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Analyzing Infrastructure Quality and Connectivity in Religious Tourism Hubs: A Factor-Based Study of Nashik City

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Abstract:

Purpose: *The study investigates the quality of infrastructure and connectivity in Nashik's religious tourism hubs, focusing on physical amenities, digital integration, and sectoral benefits to support sustainable development.*

Design/Methodology/Approach: *Primary data were collected from 128 respondents, including residents, business owners, and service providers, along with secondary sources. Reliability analysis (Cronbach's Alpha = 0.836) confirmed internal consistency, while KMO (0.781) and Bartlett's Test ($p < 0.001$) verified the suitability for factor analysis. Principal Component Analysis with Varimax rotation extracted three significant factors—Sectoral Economic Benefits, Urban Services and Connectivity, and Physical Infrastructure Quality—explaining 59.124% of total variance.*

Findings: *Results indicate moderate satisfaction with roads and sanitation, alongside higher benefits for food services and transport sectors. However, inadequacies remain in toilet facilities, water supply, and parking. The findings highlight the dual nature of Nashik's religious tourism: strong economic contributions but visible infrastructural gaps.*

Originality/Value: *Few Indian studies apply multivariate techniques such as factor analysis to examine infrastructure in pilgrimage hubs. This research provides a statistically grounded framework to identify latent dimensions of infrastructure and connectivity in Nashik.*

Social Implication: *The study offers actionable insights for policymakers and planners to enhance transport, public amenities, and digital integration, ensuring improved visitor experience and sustainable growth of religious tourism in Nashik.*

Keywords: *Religious tourism, Infrastructure quality, Factor analysis, Nashik*

1. INTRODUCTION

Nashik, known as the "Wine Capital of India," is also a prominent religious tourism hub with sites such as Trimbakeshwar, Panchavati, Buddha's Caves, and the Kumbh Mela, attracting millions annually (Bandyopadhyay, 2019). Religious tourism drives urban growth,a but its success relies on strong infrastructure and connectivity (UNWTO, 2023). In pilgrimage destinations, facilities like roads, sanitation, public transport, parking, and digital networks are vital for visitor satisfaction and competitiveness (Prideaux, 2000; Timothy & Olsen, 2006). Peak festival seasons in Nashik create heavy pressure on these systems, causing congestion and service strain (Sharpley & Sundaram, 2005). Most research on religious tourism in India focuses on socio-cultural and economic aspects, with limited attention to infrastructure and connectivity (Raj & Morpeth, 2007). Few studies use advanced methods like factor analysis to reveal hidden dimensions of infrastructure in such destinations (Hair et al., 2019).

This is especially relevant for Nashik, which is both a spiritual center and a rapidly urbanizing city. This study fills this gap by evaluating infrastructure quality and connectivity in Nashik's religious tourism hubs through a factor-based approach. Indicators such as road quality, public transport, sanitation, digital connectivity, and benefits to hospitality, retail, handicrafts, and food services are analyzed to identify key components shaping the tourist experience. The results will provide actionable insights for policymakers, planners, and stakeholders to support sustainable religious tourism in Nashik (Briedenhann & Wickens, 2004).

2. Review of Literature

2.1. Theoretical Perspectives on Infrastructure Development and Tourism Growth

Tourism development theory consistently underscores the role of infrastructure in destination competitiveness and visitor satisfaction. Butler's Tourism Area Life Cycle (TALC) model highlights how adequate infrastructure supports the growth and sustainability of destinations, while its absence accelerates stagnation (Butler, 1980). Prideaux (2000) emphasizes transport systems as the backbone of tourism development, linking accessibility to visitor flows. Dwyer and Kim's (2003) integrated model of destination competitiveness places infrastructure—both physical and service-based—among the key determinants of sustainable tourism growth. The UNWTO (2023) also identifies infrastructure, including mobility, utilities, and digital networks, as critical for maintaining resilience in tourism hubs.

2.2. Empirical Studies on Infrastructure Quality and Tourism Impacts

Empirical evidence confirms that infrastructure directly influences tourism performance. Khadaroo and Seetanah (2007) demonstrated that transport infrastructure significantly increases tourist arrivals, with island destinations being especially sensitive to access improvements. Studies in the Indian context reveal strong correlations between road quality, public transport, and tourism growth (Bandyopadhyay, 2019). Similar patterns are seen internationally—Singapore's investment in tourism infrastructure has enhanced global competitiveness and increased visitor numbers (Henderson, 2006). Beyond physical infrastructure, telecommunications and digital connectivity are increasingly acknowledged as essential complements that facilitate visitor experience, marketing, and crowd management (Gretzel et al., 2015).

2.3. Research Gaps Identified

While the importance of infrastructure for tourism is well known, there is very little research on pilgrimage cities like Nashik, especially on how peak festival seasons put extra pressure on roads, sanitation, parking, and public transport. Digital connectivity—important for visitor convenience, online payments, and smart tourism services—is often ignored in such studies. Also, most research does not look at physical infrastructure, connectivity, and related business benefits together. This study addresses these gaps by using Principal Component Analysis (PCA) with Varimax rotation to find the main factors affecting infrastructure quality and connectivity in Nashik's religious tourism hubs.

2.4. Objectives of the Study

- To assess the quality of physical infrastructure in Nashik's religious tourism hubs.
- Evaluate improvements in connectivity services due to religious tourism.
- Examine sectoral benefits to hospitality, retail, handicrafts, and food services.
- Identify key factors of infrastructure and connectivity using PCA with Varimax rotation.

2.5. Hypotheses

H_0: No significant latent factor structure explains infrastructure quality and connectivity in Nashik's religious tourism hubs.

H_1: A significant latent factor structure explains infrastructure quality and connectivity in Nashik's religious tourism hubs.

3. Research Methodology

The study was conducted in Nashik City, a major religious tourism hub featuring Trimbakeshwar, Panchavati, Buddha's Caves, and the Kumbh Mela. An exploratory and descriptive design was adopted to assess infrastructure quality and connectivity linked to religious tourism. The research covered 128 respondents selected through purposive convenient sampling, representing local residents, business owners, and tourism service providers. Primary data were collected via a structured questionnaire focusing on road quality, public transport, sanitation, digital connectivity, and sectoral benefits. Secondary data from official records and published reports supplemented the primary findings. Descriptive statistics were used to summarize responses. Kaiser-Meyer-Olkin (KMO) and Bartlett's test ensured sampling adequacy and suitability for factor analysis. Principal Component Analysis (PCA) with Varimax rotation was employed to extract latent factors influencing infrastructure quality and connectivity. This approach enabled the identification of key dimensions shaping tourist experiences in Nashik. The methodology ensured both statistical rigor and contextual relevance for policy insights.

4. Results and Discussion

The results provide an in-depth examination of infrastructure quality and connectivity in Nashik's religious tourism hubs. The discussion links the identified dimensions to the study objectives, offering insights into how these aspects influence the development and sustainability of religious tourism in the city.

Table 1. *Demographic Profile of Respondents (N = 128)*

Variable	Category	Frequency	Percent
Age	Below 18	2	1.6%
	18–30	61	47.7%
	31–40	45	35.2%
	41–50	13	10.2%
	Above 50	7	5.5%
Gender	Male	81	63.3%
	Female	47	36.7%
Occupation	Others	65	50.8%
	Shopkeepers/Street Food Vendors/Other Vendors at Religious Sites	4	3.1%
	Tourist/Tour Guide	12	9.4%
	Travel Agent/Transport Operator	1	0.8%
	Cultural Performer/Artist	4	3.1%
	Local Resident (Not related to business)	41	32.0%
	Hotel/Guesthouse Owner or Employee	1	0.8%
Education Level	Graduate	43	33.6%
	Postgraduate or Above	77	60.2%
	Secondary Education	8	6.3%
Residential Area	Rural	44	34.4%
	Urban	84	65.6%
Annual Household Income	Less than ₹1,00,000	61	47.7%
	₹1,00,001 – ₹3,00,000	35	27.3%
	₹3,00,001 – ₹5,00,000	11	8.6%
	₹5,00,001 – ₹10,00,000	13	10.2%
	Above ₹10,00,000	8	6.3%
Religion	Others	3	2.3%
	Prefer not to answer	2	1.6%
	Buddhist	35	27.3%
	Muslim	2	1.6%
	Hindu	86	67.2%

The sample is largely young (82.9% aged 18–40), male-dominated (63.3%), and highly educated (60.2% postgraduates or above). Most respondents are urban residents (65.6%) with diverse occupations, though many are not directly tourism-related. Nearly half (47.7%) have annual household incomes below ₹1,00,000. Religiously, Hindus (67.2%) and Buddhists (27.3%) form the majority. In conclusion, the demographic mix provides diverse and informed perspectives, aligning well with the study's aim of evaluating infrastructure quality and connectivity in Nashik's religious tourism hubs.

4.1. Reliability Statistics for Infrastructure, Connectivity, and Sectoral Benefit Variables

Reliability testing ensures that the variables measuring infrastructure quality,connectivity, and sectoral benefits consistently represent the intended concepts. A high Cronbach's Alpha confirms data stability and dependability for meaningful analysis.

Table 2. *Reliability Test*

Reliability Statistics		
Cronbach's Alpha	**Cronbach's Alpha Based on Standardized Items**	**N of Items**
.836	.840	15

4.2. Descriptive Statistics

Table 3. *Descriptive Statistics of Infrastructure Quality, Connectivity, and Sectoral Benefits in Nashik's Religious Tourism Hubs*

	Mean	Std. Deviation	Analysis N
Quality of developed roads	3.219	.9301	128
Improvement in public transport	3.188	1.0098	128
Quality of tourist toilet facilities	2.672	.9969	128
Maintenance of tourist spots	3.305	1.1123	128
Contribution to urban development (%)	3.148	.9314	128
Adequacy of water and sanitation facilities	2.727	1.0774	128
Days of infrastructure stress during peak festivals	3.328	1.0357	128
Improvement in local market quality	2.898	.8589	128
Impact on digital connectivity	3.086	.9138	128
Quality of parking facilities for religious tourism	2.914	.7739	128
Benefits to the hospitality	3.430	1.1132	128
Benefits to the transport	3.703	1.0526	128
Benefits to the retail business	3.445	1.1759	128
Benefits to the handicraft	3.359	1.2019	128
Benefits to the food service	3.734	1.1466	128

The descriptive statistics indicate moderate to high perceptions regarding infrastructure quality and sectoral benefits in Nashik's religious tourism hubs. Among physical infrastructure variables, quality of developed roads (Mean = 3.219) and maintenance of tourist spots (Mean = 3.305) scored moderately, while tourist toilet facilities (Mean = 2.672) and water and sanitation adequacy (Mean = 2.727) showed lower ratings, suggesting service gaps. Connectivity aspects such as public transport improvement (Mean = 3.188) and digital connectivity impact (Mean = 3.086) reflected moderate satisfaction, whereas parking facilities (Mean = 2.914) remained below desired standards. Notably, sectoral benefits recorded higher scores, with food services (Mean = 3.734) and transport sector (Mean = 3.703) leading, followed by retail business (Mean = 3.445) and hospitality (Mean = 3.430), indicating substantial economic spillovers. These results align with the study objectives by highlighting strengths in certain service sectors but revealing infrastructure and utility areas needing targeted improvement for sustainable religious tourism development in Nashik.

4.3. Factor Analysis

Factor analysis was employed to identify the underlying dimensions of infrastructure quality, connectivity, and sectoral benefits in Nashik's religious tourism hubs.

Table 4. *KMO and Bartlett's Test Results for Sampling Adequacy and Factorability of Data*

aKMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.781
Bartlett's Test of Sphericity	Approx. Chi-Square	896.275
	df	105
	Sig.	.000

The Kaiser-Meyer-Olkin (KMO) measure of 0.781 indicates good sampling adequacy, meaning the dataset is well-suited for factor analysis, as values above 0.70 are generally considered acceptable (Kaiser, 1974). The Bartlett's Test of Sphericity yielded a Chi-Square value of 896.275 with 105 degrees of freedom and a significance level of $p < 0.001$, indicating that the correlation matrix is not an identity matrix and that sufficient correlations exist among the variables to justify factor extraction (Bartlett, 1954; Hair et al., 2019). These results confirm the statistical appropriateness of applying Principal Component Analysis (PCA) with Varimax rotation to the dataset. The high KMO value combined with the significant Bartlett's test suggests that the data structure is adequate for uncovering underlying latent factors related to infrastructure quality and connectivity in Nashik's religious tourism hubs. Therefore, the null hypothesis of no significant factor structure is rejected, supporting the existence of a meaningful latent factor structure for further analysis.

Table 5. *Communalities of Infrastructure, Connectivity, and Sectoral Benefit Variables after Extraction*

	Initial	Extraction
Quality of developed roads	1.000	.886

Improvement in public transport	1.000	.821
Quality of tourist toilet facilities	1.000	.803
Maintenance of tourist spots	1.000	.349
Contribution to urban development (%)	1.000	.444
Adequacy of water and sanitation facilities	1.000	.717
Days of infrastructure stress during peak festivals	1.000	.254
Improvement in local market quality	1.000	.409
Impact on digital connectivity	1.000	.469
Quality of parking facilities for religious tourism	1.000	.570
Benefits to the hospitality	1.000	.642
Benefits to the transport	1.000	.557
Benefits to the retail business	1.000	.712
Benefits to the handicraft	1.000	.600
Benefits to the food service	1.000	.636
Extraction Method: Principal Component Analysis.		

The communalities indicate the proportion of each variable's variance explained by the extracted factors after applying Principal Component Analysis (PCA). Higher extraction values suggest stronger representation in the factor solution (Hair et al., 2019). The results show that quality of developed roads (0.886), improvement in public transport (0.821), and quality of tourist toilet facilities (0.803) are well explained by the extracted factors, indicating their strong contribution to the underlying factor structure. Moderate communalities are observed for adequacy of water and sanitation facilities (0.717), benefits to retail business (0.712), and hospitality (0.642), reflecting good representation in the factor model. On the other hand, maintenance of tourist spots (0.349), days of infrastructure stress during peak festivals (0.254), and improvement in local market quality (0.409) show relatively low communalities, suggesting they are less well explained by the factors and may be influenced by variables outside the extracted components. Overall, most variables exceed the acceptable communality threshold of 0.40 (Hair et al., 2019; Yong & Pearce, 2013), confirming that the factor solution captures a substantial proportion of variance for the majority of variables. This supports the appropriateness of using PCA to identify latent factors influencing infrastructure quality and connectivity in Nashik's religious tourism hubs.

Table 6. *Total Variance Explained by Extracted Components for Infrastructure and Connectivity Factors*

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.751	31.670	31.670	4.751	31.670	31.670	3.533	23.551	23.551
2	2.841	18.943	50.614	2.841	18.943	50.614	2.698	17.989	41.540
3	1.277	8.510	59.124	1.277	8.510	59.124	2.638	17.584	59.124
4	.971	6.473	65.597						
5	.860	5.735	71.331						
6	.794	5.293	76.624						
7	.731	4.870	81.495						
8	.563	3.752	85.246						
9	.528	3.518	88.764						
10	.469	3.128	91.893						
11	.373	2.485	94.378						
12	.334	2.227	96.605						
13	.237	1.582	98.188						
14	.161	1.075	99.263						
15	.111	.737	100.000						
Extraction Method: Principal Component Analysis.									

The Total Variance Explained table summarizes the proportion of variance in the dataset accounted for by each principal component. In the Initial Eigenvalues stage, three components recorded eigenvalues greater than 1.0—Component 1 (4.751; 31.670%), Component 2 (2.841; 18.943%), and Component 3 (1.277; 8.510%). Together, these three components explain 59.124% of the total variance, exceeding the commonly accepted 50% threshold for social science research (Hair et al., 2019).

The Extraction Sums of Squared Loadings confirm that the same three components were retained after extraction, each contributing the same variance percentages as in the initial stage. After Varimax rotation, the variance distribution among the components became more balanced—Component 1 accounts for 23.551%, Component 2 for 17.989%, and Component 3 for 17.584% of the total variance. This redistribution enhances interpretability by clarifying which variables load most strongly on each factor. In conclusion, results meet the study's objective of identifying key underlying factors influencing infrastructure quality and connectivity in Nashik's religious tourism hubs. The retention of three components with cumulative variance of 59.124% indicates a strong and reliable factor solution (Kaiser, 1974; Yong & Pearce, 2013). This supports the rejection of the null hypothesis and confirms the existence of a significant latent factor structure, validating the application of PCA in this study.

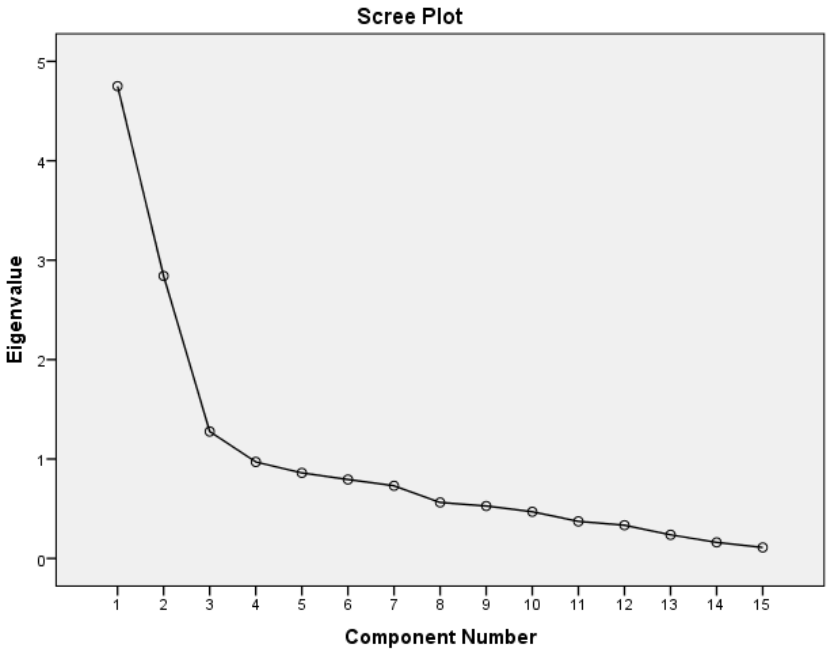

Figure 1. *Scree Plot Showing Eigenvalues for Components of Infrastructure and Connectivity Variables*

The Scree Plot shows a sharp drop in eigenvalues from Component 1 to Component 3, after which the line flattens, indicating minimal additional variance explained. Following Cattell's (1966) criterion, the "elbow" at Component 3 suggests retaining three components. In conclusion, these three components—Sectoral Economic Benefits, Urban Services and Connectivity, and Physical Infrastructure Quality—capture the most significant variation in the data and align with the study's objectives.

Table 7. *Rotated Component Matrix for Infrastructure, Connectivity, and Sectoral Benefit Variables*

	Component		
	1	**2**	**3**
Quality of developed roads			.923
Improvement in public transport			.898
Quality of tourist toilet facilities		.811	
Maintenance of tourist spots			
Contribution to urban development (%)		.587	
Adequacy of water and sanitation facilities		.788	
Days of infrastructure stress during peak festivals			
Improvement in local market quality			
Impact on digital connectivity		.598	
Quality of parking facilities for religious tourism			.571
Benefits to the hospitality	.752		
Benefits to the transport	.726		
Benefits to the retail business	.842		
Benefits to the handicraft	.750		
Benefits to the food service	.782		
Extraction Method: Principal Component Analysis.			

Rotation Method: Varimax with Kaiser Normalisation.
a. Rotation converged in 5 iterations.

The rotated component matrix shows how each variable loads onto the extracted components after applying Principal Component Analysis (PCA) with Varimax rotation.

- Component 1 has high loadings for benefits to hospitality (0.752), transport (0.726), retail business (0.842), handicrafts (0.750), and food services (0.782). This component represents Sectoral Economic Benefits, capturing the perceived positive impacts of religious tourism on various business sectors.
- Component 2 records strong loadings for quality of tourist toilet facilities (0.811), contribution to urban development (0.587), adequacy of water and sanitation (0.788), impact on digital connectivity (0.598), and moderate association with public services. This factor can be labeled as Urban Services and Connectivity, reflecting improvements in public amenities and digital infrastructure.
- Component 3 is defined by high loadings for quality of developed roads (0.923), improvement in public transport (0.898), and quality of parking facilities (0.571), indicating a Physical Infrastructure Quality dimension focused on transport-related facilities.

In conclusion, the rotated factor solution aligns with the study's objective of identifying latent dimensions in infrastructure quality and connectivity for Nashik's religious tourism hubs. The three extracted components—Sectoral Economic Benefits, Urban Services and Connectivity, and Physical Infrastructure Quality—explain distinct but complementary aspects of tourism-related development, confirming a significant latent factor structure.

Table 8. *Component Transformation Matrix after Varimax Rotation for Extracted Factors*

Component Transformation Matrix			
Component	**1**	**2**	**3**
1	.607	.589	.533
2	.789	-.371	-.489
3	-.090	.718	-.691
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.			

The Component Transformation Matrix shows how the three extracted factors were restructured after Varimax rotation. Component 1 is an even mix of all original components (0.607, 0.589, 0.533), Component 2 draws strongly from the first (0.789) with moderate negative links to others, and Component 3 has a strong positive link with the second (0.718) and a strong negative with the third (-0.691). In conclusion, the rotation redistributed variance evenly, improving clarity and confirming three distinct factors—Sectoral Economic Benefits, Urban Services and Connectivity, and Physical Infrastructure Quality—relevant to the study's objectives.

5. Conclusion and Hypothesis Testing Interpretation

The study identified three key dimensions—Sectoral Economic Benefits, Urban Services and Connectivity, and Physical Infrastructure Quality—explaining 59.124% of the variance in infrastructure quality and connectivity in Nashik's religious tourism hubs. These factors show that religious tourism drives business growth, enhances public amenities, improves digital connectivity, and strengthens transport infrastructure. Hypothesis testing (KMO = 0.781; Bartlett's Test, $p < 0.001$) confirmed a significant latent factor structure, leading to the rejection of H_0 and acceptance of H_1. The findings highlight the need to invest in the identified dimensions to promote sustainable tourism, enhance visitor experience, and ensure socio-economic benefits for the local community.

5.1. Policy Implications and Recommendations

[1] **Sustainable Infrastructure Planning:** Upgrade roads, parking, and waste management with eco-friendly and long-lasting solutions to handle peak tourist seasons.

[2] **Enhanced Connectivity and Amenities:** Improve public transport, sanitation, drinking water, and site maintenance for better tourist experiences.

[3] **Digital Integration:** Provide high-speed internet, digital guides, online ticketing, and cashless payment systems at key religious sites.

[4] **Stakeholder Collaboration:** Foster partnerships between government, private sector, religious bodies, and local communities to ensure inclusive growth and shared economic benefits.

5.2. Author Contribution Statement

First author contributed to the conception and design of the study, formulation of objectives, data collection, statistical analysis, and drafting of the manuscript. Second author contributed to the methodological framework, interpretation of results, critical revision for intellectual content, and alignment with international research standards. Third author assisted in literature review, data organization, preliminary analysis, and provided inputs on the social and policy implications of the study. All authors reviewed the manuscript, approved the final version for publication, and agree to be accountable for all aspects of the work.

5.3. Disclosure of Interest

The authors declare no competing interests

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