

Application of Principal Component Analysis in understanding Tourist Behavioural Intention-A case study from Manipur

ANJALI CHANU MOIRANGTHEM¹, ASHA GUPTA²

¹Department of Management

Arunachal University of Studies, Namsai, INDIA

²Centre of Advanced Study, Department of Botany
Manipur University, INDIA

Abstract: - A natural attraction should ensure the delivery of positive experiences for tourists that match their interests, confirming their satisfaction. If tourists have had positive experiences at a place, they are also more likely to return to the same destination in the future. A study was conducted at Loktak Lake, Manipur, a Ramsar site and a wetland of international importance for understanding the tourist behavioural intention. Data was collected from a sample of 100 tourists visiting Loktak Lake and analysed using an instrument constituting a 5-point Likert scale comprised of 10 items. Statgraphics statistical software was used to capture the data and subsequent analysis. The Principal Component Analysis (PCA) was performed. Key statistical validations obtained using Kaiser-Meyer-Olkin test (KMO) and Barlett's test. Together, the first two components account for 80% of total variance, which is quite strong. The elbow in the eigenvalue distribution in the scree plot occurs after PC2 that suggested a 2-factor structure may be meaningful for interpretation. The biplot (PC1 vs. PC2) reveals which variables drive tourist satisfaction and intention, and how they cluster.

Key Words: Tourists, Behavioural intention, Satisfaction, Likert Scale, Principal Component analysis, KMO, Barlett's test

Received: April 28, 2025. Revised: May 23, 2025. Accepted: August 17, 2025. Published: November 3, 2025.

1 Introduction

Tourism, defined by the World Tourism Organization, involves people engaging in activities for leisure, business, and other purposes for less than a year [1]. It contributes significantly to income generation, job creation, and foreign exchange contributions [2], making it crucial for economic and global development [3].

Ceballos Lascurain, IUCN 1983 special advisor, defined ecotourism as a minimally impacted, culturally respectful, and resource-preserving approach, as

confirmed by UNEP [4]. Ecotourism aims to restore environmentally friendly tourism by preserving natural and cultural values while addressing environmental issues caused by tourism itself [5].

Ecotourism is becoming increasingly important due to its environmental protection, support for education, recreation, and economic growth [6]. These locations offer high access to natural resources [7] and generate "delight factors" that tourists value, such as reassuring, relaxing, comforting, and pleasure sensations [8].

2 Problem of study

Research on tourists' travel decisions is crucial for the tourism industry's progress. Understanding the factors influencing their choice of travel, such as ecotourism, is essential for sustainable development [9]. Ecotourism has a low environmental impact, respects local cultures, and contributes significantly to preserving environmental resources [4]. The study of tourists' behavioural intention towards ecotourism is crucial for its sustainable development [10]. Understanding the factors influencing tourists' behavioural intentions, their relationships, and how they influence intentions is essential for sustainable tourism growth.

Scholars have studied tourists' behavioural intentions from various viewpoints, including the experience quality of the destination experience, the experience of destination amenities, host-guest interactions, and service quality [11].

Zhang's et al [12] study identifies the factors influencing pro-environmental behavioural intention (PEBI) among Chinese domestic tourists at ecotourism destinations. The results indicated that perceived ecotourism usefulness, publicity and education, policies and regulations, infrastructure, and perceived behavioural control have significant positive effects. A survey results indicated that tourist satisfaction only mediated perceived values, attitudes, and ecotourism behavioural intentions. Subjective norms, perceived value, attitude, and perceived behavioural control all impacted tourist satisfaction [13]. Liu et al [14] demonstrated that experiential marketing, and service

quality were positively correlated with tourists' behavioural intentions. These findings indicate that ecotourism could provide optimal experiential marketing and prompt tourists who are satisfied with the service quality to return for another ecotourism experience. Numerous studies show a direct relationship between satisfaction and behavioural intentions [15],[16], [17], [18], [19], [20].

3 Method

3.1 Area of study

The study was carried out at Manipur, India. Loktak Lake located at geographical co-ordinates 23°33'N and 93°47'E with an elevation at 768.5 m is the biggest freshwater Lake in NE India, Manipur and a Ramsar Site. Loktak lake has a surface area of 287 km² with depth varying from 2.7 to 4.6 m. It is a major tourist attraction that draws a number of domestic and foreign tourists throughout the year (Fig.1 a,b,c,d). Loktak is regarded as a wetland of international importance based on its unique biodiversity and socio-economic importance. This lake plays an important role in the economy of Manipur state. Considered as the lifeline for the people of Manipur, the lake plays an important role in socio-economic and cultural life of the people. It moderates the climate of the State, provides source of water for hydropower, irrigation, drinking water supply and source of livelihood for rural fisherman living in the surrounding areas and on *phumdis in khangpok* (huts). Due to its rich biodiversity, the lake was placed in wetland of international importance under the Ramsar Convention on March 23 1990. Characteristic features that justify its international status as a Ramsar site

include naturally occurring floating phumdis, island of various sizes of vegetation. Phumdis are floating vegetation which are a specialized habitat for many biota, besides being useful to the local people in many ways. The Keibul Lamjao National Park in the Southern part of the Lake is a unique floating wild life reserve, and the only home of the endangered Manipur Brow antlered deer or Sangai, with an estimated population of 260 (2016). Loktak lake has been the breeding ground of a number of riverine migratory fishes from the Irawady-Chindwin river system and continues to be vital as a fish habitat. The Lake also supports a significant population of resident and migratory water fowl.

Fig1(a,b,c,d) Loktak Lake, Manipur



(a)



(b)



(c)



(d)

There are 14 hills, varying in size and elevation appearing as islands in the southern part of the lake. Loktak lake has a direct catchment area of 980 sq.km and indirect catchment area of 7159 sq.km. 34 small streams directly discharge into the lake. Loktak lake has a great potential for hydropower generation, irrigation, food mitigation and support a large number of flora and fauna. Moreover, the lake is also one of the important feeding areas of a number of winter migrating birds. Phumdis are the floating islands occurring in the lake and happen to be the most characteristic feature of it. They float in suspended state and displace water due to buoyancy. These floating islands occur in all sizes and thickness and are heterogeneous mass of soil, vegetation and organic matter in different stages of decay. The phumdis float on the lake water with one fifth of thickness above and four fifth under the water surface. 40 sq.km of continuous expanse of floating sheet of phumdi provides the natural habitat of highly endangered brow antlered deer. There are also about 55 rural and 4 urban settlements around the lake that

derive sustenance from vegetation growing on the phumdis. Besides, the phumdi support rich flora and fauna, the local populace obtain vegetables, fuel, medicines and fodder from the phumdi vegetation.

3.2 Objectives

The study was conducted with the objective to explore how destination image influences behavioural intention of tourists. The goal was to find out what factors affect tourists' behavioural intentions. This study aimed to investigate the relationship between destination's attraction, culture, activities, food, accommodation, transport on behavioural intentions viz revisit and recommendation for a Ramsar site, Manipur and to suggest in the light of the study, future directions for carefully planned visitor experiences promoting ecotourism.

3.3 Sampling, Measurement

The theoretical and practical methods were employed in the study, literature analysis through the collection, identification, compilation of relevant research literature was followed by simple random sampling to collect data from tourists visiting Manipur. Primary data was collected through questionnaires and interviews.

The destination image was measured with eight (8) items which addressed the Attraction, accommodation, transport, accessibility, food, culture, special activities, shopping attributes. Remaining part of the instrument measured behavioural intention construct. Behavioural intentions had two items (willingness to recommend and repeat visit). This is adopted from previous studies [21], [22], [23], [24] who measured behavioural intentions by using two

indicators (repeat visit and recommendation).

All factors were measured on a five-point Likert Scale (1=strongly disagree and 5=strongly agree or 1=strongly dissatisfied and 5=strongly satisfied). Data was collected from a sample of 100 tourists visiting Loktak Lake, Manipur during 2024.

3.4 Principal Component Analysis

Principal component analysis is a statistical technique used in tourism studies to reduce the number of variables by creating new synthetic ones by linearly combining initial ones [25]. Principal component analysis is beneficial for situations requiring the creation of multiple scales of analysis. This method is complemented with other techniques like K-test and ANOVA, helping to understand the inherent nature of the phenomenon.

The Principal Component Analysis (PCA) was employed so as to reduce data dimensionality and the underlying patterns among variables identified. For ensuring comparability, all the variables were standardized. For sorting out the relationships among variables, correlation matrix was generated from where the eigenvalues and eigenvectors were extracted. Eigen values represented the amount of variance whereas eigenvectors explained the direction of each principal component. Eigenvalues are the numbers that tell how much variance (how spread out the data is) along each eigenvector. A higher eigenvalue means corresponding eigenvector captures more variance and is therefore more important. Eigenvectors are the directions of the axes in PCA, where the data varies the most. If

the data points scattered in a cloud, the eigenvectors point along the directions where the cloud is most spread out. A scree plot was prepared, the elbow in the eigenvalue distribution of the scree plot suggest the number of components meaningful for interpretation. The elbow is a point where the curve starts to flatten out, suggesting that further components are insignificant to explain data's variability.

Component scores were generated by multiplication of standardized data with selected eigenvectors, and principal components were obtained. Finally, the variable loadings were examined to understand which variables contribute most to each component thus helping in interpretation of the biplot.

Principal component analysis is used in tourism studies to analyse factors such as tourist attractions, consumer behavior, market segmentation, destination image, residents' perceptions, and demand characteristics. This method is commonly used due to its quantitative nature and high incidence of variables. This method, compared to VARIMAX, effectively explains tourism problems across dimensions. It remains a crucial quantitative approach, but future research could enhance its usefulness by combining qualitative approaches.

3.5 Data Analysis

PCA was used to test for the statistical relationship between destination attraction accommodation transport, cultural events, activities at site and behavioural intentions (revisit, recommendation). KMO and Bartlett's Test were intended to ensure that

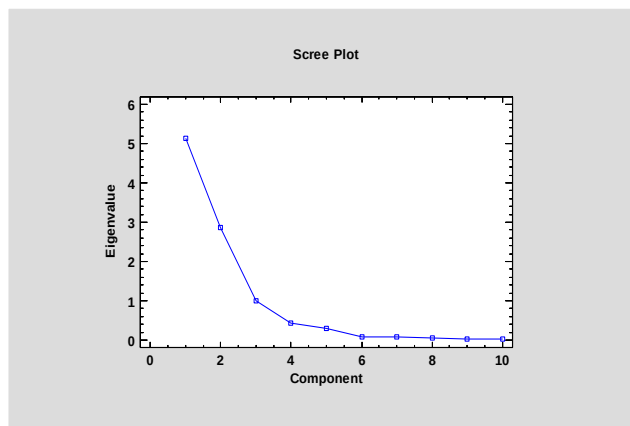
items measuring the conceptualized construct and dimensions have internal consistency and that the quality of model measurement meets acceptable statistical levels.

To determine the measure of sample adequacy Kaiser-Meyer-Olkin test (KMO) was done which measures whether the data was appropriate for factor analysis. The appropriateness of data means that KMO value must not be less than 0.5 according to Kaiser and literature [26].

4 Results and Discussion

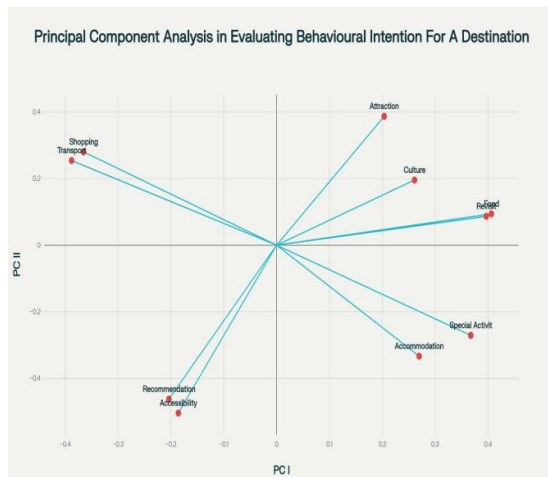
Key statistical validations were upheld. KMO Value (0.753) indicated good sampling adequacy for PCA; revealing correlations among items were sufficiently compact. The Bartlett's Test ($p < 0.001$) confirmed that variables are correlated enough to justify PCA. Together, the first two components account for 80% of total variance, which is quite strong. The elbow in the eigenvalue distribution in the scree plot occurred after PC2 suggesting that 2 components are meaningful for interpretation (Fig 2).

Fig 2- A Scree plot of the eigenvalues



The biplot (PC1 vs. PC2) reveals which variables drive tourist satisfaction and intention, and how they cluster (Fig3).

Fig3: Principal Component Analysis in Evaluating Behavioural Intention for A Destination



The x-axis (Component 1) and y-axis (Component 2) represent the first two principal components extracted from the dataset. These components capture the greatest variance in the data and allow a reduced dimensional representation (Table 1).

The analysis of Eigen values reflect that the first two components have eigenvalues > 1 , explaining 80 % of the total variance—a strong dimensionality reduction. This suggests that tourists responses clusters into two distinct directions. These clear dimensions allow for targeted messaging and visitor segmentation(Table1).

Table 1: Analysis of Eigen Values

Component Number	Eigen Value	Variance (%)	Cumulative Variance (%)
1	5.141	51.405	51.405
2	2.865	28.652	80.057
3	0.991	9.908	89.965
4	0.445	4.454	94.418
5	0.296	2.963	97.381
6	0.091	0.908	98.289
7	0.077	0.769	99.058
8	0.043	0.440	99.498
9	0.033	0.326	99.824
10	0.176	0.176	100.000

PCA biplot helps to interpret which observed variables are most influential in explaining the main sources of variation in the data and which variables tend to cluster or oppose one another in multivariate space. The plot visually narrates how variables are associated with the principal components and with each other (Fig 3, Table2).

Table 2: Factor Loadings on PCI and PCII

No.	Variable	PC I	PC II
1	Attraction	0.204	-0.387
2	Accommodation	0.270	-0.333
3	Transport	0.388	0.254
4	Accessibility	-0.186	-0.564
5	Food	0.407	0.094
6	Culture	0.261	0.196
7	Special Activities	0.367	-0.271
8	Shopping	-0.365	-0.280
9	Recommendation	-0.204	-0.462
10	Revisit	0.397	0.087

Thus, variables close together (e.g., Attraction, culture, special activities) share similar patterns across samples and are positively correlated whereas, variables on opposite sides (e.g., Recommendation and Revisit) are potentially negatively correlated (Fig3, Table2).

PC I demonstrates overall Experience Quality. PCI demonstrates that culture and revisit intention point in same direction with high magnitude vectors—these are central to overall tourist contentment. Shopping and special Activities also align closely, suggesting emotional and

experiential factors heavily influence revisit intention. The negative or ambivalent influencers on PCI finds Transport and Recommendation point away from the cluster—highlighting concerns around unmet expectations.

PC II Themes around Trade-offs and Divergences. Thus, accessibility and recommendation show divergence from cultural/experiential vectors—indicating a possible tension between ease of access and depth of satisfaction. A special feature is that Attraction points orthogonally—

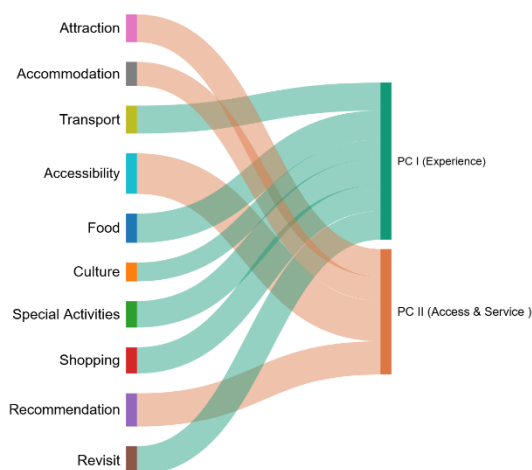
suggesting it is valued independently from others (Fig3, Table2).

Component 1 synthesizes emotional, cultural, and activity-based satisfaction—and constitutes the core factor whereas Component 2 reflects logistics vs. meaningful engagement—a nuanced secondary driver. These insights can guide tourism strategy that improves accessibility without undermining authentic engagement. Thus the results of 1st component prioritizes cultural and experiential elements with high loadings on culture, special activities, and revisit intention. Component 1 suggests that emotional engagement drives tourism loyalty. By investing in community-led cultural events, eco-interpretation trails, and experiential offerings like boating, birdwatching, or craft workshops will ensure emotional engagement of tourists. Component 2 highlights a divergence between logistic factors (accommodation, transport) and deeper experiential satisfaction. Improving access and facilities without compromising the site's sense of authenticity and ecological integrity will help resolve the accessibility vs. engagement tensions. Thus, the PCA biplot and scree plot offer excellent visual tools to teach trade-offs and clustering in tourist preferences. In the Principal Component analysis, attraction emerges as orthogonal to others. The analysis suggests that attraction, a component of a destination's appeal, is statistically independent and not influenced by factors like transport or culture, suggesting that heritage is strong enough as perceived and valued independently of external factors. Manipur's natural and cultural allure remains resilient despite political tension

and poor infrastructure, attracting visitors who however hesitate to recommend due to external discomforts.

The Sankey diagram (Fig 4) created at SankeyMATIC.com [27] narrates visual translation of PCA loadings. It shows how each of the 10 observed variables (destination image and behavioural intentions) contribute to the two extracted principal components (PC I and PC II). Each flow from a variable to a component represents the strength and direction (loading magnitude) of its relationship — wider flows indicate stronger influence.

Fig 4. Sankey Diagram showing flows of Variables



Variables flowing toward PC I (Experience & Comfort) are reflected as green links in the diagram (Fig4). These variables have stronger loadings on PC I, meaning they describe the experiential dimension of the destination. PC I is closely linked with tourists' repeat visitation intentions (Revisit), showing that positive experiences drive loyalty.

Variables flowing toward PC II (Access & Service) are reflected as orange links in the diagram (Fig 4). These variables have

higher loadings on PC II, capturing the accessibility–recommendation dimension. PC II emphasizes service quality and ease of access, strongly tied to tourists' willingness to recommend the destination. It reflects the functional and infrastructural evaluation.

PC I is related to positive experiential and service-oriented dimensions. It shows Strong positive loadings from Food (0.407), Revisit (0.397), Transport (0.388), and Special Activities (0.367) suggesting visitor satisfaction and the behaviour intention to revisit the destination.

PC II reflects the constraints and barriers as it shows strong negative loadings from Accessibility (-0.564), Recommendation (-0.462), and Attraction (-0.387). This component reflects assessibility constraints and can be interpreted for perceived limitations impacting adversely recommendation.

Variable Roles
Food and Revisit are the key drivers of positive tourism experiences as reflected by the magnitude of loadings on PCI. However, Accessibility and Recommendation exhibit strong negative loadings on PC II pointing need for improvement

Moderate negative loadings of Shopping and Accommodation on both PCs suggest mixed perceptions

Strategic Insights for management based on PC I should focus on improving food services, transport infrastructure, and special activities for boosting revisit intentions.

Based on PC II its important to address constraints and barriers in accessibility so as to improve recommendation intent of tourists. The policy programmes may

focus on arranging digital guides, signage and providing for visitors engagement

According to studies by Baker and Crompton [15], Thrane [16], Baron and Kenny [17], Yuan & Jang [18], Um et al [19], Valle et al [20] and others there is a strong correlation between behavioral intentions and satisfaction.

Revisiting is a significant economic and tourist attraction phenomenon [28], with some visitors revisiting a destination based on satisfaction with the first visit [29]. However, satisfaction alone may not explain the phenomenon, as satisfied tourists may prefer to visit another destination [30].

Tourists who are less satisfied may return to a destination and become repeat visitors [23] [30], potentially reducing the risk of future disappointments. Factors influencing return intention include novelty seeking [31], natural and cultural environment, adventure, climate, events and activities [32], safety and security, relaxation, local people's friendly attitude towards visitors [33], leisure, entertainment, transportation, shopping, accommodation, price [34], destination image [35], [36], [37], attractiveness [37], satisfaction [32], [36], [38], [39], previous experience, motivation [37], [40], [41], and tourists' perception [34], [42]. However, these factors depend on visitor behavior, taste, purpose of visit, visitor judgment, concession of visit, and destination circumstances. Therefore, identifying key factors influencing revisit intention is crucial.

5 Conclusion

It is suggested to enhance transportation and accessibility as they have detrimental effect on experiential ratings. Attraction's core charm is to be protected by highlighting its natural beauty and uniqueness. Tourists' experiences must be designed in such a way that prioritize community engagement and guided access to foster trust and contextualize volatility.

Emotional drivers in ecotourism shape how tourists connect with a destination beyond just amenities. Experiencing vast water bodies surrounded by blue hills, endangered and endemic deer Sangai, floating phumdis (vegetation islands) of various sizes, watching migratory birds in a Ramsar wetland arouses sense of awe and wonder. Interacting with indigenous communities, learning traditional fishing practices, observing rituals on creation myth, the annual deity appeasement festival Laiharaoba at Moirang or attending Loktak day celebration can connect both local people and culture. The vast expanse of water, beautiful islands, picturesque waterscape, phumdi experience makes one feel relaxed and inspired by nature permitting personal fulfilment and growth. Visiting natural wilderness sites, seeing endemic flora and fauna in the world's only floating national park promotes ecological protection. It also promotes willingness for contributing towards water and wetlands conservation. Using the sights, sounds, and scents of nature to stimulate the senses for example, the aroma of the wetland flora in bloom, the flavor of traditional foods, the magnificent bamboo crafts, or the lovely handwoven shawls provide stronger word-

of-mouth recommendations, more support for environmental preservation, and a greater desire to return, all reflecting frequently the results of such natural encounters.

The drop in tourists has already had a significant impact on the lives of many locals as well as on hotels, restaurants, and other businesses. The State of Manipur has seen a rise in violence that erupted on 3rd May 2023 which has hurt the local economy and reduced tourism. Concerned will have to think about carefully planned visitor experiences that emphasize community engagement or guided access fostering trust.

Future Directions

- **Infrastructure improvement:** Prioritize spending money on transportation, food services and special events to improve revisit and satisfaction of tourists
- **Cultural Programming:** Create activities that are immersive and fit with the local culture and nature.
- **Accessibility Planning:** Improve signage, mobility options, and digital navigation tools
- **Visitor Segmentation:** Utilize PCA-derived clusters and endeavour to make experiences distinct for different types of visitors
- **Sustainability:** Encourage infrastructure that is eco-friendly and promote visitors' behaviour with less impact

As a quantitative analytical technique, PCA will remain an important approach to understand tourism and addressing its research objectives. In future research, its applicability can be enhanced by complementing/ combining principal component analysis with qualitative approaches.

Acknowledgement

The authors are thankful to the tourists who provided valuable information for this piece of research. Authors also acknowledge three anonymous reviewers whose constructive suggestions helped in improving the manuscript. Authors express their thankfulness to WSEAS for providing support in publication of this article.

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