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Carrying Capacity-Based Urban Design Framework to Tackle Overtourism in the Pilgrim Sites of India

Devika D.K.P.[1,*], Sruthi Satheesan[2]

Abstract

Overtourism has emerged as a rapidly spreading concept across tourist destinations worldwide. Pilgrim sites, such as Varanasi, Vaishno Devi, and Tirupati, have suffered from the continuous surge of visitors, especially during peak seasons or festivals, causing environmental degradation, choking crowd situations and a lower visitor experience, and decline the quality of life for the residents. This, along with poor infrastructural planning, causes a significant threat to sustainable development in the pilgrim sites. Carrying capacity assessment is an approach to deal with the impacts of overtourism and develop sustainable development plans for the tourist destinations. Carrying capacity, as UNWTO explains, is the maximum number of people that can be at a tourist destination at the same time without damaging the physical, economic, and sociocultural environment or decline in visitor satisfaction. Despite being relevant, urban design and tourism developments are two areas that have not been integrated as often as in a planning approach. Bridging this gap, this study attempts to develop urban design strategies to mitigate overtourism impacts in the pilgrimage sites of India, using carrying capacity as a tool. The study will be limited to physical–ecological and sociodemographic dimensions of carrying capacity. The research aims to identify parameters, sub parameters, and ultimately develop design strategies that can be implemented at any pilgrimage site. The strategies adopted can be further detailed to suit the characteristics of a particular pilgrimage site that require carrying capacity-based design solutions for the same.

Keywords: Carrying capacity, overtourism, pilgrim sites, sustainable development, urban design

INTRODUCTION

Overtourism has been a global phenomenon spreading across tourist destinations around the world. Pilgrim sites in India too, are facing the challenges of overtourism, affecting the visitor experience and the quality of life of residents. According to Hindustan Times report by Bhushan [1], in July 2015, 27 pilgrims died in a stampede on the banks of the Godavari, where devotees had gathered on the opening day of "Pushkaram" festival in Andhra Pradesh's Rajahmundry district.

***Author for Correspondence**
Devika D.K.P.
E-mail: devikadevadas039@gmail.com

[1]Student, Department of Architecture and Planning, College of Engineering Trivandrum, Thiruvananthapuram, Kerala, India
[2]Assistant Professor, Department of Architecture and Planning, College of Engineering Trivandrum, Thiruvananthapuram, Kerala, India

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Similar cases have been reported from many other destinations as well. Pilgrim sites are spiritual abodes where people visit for religious reasons as well as for mental peace. These factors highlight the need for the study to tackle overtourism and develop sustainable development solutions for the pilgrimage sites.

Research shows that capacity and its components have already been defined and studied in different fields. Carrying capacity studies have been carried out in the fields of planning and other related fields, but there is a lack of an urban design perspective to

use carrying capacity as a tool, which is an identified research gap for the study. To develop an urban design framework to tackle overtourism in the pilgrimage sites of India by using carrying capacity as a tool. The main objectives of the study was understanding the theoretical concept of carrying capacity and overtourism, analyzing the overtourism trends and the challenges of urbanization in the pilgrim sites in India, identification of various urban design components and parameters to analyze carrying capacity through theories and comparative study of case studies and developing an urban design tool kit for assessing carrying capacity in the pilgrim sites and propose urban design strategies for the same.

OVERTOURISM IN THE PILGRIM SITES OF INDIA

Overtourism, in simple words, is the phenomenon of a high influx of tourists to a tourist destination in such a way that it negatively affects the visitor experience of tourists and quality of life of residents of that destination. It can be adapted per area according to infrastructure, locals' hardness toward tourists, environmental capacity, and natural resources. Overtourism can be caused by two factors, which are geographical characteristics and overall growth and development of a destination [2]. Pilgrim sites in India have long been drawing millions of tourists for both religious reasons and other leisure activities. Religious places, like Rishikesh, are global attractions for their scenic beauty, adventure, and religious tourism activities. Studies also find that overtourism affects the local communities in a negative manner, in aspects such as water availability, rent hiking, and availability of houses for rent [3]. One of the primary issues is neglecting the carrying capacity of the area, which puts a lot of pressure on the transportation network, combined with other climatic factors, causes landslides or accidents with death toll. For example, the Char Dham Yathra of Uttarakhand causes serious pressure on the transportation capacity for a very short season [4]. Another challenge is the disposal of waste, including the management of plastic waste that pollutes the sacred places. The third challenge is the commodification of religion, which affects the authenticity and sacredness of the pilgrimage site.

TOURISM CARRYING CAPACITY

According to the United Nations World Tourism Organization, Tourism Carrying Capacity (TCC) is the maximum number of people who can visit a tourist destination at any given time without leading to unwanted physical damage to the environment, economic, or sociocultural environment, or an unacceptable decrease in visitor satisfaction quality (Figure 1). The TCC has primarily three dimensions, which are the Natural – Ecological, Sociodemographic, and Economic–Political dimensions [5].

Figure 1. Dimensions of tourism carrying capacity.
Source: Sati (2018) [5].

O'Reilly [6] also described three components of TCC, which are as follows:

- *Physical carrying capacity (PCC):* how many people can use the place at a time without doing extensive physical harm to the surroundings and quality of life with visitors.
- *Social carrying capacity:* residents, or people who live near the tourist area, tolerance level on the number, and behaviors of tourists there.

There are two parts of SCC, which include: Before the number of alternative destinations (i) the quality of the visitor experience in case of tourists, (a) the tourist residency threshold – willingness of locals to have tourist.

- *Economic carrying capacity:* How much of the tourism functions local desirable activities and the least deterioration in tourist destinations that were hit due to the destruction of local attractions could be absorbed.

Theories Related to Carrying Capacity

The theories related to carrying capacity explain the various ways in which carrying capacity has been worked through and define the indicators or parameters used in the theories. Some of the major theories investigated are.

Limits of Acceptable Change (LAC) Theory

The LAC theory is a framework developed for managing the impacts of human activities on natural and cultural resources, especially in protected areas and wilderness settings (Table 1). It was introduced by Stankey, Cole, and others in the late 1970s. The main concept of LAC is that change is inevitable, but it should take place within the bounds that make its sustainability possible [7].

Table 1. Indicators in LAC theory.

Ecological Indicators	1. Species diversity. 2. Ecosystem health. 3. Habitat quality.
Social Indicators	1. Crowding levels. 2. Satisfaction ratings. 3. Perceptions of site quality.
Economic Indicators	1. The economic impacts of tourism on local people.

Source: Author.

Doxey's Irridex Model

Doxey's Irridex Model, created by George Doxey in 1975, offers a theoretical framework for comprehending the relationship between tourism development and host community attitudes toward visitors. It emphasizes how local perceptions of tourism change over time as tourist numbers rise and the strain on local resources and cultural traditions increases (Table 2). This model is especially pertinent for examining overtourism and its sociocultural effects on pilgrimage and heritage sites in India.

Table 2. Indicators in Doxy's Irridex model.

Social Indicators	1. Level of satisfaction and dissatisfaction among locals concerning tourist activities. 2. Instances of conflict or cooperation between locals and tourists. 3. Changes in cultural practices resulting from tourism influences.
Economic Indicators	1. The degree to which the local community economically benefits from tourism. 2. Perceived disparities in the distribution of benefits linked to tourism.
Environmental Indicators	1. Degradation of natural or built heritage. 2. Strain on infrastructure.
Cultural Indicators	1. Erosion of authenticity in cultural and religious practices. 2. Growing commercialization of pilgrimage sites and traditions.

Source: Author.

Tourism Area Life Cycle (TALC) Theory

The Tourism Lifecycle Theory, commonly referred to as Butler's Tourism Area Life Cycle (TALC) model, was proposed by Richard W. Butler in 1980. This framework delineates the progression of a

tourist destination over time, from its initial discovery to its possible decline. The theory posits that destinations, akin to consumer products, undergo a predictable life cycle influenced by tourism demand, the development of infrastructure, and outside pressures.

URBAN DESIGN IN TOURISM MANAGEMENT

The study conducted by Jamieson [8] explored the role of urban design in tourism destination management. They have simplified the dimensions of the destination management process and carrying capacity and urban design are two dimensions among them (Figures 2 and 3). They also explored the civic dimensions of placemaking that relate to urban design and tourism. Here, we can establish that carrying capacity and urban design are interrelated to provide better infrastructure, increase quality of life, provide a better experience to tourists, and maintain the sense of place for the resident population.

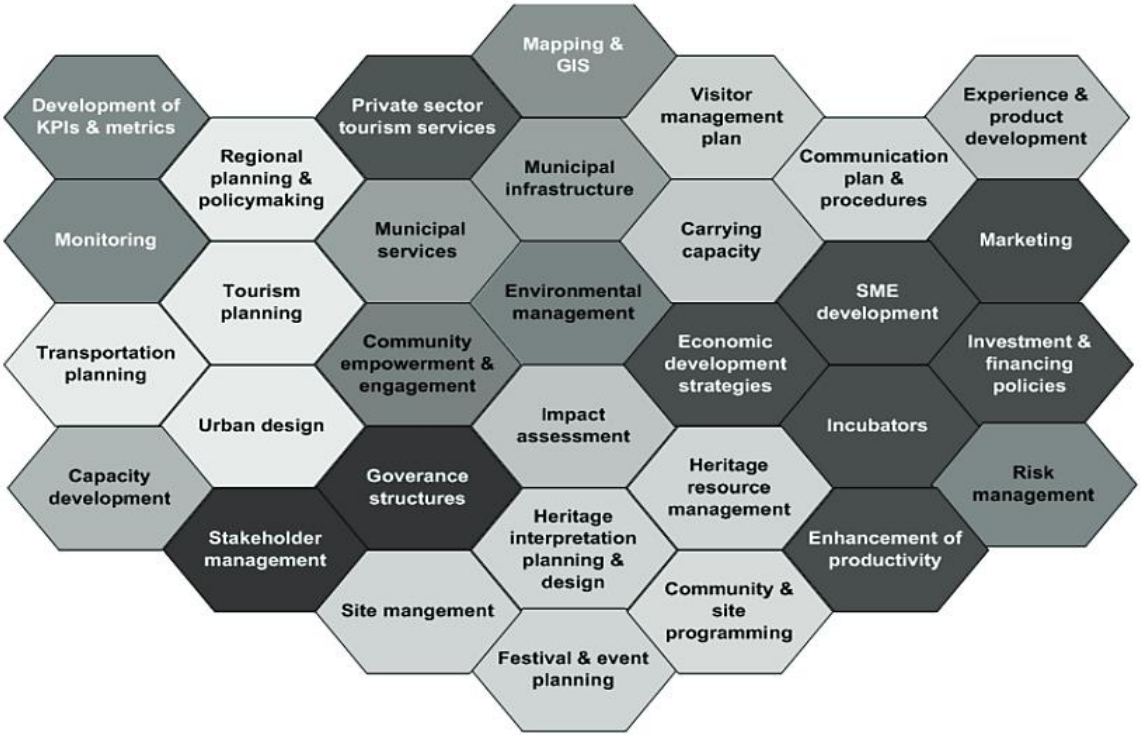


Figure 2. Dimensions of tourism carrying capacity.
Source: Jamieson and Jamieson (2014) [8].

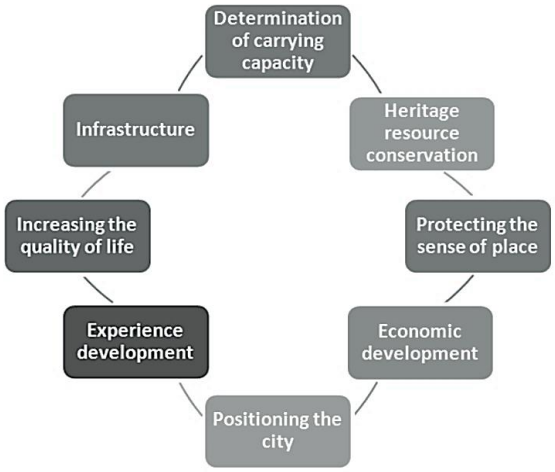


Figure 3. Dimensions of placemaking.
Source: Jamieson and Jamieson (2014) [8].

RESEARCH QUESTION

What are the urban design strategies that can be taken up to tackle overtourism in the pilgrimage sites of India to maintain the sustainability of the sites?

RESEARCH METHODOLOGY

The parameters are identified through the literature review of theories on carrying capacity and TCC. The overtourism trends in the Indian pilgrimage sites is also studied. After this, a few case studies that have calculated the carrying capacity of certain destinations are studied, and from the study, the parameters they have used are identified. After analyzing three case studies of different tourist destinations, parameters are listed down that can be analyzed from an urban design perspective. The sub parameters are found by analyzing other case studies that have effectively used parameters to solve urban issues. From this, a comparative analysis is done and finally strategies and guidelines for each of the components of carrying capacity are developed (Figure 4).

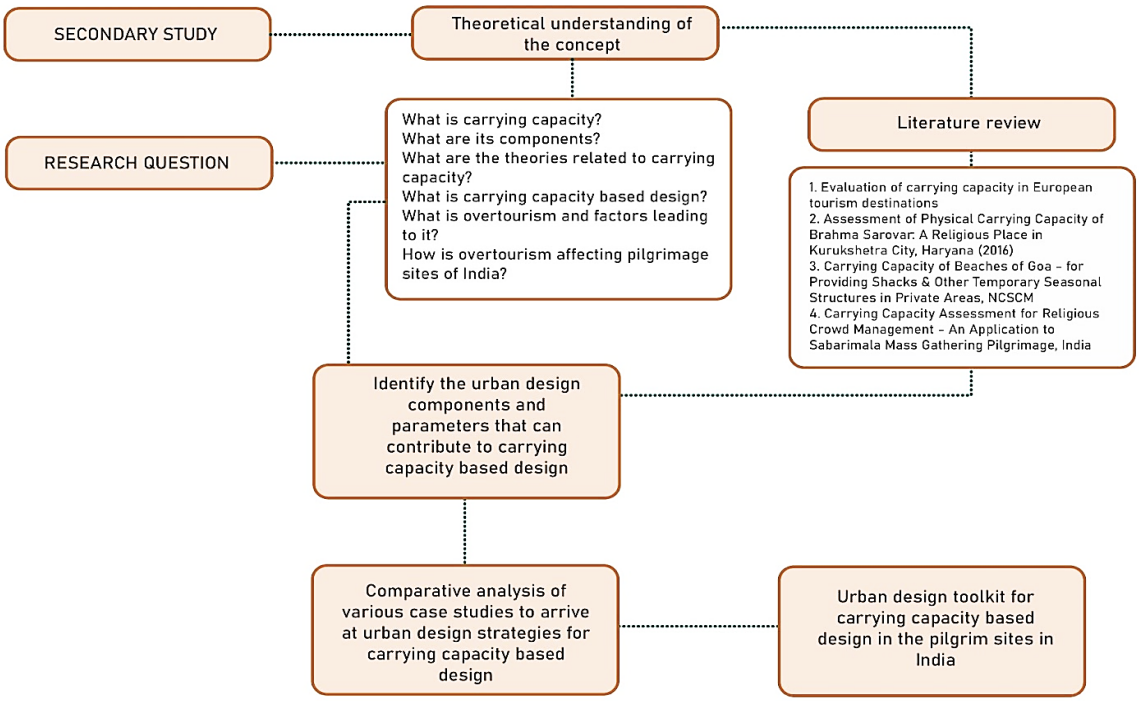


Figure 4. Research methodology.
Source: Author.

LITERATURE CASE STUDIES

Assessing the Carrying Capacity in European Destinations

The study by Coccossis [9] was aimed at building a systematized methodological framework, with enhancing the know-how on the TCC, i.e., measurement and application of this concept in practice specific to the European tourist destinations.

This report gives an understanding of the various factors that need to be investigated while assessing carrying capacity and identification of indicators for the same (Figure 5). In the Indian context, there are no specific studies that give an understanding of the different components of TCC rather, studies on any single component are available.

PCC Assessment of Brahma Sarovar, Kurukshetra City, Haryana

The paper focuses on Brahma Sarovar, which is part of the religious and tourism circuit extending from Mathura–Vrindavan in Uttar Pradesh to Kurukshetra in Haryana, India. This area is significant due to its religious importance and the inflow of pilgrims during major events (Figure 6).

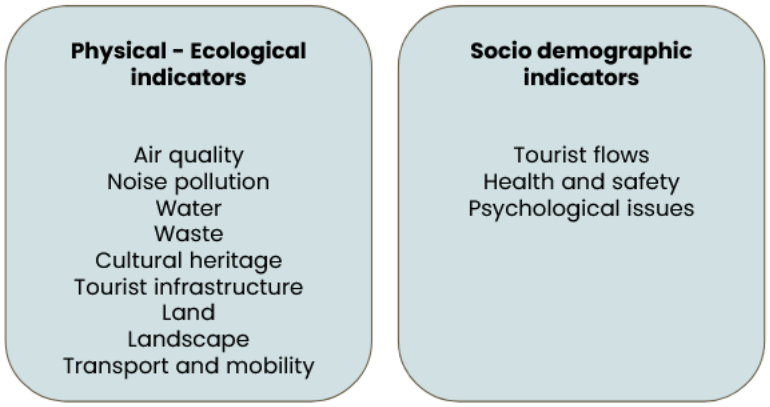


Figure 5. Indicators identified from the assessment.
Source: Coccossis et al. (2002) [9].

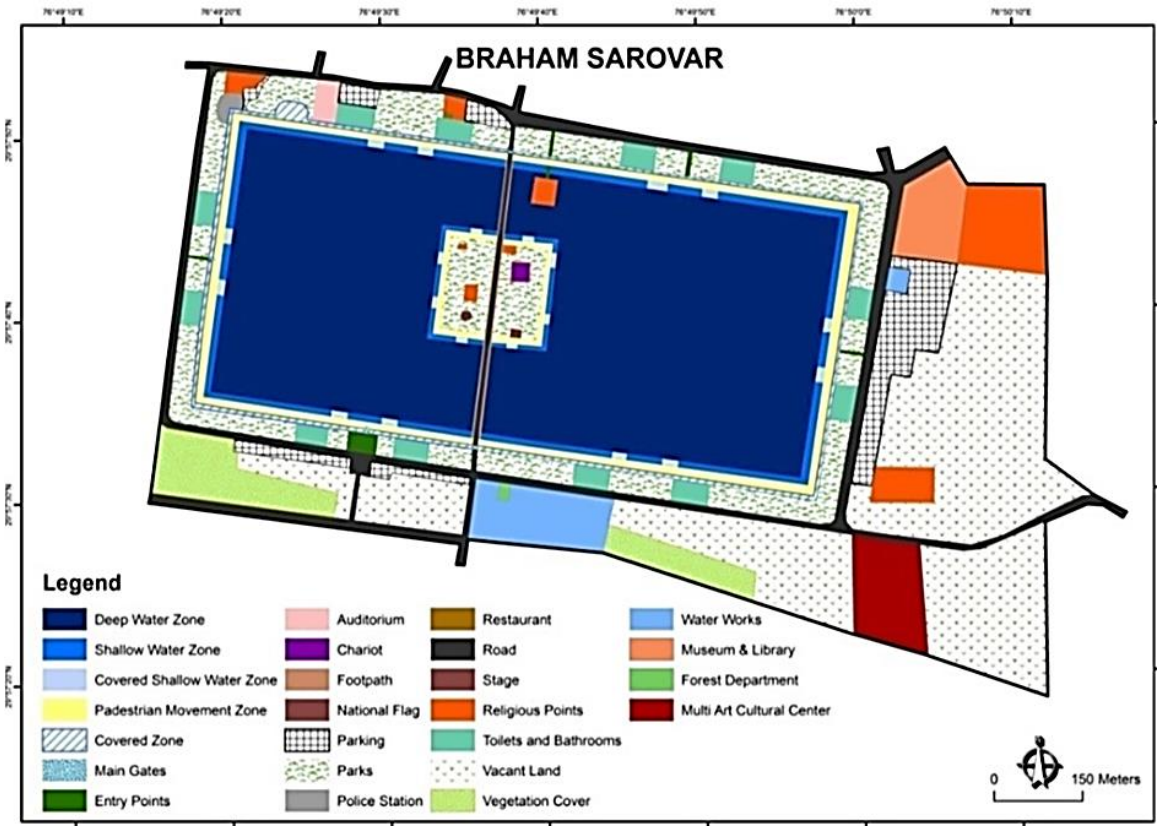


Figure 6. Land use landcover map of Brahma Sarovar.
Source: Jangra and Kaushik (2017) [10].

This analysis is carried out by analyzing the components as follows:

1. Land use and land cover
2. Parking capacity
3. Toilet and bathroom capacity
4. Drinking water capacity
5. Footpath capacity

The study calculated the PCC in the following method:

Physical Carrying Capacity (PCC) = A x V/a x f

Where, *PCC* = Physical Carrying Capacity

A = Area suitable for tourism (measured in square meters).

V/a = Appropriate space for displacement of tourists (number of tourists per square meter).

Rf = Rotation factor (number of visits per day).

The analysis was done using various methods, such as an unstructured questionnaire using random purposive sampling, and secondary data for identifying the number of toilets, drinking water points, etc. Quick bird imagery for preparing land use for the year 2014 [10–12]. From this paper, the components that need to be studied in the case of a pilgrimage site for assessing the PCC is identified.

PCC Assessment of Beaches in Goa

This NCSCM's (2016) [11] report studies the PCC of selected beaches in Goa and provides guidelines and standards for the number of shacks, the material to be used, and the heights up to which they can be built. For the carrying capacity study, they used various indicators such as:

- Overcrowding/congestion/ saturation number of beds per hectare (e.g., up to 50 beds/ ha for rural areas and up to 100 beds/ ha for urban areas).
- Tourist infrastructure (no. of beds to population) (rural – up to 0.5 and urban – up to 1).
- Area available (in sq. m) for tourists and residents (e.g., 50 sq m per person for rural areas and 25 sq m per person for urban areas).

For the analysis, they used different methods, including the use of instruments, such as GIS for measuring the beach area available for recreational purposes, enabled zoning of the beach stretches according to the different ecologically sensitive area, fishing space, river/creek areas, eroding areas, and the available beach area for erection of temporary shacks [13–15].

From the study, our key understanding is the calculation of total area available for tourism using the land use landcover map, and how guidelines can be proposed for temporary structures, including their height, setbacks, and architectural implications.

PCC Assessment of Sabarimala, Kerala

This paper, Illiyas et al. (2020) [12], discusses the pilgrimage to Sabarimala (Figure 7), located in Kerala, India. Sabarimala is one of the prime destinations for religious mass gatherings known for annual festivities that draw millions of devotees. The study defines the PCC of the site and includes:

- *Crowd Density Analysis:* Evaluating the comfortable and threshold crowd densities.
- *Space Utilization:* From active crowd areas to the various zones of observed space utilization values.
- *Pilgrimage Movement:* To observe inward, outward movements, and circulation of pilgrims during a 3-day period.

The paper identifies major influencing factors for pilgrim movement and crowd management as follows:

- *Service Level at the Holy Step:* This has been identified as the dominant factor controlling the pilgrim flow, especially in deity darshan (viewing of the deity).
- *Capacity at Darshan Facility:* This capability is essential in managing crowd movement, where pilgrims can gain darshan at a given capacity [16–19].

This paper was studied to understand how PCC can be analyzed for a pilgrimage site, such as Sabarimala, and the factors that can be considered to analyze the same. From the study, the main understanding is how the holy step, which was the crucial factor, was used for estimating the PCC.

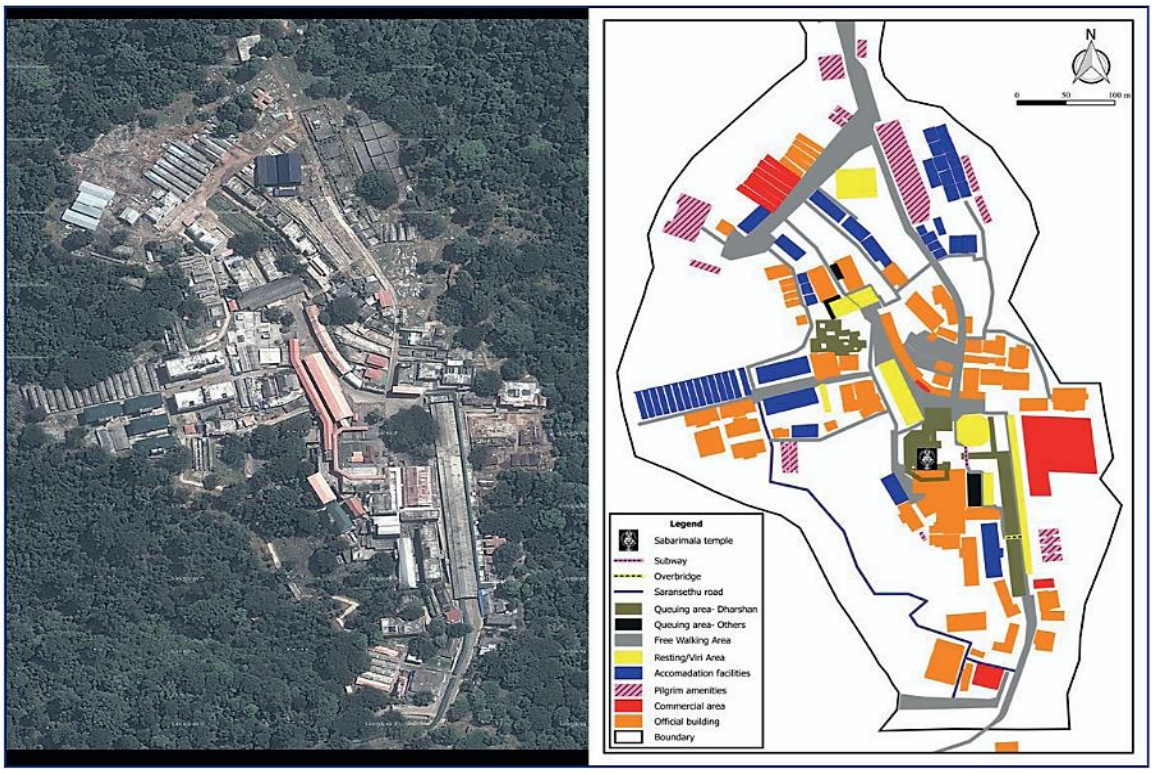


Figure 7. Space utilization map of Sannidanam, Sabarimala.
Source: Illiyas et al. (2020) [12].

PARAMETER DERIVATION

From the literature case studies done above, we have identified certain parameters or indicators that are used in the case studies. The Table 3 gives a conclusion of the literature review with parameters identified (Table 3).

The literature studied is analyzed using a comparative analysis, where the parameters used in different case studies are found and suitable parameters for the study is derived (Table 4).

From the theories studied and the literature case studies analyzed, parameters and sub parameters for developing strategies have been identified. Table 5 gives an understanding of the same.

STRATEGY DEVELOPMENT

The parameters and sub parameters identified are studied from an urban design perspective to understand how strategies could be developed for tackling overtourism in the pilgrimage sites. The Table 6 gives an understanding of the same (Table 6).

STRATEGIES AND GUIDELINES

After analyzing the strategies adopted by different pilgrim sites for each of the parameters found, the urban design strategies and PCC assessment have been identified (Tables 7 and 8).

For calculating PCC, the formula that is used:

Physical Carrying Capacity (PCC) = $A \times V/a \times f$

Where, *PCC* = Physical Carrying Capacity; *A* = Area suitable for tourism (measured in square meters); *V/a* = Appropriate space for displacement of tourists (number of tourists per square meter); *Rf* = Rotation factor (number of visits per day)

Table 3. Literature review summary.

Place of Research	Factors Studied	Methods Used	Parameters/Indicators Identified
Brahma Sarovar, Kurukshetra	• Area suitable for tourism • Appropriate space for displacement of tourists • Rotation Factor • Duration of usability • Visit duration	• Random Purposive Sampling • Quickbird imagery for preparing land use	• Land use. • Parking Capacity. • Toilet Capacity. • Footpath Capacity.
Beaches of Goa	• Regulated activities • Infrastructure availability • Ecologically sensitive areas • Shoreline changes • Villages with fishing activities	• GIS for data extraction • In-field surveys • Transect walks	Overcrowding/congestion/saturation.
Sabarimala	• Service level at holy step • Capacity of the darshan facility	• Field survey and GIS mapping • Field observations	• Total area. • Area available for pilgrim movement. • Crowd movement. • Usage. • Comfort. • Threshold. • Rotation factor. • Daily Capacity.

Source: Author.

Table 4. Comparative analysis of the three case studies and parameters identified.

Components	Case Study 1 (Brahma Sarovar)	Case Study 2 (Beaches of Goa)	Case Study 3 (Sabarimala)	Parameters Identified from Case Studies
Physical Carrying Capacity parameters	• *Parking Capacity* – no of vehicles per day at a time • *Toilet Capacity* – No of toilets required to satisfy the tourist population • *Footpath Capacity* – No of persons that can freely move per hour in any direction	Overcrowding/congestion/saturation Tourist infrastructure	Area available for crowd movement Space utilization by pilgrims Crowd density – standing crowd, moving crowd, resting crowd Rotation factor Circulation system	Parameters that can be used for framework: • Crowd density. • Space utilization. • Footpath Capacity. • Parking Capacity. • Circulation system.
Ecological Carrying Capacity parameters	• *Land use and its usage* – average space and time	Area available (in sq.m) for tourists and residents Water demand in peak seasons	–	• Land use and its usage. • Availability of land for tourists and residents. • Water demand.
Social Carrying Capacity parameters	–	Ratios of residents to tourists	Usage Comfort	• Resident tourist ratio. • Comfort (influenced by tourist flow).

Source: Author.

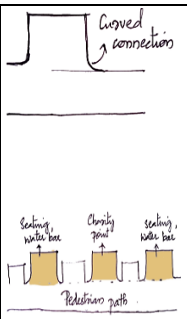
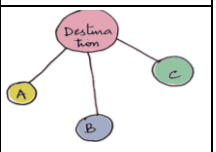
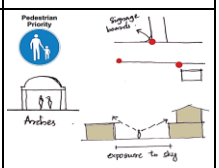
Table 5. Parameters and sub parameters identified.

Component	Parameters	Sub Parameters
Physical carrying capacity	Crowd density	• Hotspots. • Peak time of crowds. • User distribution with pedestrian behavior. • Wayfinding. • Crowd density and pedestrian speed. • Crowd density and visitor experience.
	Parking capacity	• Demand-capacity ratio. • Transport infrastructure analysis. • Future parking potential identification. • Parking facility experience of users.
	Circulation	• Pedestrian pathways. • Vehicular access points.

		• Traffic and pedestrian movement mapping. • Accessibility.
	Cultural heritage	• Heritage value. • Effect of tourism on built structures.
	Tourist infrastructure	Tourist bed/permanent population.
	Landscape	• Height of construction. • Architectural aspects.
Ecological carrying capacity	Land use and its usage	• Land use pattern transformation. • Land use contribution to overall capacity.
	Water demand	• Supply and demand study. • Population projections and seasonal variations. • Categorizing water use. • Impact of rituals on water demand. • Rainwater harvesting potential. • Toilet capacity w.r.t toilet demand.
Social carrying capacity	Tourist satisfaction level	Visitor satisfaction analysis.
	Resident satisfaction level	Tourist – resident ratio. Cultural impact analysis.

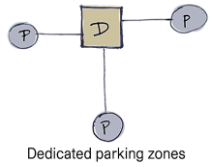
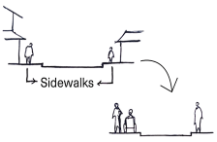
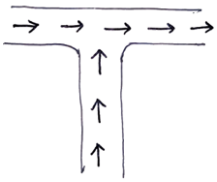
Source: Author.

Table 6. Strategies adopted.

S.N.	Parameter	Sub Parameters	Case Study	Strategy Adopted	
Physical Carrying Capacity					
1	Crowd density	Hotspots Peak time in crowd User distribution with pedestrian behavior Wayfinding Crowd density and pedestrian speed Crowd density and visitor experience	Hajj Pilgrim Site, Mekkah Kadi, S., Abdullah, A., Bachok, S., Baydoun, Z., & Berghout, A. (2024). Analysis Of the Crowd Management and Pedestrian Movement During Hajj Pilgrimage on Makkah. Planning Malaysia, 22. https://doi.org/10.21837/pm.v22i34.1601	Introduction of public squares with water bars, seating and waiting areas. Curved connection between the pathway and redesigned squares to mobilize the flow of crowd Services were placed out of the right of way Entrances were cleared of any obstruction. Larger bathrooms were constructed to accommodate the crowd.	
			Managing Crowds at Events and Venues of Mass Gatherings NDMA. Managing Crowd at Events and Venues of Mass Gathering, A Guide for State Government, Local Authorities, Administrators and Organizers; 2014.	Multiple routes need to be encouraged, especially for vulnerable groups with varied gradient (normal, expressway, emergency).	
			Higher Density Environments and the Critical Role of City Streets as Public Open Spaces Wen L, Kenworthy J, Marinova D. Higher Density Environments and the Critical Role of City Streets as Public Open Spaces. Sustainability. 2020;12(21):8896. https://doi.org/10.3390/su12218896	Street as viewing corridor – framed by low to medium rise buildings Streets as multi-purpose spaces – Pedestrianizing the streets and disincentivize vehicle use Entry points to the site emphasized through elements, such as arches, changes in street surface and color. Wayfinding measures, such as signages, indicating pedestrian priority.	

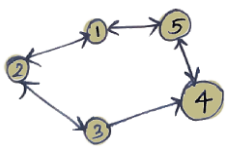
Source: Author.

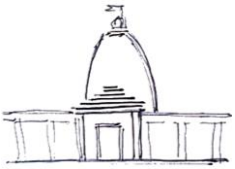
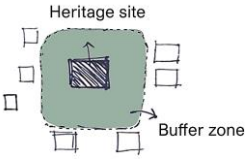
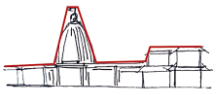
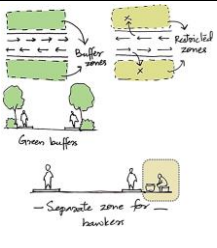
Table 7. Urban design strategies adopted.

S. N.	Parameter	Sub Parameter	Case Study	Strategies Adopted	
2	Parking Capacity	Demand-capacity ratio Transport Infrastructure analysis	Nanjangud, India Dash, M, Devi R, Bhat AR, N, S. D., Kokeri KK, N, SH. Influence of walkability parameters on people's mobility in a pilgrimage town: A case study of Nanjungud, India. JAsian Architect Build Eng. 2024:1–16. https://doi.org/10.1080/13467581.2024.2402775	Developing parking policy and dedicated parking zone. Effective parking layout design for organized parking.	
		Future parking potential identification Parking facility experiences for users	Renukamata Mandir, Mahur Mahalaxmi Temple, Kolhapur, Shinde P, Kashid MG. Explication for Haphazard and Uncontrolled Development Around the Pilgrim Centre-mohta Devi and Its Impacts in Its Vicinity. International Journal of Engineering Research & Technology (IJERT), ISSN: 2278-0181. 2024 May;13(5).	Integrating entry and exit points with parking areas for better vehicular flow. Barrier free designs to create inclusivity.	
3	Circulation	Pedestrian pathways	Nanjangud, India Dash, M, Devi R, Bhat AR, N, SD, Kokeri KK, N, SH. Influence of walkability parameters on people's mobility in a pilgrimage town: a case study of Nanjungud, India. J Asian Architect Build Eng. 2024:1–16. https://doi.org/10.1080/13467581.2024.2402775	Proper sidewalks throughout the area for pedestrians. Proper segregation of vehicular and pedestrian movements. Barrier free pathway designs for inclusive public spaces.	
		Vehicular access points Traffic and pedestrian movement mapping	Hajj Pilgrim Site, Mekkah Kadi S, Abdullah A, Bachok S, Baydoun Z, Berghout A. Analysis of the crowd management and pedestrian movement during Hajj pilgrimage on Makkah. Planning Malaysia. 2024. p.22. https://doi.org/10.21837/pm.v22i34.1601	Implementation of one-way systems. Designated drop-off zones for streamlining traffic flow. Widening the pedestrian footpath to accommodate the crowd.	

Source: Author.

Table 8. Strategies adopted from case studies.

S. N.	Parameter	Sub Parameters	Case Study	Strategies Adopted	
3	Circulation	Accessibility assessments	Chandan S, Kumar A. Challenges for urban conservation of core area in pilgrim cities of India. J Urban Manage. 2019;8(3):472–484. https://doi.org/10.1016/j.jum.2019.05.001	Traffic within the historic towns needs to be controlled. Improve linkage and tourist infrastructure.	

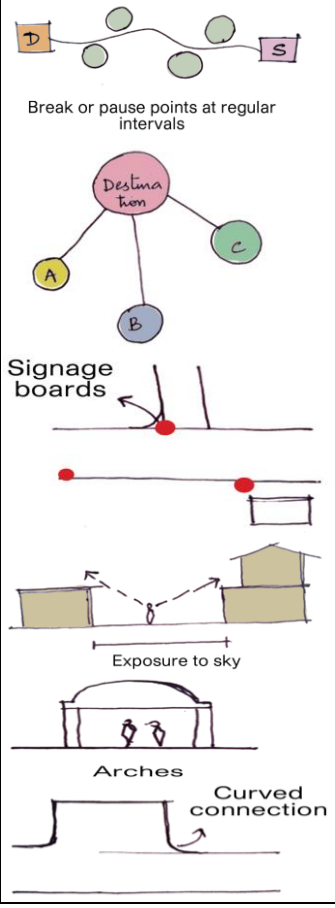
4	Cultural Heritage	Heritage value	Chandan S, Kumar A. Challenges for urban conservation of core area in pilgrim cities of India. J Urban Manage. 2019;8(3):472–484. https://doi.org/10.1016/j.jum.2019.05.001	Protection of heritage structures and cultural landscape. Adaptive reuse heritage buildings around the religious structures, if possible.	
		Effect of tourism on built structures	Shinde P, Kashid M. G. Explication for Haphazard and Uncontrolled Development Around the Pilgrim Centre-Mohta Devi and Its Impacts in Its Vicinity. International Journal of Engineering Research & Technology (IJERT), ISSN: 2278-0181. 2024 May;13:5.	Establish a restricted or buffer zone around the sacred space to maintain the ambiance. Enlighten the visitors regarding the heritage importance of the pilgrim site.	
5	Landscape	Height of construction	Planning for urbanization in religious tourism destinations: Insights from Shirdi, India	Restrict height of built structures around the religious structure to ensure its prominence in the landscape. Local architectural style of the area needs to be followed at least in a 500m radius.	
		Architectural aspects	Chandan S, Kumar A. Challenges for urban conservation of core area in pilgrim cities of India. J Urban Manage. 2019;8(3):472–484. https://doi.org/10.1016/j.jum.2019.05.001	Limit the building heights to ensure the prominence of religious structure in the landscape. Preserve structures of cultural importance	
Ecological Carrying Capacity					
1	Land use and its usage	Land use pattern transformation	Shirdi Temple, India, Kiran A. Shinde (2016): Planning for urbanization in religious tourism destinations: insights from Shirdi, India, Planning Practice & Research.	Mixed use developments are preferred for pedestrian movement Zoning regulations for heritage preservation areas.	

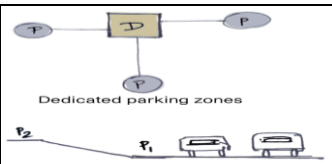
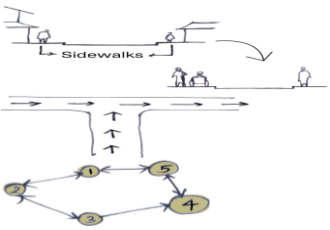
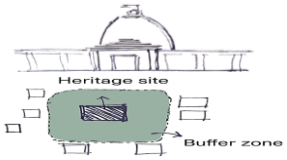
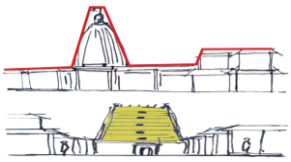
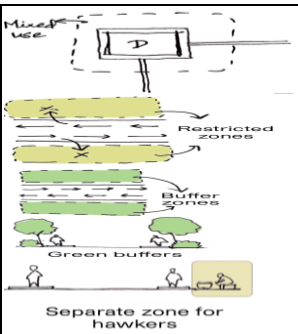
		Landuse contribution to overall capacity	Explication of Haphazard and Uncontrolled Development Around the Pilgrim Centre – Mohta Devi and its vicinity	Restrict activities to certain areas by providing corridors or buffer areas, especially in hilltops Vehicular and pedestrian movement restricted to certain areas Removal of illegal encroachments to increase usable areas Create hawkers' zone for vendors.	

Source: Author.

After finding out the PCC, the urban design strategies that can be followed are given in Table 9:

Table 9. Strategies for pilgrim site.

S.N.	Parameters	Sub Parameter	Strategies Adopted	
Physical Carrying Capacity				
1	Crowd density	Hotspots	Integrate public squares into the built fabric for decentralizing the crowd. Provide sanitation facilities, resting and waiting areas for the users. Wherever turn points are present, it should be curved to mobilize the flow of the crowd. Introduce pause points for the users at regular intervals to pause and rest and continue the journey. Incorporate multiple routes for vulnerable groups, especially elderly Pedestrianize areas near to the pilgrim site for smooth flow of the crowd. Entry points and exit points to be given due importance and designed to stand out for easy locating – these could be arches, changes in street surface or color. Signages showing pedestrian prioritized routes for sense of direction. Street as a viewing corridor – exposure to sky gives sense of less crowding.	
		Peak times of crowd		
		User distribution with pedestrian behavior		
		Wayfinding		
		Crowd density and pedestrian speed		
		Crowd density and visitor experience		

2	Parking capacity	Demand-capacity ratio Transport Infrastructure analysis Future parking potential identification Parking facility experiences for users	Provision for dedicated parking zones for the users will reduce the waiting time for vehicles Parking layout to be effective for organized parking. Easy entry and exit to the parking area will ensure smoother flow of vehicles. Provide barrier free designs for inclusiveness Disable friendly parking as per standards to be provided	
3	Circulation	Pedestrian pathways Vehicular access points Traffic and pedestrian movement mapping Accessibility assessments	Provide pedestrian pathways throughout for seamless connectivity. Segregate vehicle and pedestrian movements to avoid conflicts. Provide barrier free pedestrian paths for better accessibility. Wherever alternate routes cannot be proposed, one-way systems can be implemented. Drop off zones need to be designated for safety. Wherever area is available, pedestrian footpaths can be widened and vehicular. Carriageways can be minimized to promote walkable streets.	
4	Cultural heritage	Heritage values Impact of tourism on heritage structures Cultural activities	Adaptive reuse heritage buildings around the religious structures, if possible. Establish a restricted or buffer zone around the sacred space to maintain the ambiance. Enlighten the visitors regarding the heritage importance of the pilgrim site.	
5	Landscape	Height of construction Architectural aspects	Restrict height of built structures around the religious structure to ensure its prominence in the landscape. Preserve structures of cultural importance. Local architectural style of the area needs to be followed at least in a 500 m radius.	
Ecological Carrying Capacity				
1	Land use and its usage	Land use pattern transformation Land use contribution to overall capacity	Zoning regulations need to be addressed for heritage and cultural zones. If it is an urban area, the area surrounding the sacred space may be of mixed use, to encourage pedestrians to walk. In hilltops or mountainous regions, restricting activities by providing buffer zones or corridors will be effective to prevent environmental degradation. Vehicular movement may be restricted in some areas depending on its capacity. Illegal encroachments need to be removed to increase usable area. Create separate zones for vendors.	

Source: Author.

CONCLUSIONS

With the growing nature of pilgrimage tourism, it has grown into one of the biggest issues, affecting the strain on infrastructure, degradation of the environment, and dilution of culture. A carrying capacity framework provides a structured approach to analyze and manage the physical, social, and environmental limits of these sites. The thresholds of visitors and visitor impact on residents and communities, and ecosystems can then work as a good guide for all stakeholders to make decisions about both preservation and accessibility. The study analyzed various case studies to carry out a carrying capacity assessment, especially in pilgrimage sites. The strategies adopted can be further detailed to suit the characteristics of a particular pilgrim site that requires carrying capacity-based assessment and design solutions for the same. The balance of the visitor needs with that of the residents and communities and the environment will allow India to conserve its rich cultural heritage, welcoming millions of pilgrims every year. In doing so, it may be of prime importance in designing resilient pilgrimage destinations that honor tradition and modernity.

Declaration of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript.

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Abbreviations

TCC	Tourism Carrying Capacity.
PCC	Physical Carrying Capacity.
SCC	Social Carrying Capacity.

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