB	0.253	Medium
PV → RTB	0.082	Small
SAT → RTB	0.010	Negligible

Note: PV = Perceived Value; EI = Ecotourism Intention; SAT = Tourist Satisfaction; RTB = Responsible Tourist Behaviour
Source: SmartPLS 4 Structural Model Output, Jashpur Field Data (2025); N = 425

Measurement and Structural Model

Mediation analysis (Table 8; 5,000 resamples) confirmed both indirect pathways. The pathway through ecotourism intention was strong (β = 0.316, p < .001, H_6), indicating that tourists who perceived the Jashpur experience as valuable were more likely to develop stronger ecotourism intentions, which in turn supported responsible conduct. The pathway through tourist satisfaction was significant but weaker (β = 0.063, p = .028, H_7). Because the direct effect of perceived value on responsible tourist behaviour remained significant, the

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results indicate partial mediation, with the motivational route through ecotourism intention considerably stronger than the affective route through satisfaction.

Table 8. Indirect Effects and Mediation Analysis Results

Hypothesis	Path	β	t-value	p-value	Result
H6	PV → EI → RTB	0.316	10.680	<0.001	Accepted
H7	PV → SAT → RTB	0.063	2.200	0.028	Accepted

Note: PV = Perceived Value; EI = Ecotourism Intention; SAT = Tourist Satisfaction; RTB = Responsible Tourist Behaviour
Source: Author's Mediation Analysis Using SmartPLS 4, Jashpur Field Data (2025); N = 425

IPMA, with responsible tourist behaviour as the target construct, identified ecotourism intention as having the highest importance (total effect = 0.455) and performance (81.6/100), followed by perceived value (importance = 0.304, performance = 78.3) and tourist satisfaction (importance = 0.091, performance = 69.4) (Figure 4). This positions ecotourism intention as the strongest strategic driver, combining high importance with high performance, while perceived value is a secondary but still important priority and tourist satisfaction is a lower-priority construct.

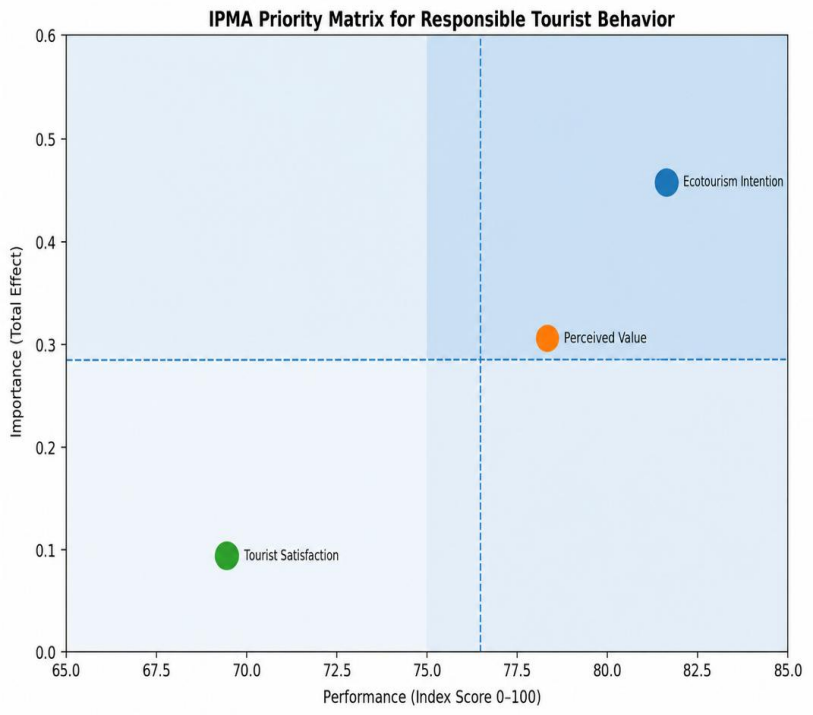


Figure 4. IPMA Priority Matrix Showing Importance–Performance Positioning of Key Predictors of Responsible Tourist Behaviour in Jashpur

Machine-Learning Prediction and SHAP-Based Explainability

To complement the explanatory results, responsible tourist behaviour was predicted from perceived value, tourist satisfaction, ecotourism intention, and demographic variables

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(age, sex, education, monthly income). Ridge Regression produced the strongest test-set performance (R^2 = 0.645, MAE = 0.291, RMSE = 0.367), outperforming Random Forest (R^2 = 0.618) and Gradient Boosting (R^2 = 0.605) (Table 9). Since MAE and RMSE are on the same 1–5 response scale as responsible tourist behaviour, these values indicate acceptable prediction error. Five-fold cross-validation of the Ridge model produced a mean R^2 of 0.566 (SD = 0.077), indicating reasonably consistent performance across data partitions.

Table 9. Machine-Learning Model Performance for Predicting Responsible Tourist Behaviour

Model	Test R^2	MAE	RMSE
Ridge Regression	0.645	0.291	0.367
Random Forest Regressor	0.618	0.302	0.381
Gradient Boosting Regressor	0.605	0.303	0.388

Source: Author's Python-Based Machine-Learning Analysis, Jashpur Ecotourism Dataset (2025); N = 425

SHAP analysis of the Ridge Regression model (Figure 5) showed ecotourism intention as the most influential predictor (mean |SHAP| = 0.2231), followed by perceived value (0.1179) and tourist satisfaction (0.0270), with demographic variables contributing comparatively little (sex = 0.0134; monthly income = 0.0100; age = 0.0070; education = 0.0030). Higher values of ecotourism intention and perceived value were associated with positive contributions to predicted responsible tourist behaviour, while tourist satisfaction and the demographic variables clustered closer to zero. This confirms that responsible tourist behaviour is predicted primarily by behavioural-psychological rather than demographic variables, consistent with the PLS-SEM results where ecotourism intention had the strongest direct effect and tourist satisfaction the weakest.

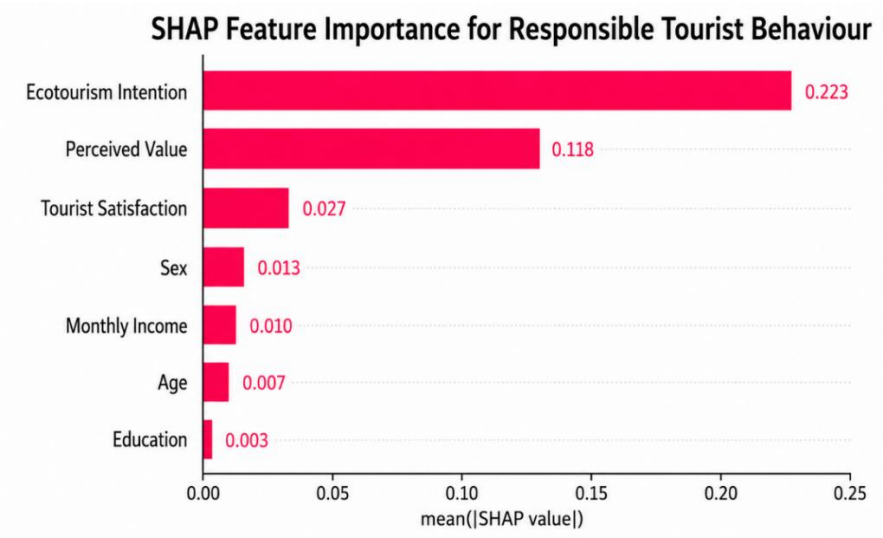


Figure 5. SHAP-Based Predictor Importance for Responsible Tourist Behaviour

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Integrated Interpretation and Discussion

The PLS-SEM, IPMA, and SHAP results converge on a consistent finding: responsible tourist behaviour in Jashpur is explained and predicted mainly by ecotourism intention and perceived value, while tourist satisfaction and demographic variables play comparatively weaker roles. This supports the VAB framework's behavioural logic while extending it through predictive explainability. Tourists' responsible conduct is not shaped simply by whether they enjoyed the experience; it depends more on whether they develop a clear intention to engage in ecotourism and perceive the destination as meaningful and valuable.

The weaker, though statistically significant, role of tourist satisfaction is an important finding for emerging destinations such as Jashpur, where formal visitor-management systems, interpretive signage, and structured eco-education remain limited. Satisfaction may function as affective reinforcement rather than the main behavioural driver (Kartika et al., 2019). Tourists may enjoy the experience without automatically converting satisfaction into responsible action (Jiang et al., 2022). This suggests satisfaction-enhancing measures, such as cleanliness, signage, waste bins, safe pathways, and guide quality, should be paired with value-based and intention-building strategies rather than treated as a sufficient lever on their own. For example, waste-management facilities could be paired with clear ecological messaging, and guided walks could connect scenic experience with conservation and cultural respect.

This pattern is broadly consistent with, but also extends, prior VAB-based tourism studies. Kim et al. (2023) similarly found satisfaction to be a comparatively modest predictor of environmentally responsible behaviour intention relative to motivational constructs, while Oviedo-García et al. (2016) emphasised perceived value as a key mediating link between ecotourism knowledge and satisfaction. Similarly, Laela (2024) found that perceived enjoyment and memorable tourism experiences were important antecedents of destination loyalty, further indicating that experiential and value-related evaluations can have greater behavioural relevance than satisfaction considered in isolation. The present study adds to this line of work by showing, within a single tribal and infrastructure-limited destination, that the motivational pathway through ecotourism intention dominates not only in explanatory strength (PLS-SEM) but also in purely predictive terms (SHAP), a form of triangulation that most VAB-based studies in tourism have not attempted, since they typically rely on structural modelling alone.

The convergence between PLS-SEM and SHAP, despite testing explanatory relationships and predictive contribution respectively, strengthens confidence that ecotourism intention and perceived value are the priority behavioural levers for Jashpur. Because Jashpur represents an emerging tribal destination still in a formative stage, embedding intention- and value-building interventions from the outset may be more effective than adding them later as

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corrective measures. For destination managers, the results imply that budget and staff time are better directed toward intention and value building activities than toward satisfaction-only amenities, since the latter showed the weakest link to responsible conduct in both analyses.

The comparative performance of the three machine-learning models also carries a modest substantive implication. Ridge Regression, a regularised linear model, outperformed both tree-based ensembles, suggesting the relationship between the behavioural predictors and responsible tourist behaviour is largely linear and additive rather than driven by complex interactions or threshold effects, a useful cross-check on the PLS-SEM specification, which likewise assumes linear structural paths.

The relatively small predictive contribution of demographic variables (age, sex, education, monthly income) is itself a practically useful finding: Jashpur's ecotourism management does not need to segment interventions heavily by visitor profile. Rather than designing separate messaging for different age groups or income brackets, destination managers can concentrate resources on a smaller set of psychological levers, ecotourism intention and perceived value, that apply broadly across the visitor base, simplifying the practical design of interpretation and orientation programmes considerably.

In terms of concrete design, several specific mechanisms follow directly from the results. Because ecotourism intention was the dominant driver, pre-arrival digital nudges, short orientations at ticketing points, and simple visitor pledges (e.g., carrying reusable water bottles, staying on marked trails) are low-cost ways to strengthen intention before behaviour is enacted. Because perceived value was the second-strongest lever, involving Oraon, Munda, and Kharia community members directly as guides and storytellers, rather than relying solely on generic signage, is likely to increase the perceived authenticity of the visit and translate into stronger downstream intention and more responsible conduct.

4. CONCLUSION

This study examined responsible tourist behaviour in Jashpur, an emerging ecotourism destination with limited formal tourism infrastructure and visitor-management systems, integrating PLS-SEM, mediation analysis, IPMA, machine-learning prediction, and SHAP-based explainability. Perceived value was a key antecedent of both ecotourism intention and tourist satisfaction. Ecotourism intention emerged as the strongest driver of responsible tourist behaviour across every analytical stage: the strongest direct effect in the structural model, the highest importance in IPMA, and the highest predictive contribution in SHAP. Perceived value also directly influenced responsible tourist behaviour and strengthened both intention and satisfaction, while tourist satisfaction, though statistically significant, contributed comparatively little to practical and predictive terms.

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The findings indicate that responsible tourist behaviour in emerging ecotourism destinations is shaped more strongly by motivational intention and perceived value than by satisfaction alone; tourists' responsible conduct depends not just on enjoying the experience but on perceiving the destination as meaningful, environmentally valuable, and culturally grounded. Methodologically, the study demonstrates how theory-based explanatory modelling can be complemented by machine-learning prediction and SHAP-based interpretation, offering a more robust understanding of responsible tourist behaviour than explanatory modelling alone, and a template that other emerging destinations could adopt.

Practically, Jashpur's ecotourism planning should prioritise intention-building and value-enhancing interventions, including pre-visit awareness, site-level eco-orientation, bilingual signage, trained local guides, community-based storytelling, waste-management messaging, and visible links between tourism and local livelihoods. Such measures can help convert positive tourist perceptions into responsible conduct, particularly where formal regulatory systems are still developing.

The integration of PLS-SEM and SHAP also offers a methodological contribution to ecotourism behaviour research more broadly: PLS-SEM explains hypothesised relationships among constructs, machine learning evaluates predictive performance, and SHAP identifies each variable's relative predictive contribution. The convergence between these approaches increases confidence in the central finding without conflating explanation with prediction, since SHAP values are interpreted here as predictive rather than causal evidence.

This study is limited by its cross-sectional design and single-destination focus, which restrict causal and generalisable claims, and by its reliance on self-reported behaviour rather than observed conduct. Future research may test this integrated framework in other rural, tribal, and under-regulated ecotourism destinations, examine longitudinally whether intentions translate into actual behaviour over time, and use mixed methods to explore how tourists interpret ecological value, cultural responsibility, and community participation during destination experiences. contexts.

5. DISCLOSURE STATEMENT

The author(s) declare no competing financial or non-financial interests related to this manuscript.

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7. DATA AVAILABILITY STATEMENT

The data supporting this study are available from the corresponding author upon reasonable request; raw participant-level data are not publicly available because participant consent did not include public data sharing.

8. DECLARATION ON THE USE OF GENERATIVE AI

During manuscript preparation, the author(s) used generative AI tools for language refinement and formatting support only. The tools were not used to generate research data, conduct statistical analysis, or replace author interpretation. The author(s) reviewed and verified all AI-assisted output and took full responsibility for the accuracy and integrity of the manuscript.

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