

PEDESTRIAN FACILITIES USING SERVICE LEVEL BENCHMARK

Bachelor of Planning

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PEDESTRIAN FACILITIES USING SERVICE LEVEL BENCHMARK

*A Thesis Project
submitted in partial fulfillment of the requirements for
the award of the degree of*

Bachelor of Planning

By
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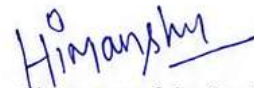
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DECLARATION

I **HIMANSHU SINGHAL**, Scholar No **2211002136** hereby declare that the thesis titled Pedestrian Facilities Using Service Level Benchmark submitted by me in partial fulfilment for the award of degree of Bachelor of Planning, at Maulana Azad National Institute of Technology, Bhopal, India, is a record of Bonafide work carried out by me. The matter/result embodied in this thesis has not been submitted to any other University or Institute for the award of any degree or diploma.

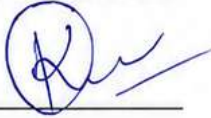

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CERTIFICATE

This is to certify that the declaration made by **HIMANSHU SINGHAL** is true to the best of my knowledge and that the student has worked under my guidance for one semester in preparing this thesis.

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Contents

TABLES AND GRAPHS	v
Chapter 1: UNDERSTANDING DEVELOPMENT	1
1.1 Introduction.....	1
1.2 Conceptual and Policy Framework	2
1.2.1 Complete Street Concept.....	2
1.2.2 Safe Street Concept.....	2
1.2.3 Service Level Benchmarks (SLB).....	3
1.2.4 IRC:103–2012 Guidelines	3
1.3 Literature Review (Overview)	3
1.4 Need for the Study and Research Gap.....	4
1.5 Aim and Objectives	5
1.5.1 Aim.....	5
1.5.2 Objectives	5
1.6 Research Questions	5
1.7 Study Area Profile: Atal Path, Bharatpur.....	6
1.8 Relevance of Study Area – Atal Path, Bharatpur	7
1.9 Expected Outcomes.....	9
1.10 Scope and Limitations	9
1.10.1 Scope	9
1.10.2 Limitations.....	9
Chapter 2: Literature Review, Policies, and Case Studies	11
2.1 Review of National and International Literature.....	11
2.1.1 The Foundational Role of Walking in Urban Mobility	11
2.1.2 Pedestrian Level of Service (LOS) Concepts and Evolution.....	11
2.1.3 International Perspectives on Pedestrian Planning.....	12
2.1.4 Pedestrian Planning in the Indian Context.....	12
2.1.5 The Role of Service Level Benchmarks (SLB) in India.....	12
2.2 Review of Policies, Standards, and Case Studies.....	13

2.2.1 Policies and Standards.....	13
2.2.2 Case Studies: Global and National Best Practices	17
2.3 Identification of Research Gaps and Best Practices	19
2.3.1 Research Gaps.....	19
2.3.2 Best Practices	20
2.4 Detailed Base Maps	22
2.4.1 Importance of Base Maps in Pedestrian Assessment	23
2.4.2 Key Layers for Base Maps of Atal Path	24
CHAPTER 3 : CASE STUDIES AND BEST PRACTICES	26
3.1 Criteria for Selection of Case Studies	26
3.2 Indian Case Study 1: Pedestrian Improvement Project, Connaught Place, Delhi.....	27
3.3 Indian Case Study 2: Complete Streets Initiative, Pune	27
3.4 International Case Study 1: Times Square Pedestrianization, New York	28
3.5 International Case Study 2: Exhibition Road, London.....	29
3.6 Comparative Analysis of Case Studies	29
3.7 Best Practices Derived from Case Studies	30
3.8 Applicability to Study Area.....	30
3.9 Conclusion of Case Studies	30
CHAPTER 4: METHODOLOGY	31
Key Components of Methodology	31
4.1 Research Design and Approach	31
4.2 Study Area Selection and Delineation	32
4.3 Segmentation of Study Corridor	32
4.4 Data Collection Methodology	35
4.5 Physical Infrastructure Survey	36
4.6 Pedestrian Volume Count Survey	37
4.7 Service Level Benchmark (SLB) Assessment	39
4.8 Pedestrian Level of Service (LOS) Analysis	40
4.9 User Perception Survey	40
4.10 Data Analysis Techniques	41
4.11 Integration of Findings.....	41

CHAPTER 5: DATA ANALYSIS AND INTERPRETATION 42

5.1 Overview of Existing Conditions	42
5.2 Physical Infrastructure Analysis	43
5.3 Pedestrian Volume Analysis	45
Flow Characteristics	46
5.4 Pedestrian Demographics Analysis	47
5.4 Service Level Benchmark (SLB) Analysis	48
5.5 Level of Service (LOS) Analysis	49
5.6 User Perception Analysis	50
.....	51
5.7 Safety Analysis	52
5.8 Gap Analysis	52
5.9 Priority Zone Identification.....	52
5.10 Statistical and Qualitative Analysis of Pedestrian Conditions	53
5.10.1 Introduction.....	53
5.10.2 Level of Service (LOS) Analysis	53
5.10.3 Identification of Key Safety Issues	54
5.10.4 Tourist Perception Analysis	55
5.10.5 Pedestrian Demographics and Survey Insights.....	56
5.10.6 Priority Zone Identification	56
5.10.7 Qualitative Insights and User Feedback	57
5.11 Key Insights and Interpretation	58
5.12 Conclusion of Data Analysis.....	58

CHAPTER 6: PROPOSALS AND STRATEGIES 59

Objectives of Proposals	59
6.1 Proposal Framework and Planning Approach.....	59
6.2 Proposal 1: Safe and Accessible Pedestrian Crossings.....	60
6.3 Proposal 2: Continuous and Barrier-Free Footpaths	62
6.4 Proposal 3: Encroachment Management and Vendor Integration.....	64
6.5 Proposal 4: Street Lighting and Night-Time Safety	65
6.6 Proposal 5: Pedestrian Wayfinding and Tourist Support System.....	66
6.7 Proposal 6: Traffic Calming Measures	67

6.8 Proposal 7: Universal Accessibility Design	68
6.9 Proposal 8: Green Infrastructure and Streetscape Enhancement	69
6.10 Proposal 9: Priority Zone Development	70
6.11 Implementation Strategy	71
Conclusion Points.....	71
6.12 Proposal: 4E Framework and Service Level Benchmarking (SLB) for Pedestrian Infrastructure.....	72
6.12.1 Proposed Strategy.....	72

CHAPTER 7: CONCLUSION AND RECOMMENDATIONS 76

7.1 Summary of Key Findings	76
7.2 Effectiveness of Methodology	77
7.3 Achievement of Study Objectives	77
7.4 Planning Implications	78
7.5 Recommendations for Improvement	78
7.6 Scope for Future Research	79
7.7 Final Conclusion	80

CHAPTER 8: IMPLEMENTATION FRAMEWORK AND COST ANALYSIS 81

8.1 Implementation Strategy and Approach	81
8.2 Phasing of Development.....	82
8.3 Stakeholder Involvement and Institutional Framework	82
8.4 Cost Estimation of Proposed Interventions	83
8.5 Cost-Benefit Analysis	83
8.6 Funding Mechanisms.....	84
8.7 Monitoring and Evaluation Framework.....	84
8.8 Risk Assessment and Mitigation	84
8.9 Conclusion of Implementation Framework	85
References.....	86

TABLES AND GRAPHS

Table 2.1: MoHUA Service Level Benchmarks for Pedestrian Infrastructure Facilities

Table 4.1: Segment-wise Characteristics of Study Corridor

Graph 4.1: Segment-wise Pedestrian Volume (Bar Graph)

Graph 4.2: Land Use Distribution (Pie Chart)

Graph 4.3 : Segment Length Distribution (Pie Chart)

Table 4.2: Segment-wise Issues Identified

Graph 4.4:-Comparison of physical infrastructure performance across study segments

Table 4.3: Physical Infrastructure Audit Checklist with Scores

Graph 4.4:- Segment vs pedestrian volume

Graph 4. 6: - % road with footpath vs without footpath

Table:- 5.1 Pedestrian Safety Perception Survey

Table:- 5.2 Pedestrian Volume Count

Bar Chart:- 5.3 Pedestrian Volume Segment

Bar Chart :- 5.4 Age Group Distribution

Pie chart:- 5.5 Male Female Distribution

Table: - 5.5 LOS classification per segment

Bar Chart:- 5.6 LOS values per Segment

Bar Chart:- 5.7 Age group distribution

Figure 5.8: Segment-wise LOS Comparison (Morning vs Evening)

Figure 5.9: Major Pedestrian Safety Issues

Caption: Figure 5.10: Tourist Perception of Pedestrian Infrastructure

Figure 5.11: Tourist Demographic Distribution

Figure 5.12: Priority Zone Classification

Bar Chart:- 5.13 Suggested Heat Map

Chapter 1: UNDERSTANDING DEVELOPMENT

1.1 Introduction

Urban mobility in India has long been characterized by a predominant focus on motorized transport planning, often at the expense of the fundamental needs of pedestrians. This historical bias has created urban environments that are frequently hostile to walking, despite its intrinsic value. Walking remains the most inclusive, affordable, and environmentally sustainable mode of transport, forming the backbone of urban accessibility for a vast majority of the population. In Indian cities, it is estimated that approximately 30–40 percent of all daily trips are completed entirely on foot, and virtually all trips, regardless of their primary mode, involve a walking component at some stage [1]. Consequently, the quality and availability of pedestrian infrastructure are paramount in shaping urban livability, accessibility, and social equity.

However, the reality on the ground in most Indian cities presents a stark contrast to this ideal. Pedestrian infrastructure is typically fragmented, characterized by discontinuous footpaths, widespread encroachments, inadequate widths, perilous crossings, insufficient lighting, and a pervasive lack of universal accessibility. These deficiencies frequently compel pedestrians to utilize carriageways, thereby exposing them to direct conflicts with fast-moving vehicular traffic. This precarious situation has directly contributed to alarmingly high pedestrian accident rates, making pedestrian safety a critical and escalating urban concern. The problem is particularly acute in medium and small cities, where the pace of rapid urbanization has far outstripped the development of adequate and thoughtfully planned infrastructure.

In recognition of these profound challenges, there has been a gradual but discernible shift in national urban policies. The trajectory is moving away from a purely vehicle-centric planning paradigm towards a more people-centric approach to street design. Emerging concepts such as Complete Streets and Safe Streets advocate for a fundamental re-imagining of streets not merely as conduits for traffic, but as vibrant public spaces. These concepts champion the idea that streets must be designed to safely and comfortably accommodate all users, encompassing pedestrians, cyclists, children, the elderly, and persons with disabilities. Within this evolving framework, streets are recognized as vital urban arteries that contribute significantly to economic activity, foster social interaction, and enhance overall environmental quality.

To facilitate evidence-based planning and ensure accountability, the Ministry of Housing and Urban Affairs (MoHUA) has introduced Service Level Benchmarks (SLBs) for urban services. These SLBs provide a set of measurable indicators designed to assess the quality of infrastructure services from the perspective of the end-user. For pedestrian facilities, the SLBs focus on a range of critical parameters, including footpath coverage, continuity, width adequacy, the provision of safe crossing facilities, appropriate lighting, universal accessibility, and the overall Pedestrian Level of Service (LOS). This performance-based approach enables an objective evaluation and comparison of pedestrian infrastructure across diverse urban contexts, allowing cities to identify specific areas for improvement and prioritize strategic investments.

Bharatpur, a tier-2 historic city located in Rajasthan, exemplifies a context with high pedestrian dependence. Its compact urban form, mixed land use patterns, and limited public transport options naturally lead to a significant reliance on walking. Atal Path, a key urban corridor within Bharatpur, has been developed with the explicit intention of improving street conditions. Nevertheless, the actual performance of pedestrian facilities along this corridor, particularly concerning safety, accessibility, and comfort, necessitates a systematic and rigorous evaluation. This study directly addresses this need by applying the established SLB and LOS frameworks to comprehensively assess the existing pedestrian infrastructure along Atal Path, thereby identifying the discrepancies between planned provisions and the on-ground reality.

1.2 Conceptual and Policy Framework

The assessment of pedestrian facilities is deeply rooted in a conceptual and policy framework that has evolved to prioritize sustainable and inclusive urban mobility. This section elaborates on the key concepts and policies guiding the present study.

1.2.1 Complete Street Concept

The Complete Street Concept represents a transformative approach to urban street design. It advocates for streets that are planned, designed, operated, and maintained to enable safe, convenient, and comfortable access for all users, regardless of their age, ability, or mode of transport. This holistic vision moves beyond the traditional vehicle-centric model to create balanced and equitable street environments. A truly complete street integrates various elements, including continuous and unobstructed footpaths, dedicated cycle tracks, safe and clearly marked pedestrian crossings, accessible public transport stops, and effective traffic calming measures. The core principle is the equitable distribution of street space, consciously prioritizing vulnerable road users such as pedestrians and cyclists. In the Indian context, the adoption of complete street principles is increasingly recognized as vital for enhancing walkability, improving safety, and fostering more vibrant urban public spaces.

1.2.2 Safe Street Concept

Complementing the Complete Street approach, the Safe Street Concept is fundamentally focused on reducing road crashes, injuries, and fatalities. This concept operates on the understanding that road safety is not solely a function of individual user behavior but is significantly influenced by the design and characteristics of the infrastructure itself. Safe streets are engineered to minimize risks by addressing critical design elements, implementing effective speed management strategies, ensuring optimal visibility for all users, and mitigating conflict points between different modes of transport. Key features of safe streets include the incorporation of raised crossings, the provision of refuge islands for pedestrians at wide intersections. These elements collectively work to create a protective environment for pedestrians and cyclists, thereby enhancing overall road safety.

1.2.3 Service Level Benchmarks (SLB)

The Service Level Benchmarks (SLB), introduced by the Ministry of Housing and Urban Affairs (MoHUA), provide a crucial framework for assessing the performance of urban infrastructure and services. For pedestrian facilities, the SLB framework represents a paradigm shift from merely measuring the availability of infrastructure to evaluating the actual quality of service delivered to the user. The indicators within the SLB framework for pedestrian facilities are designed to assess performance across several critical dimensions: accessibility, safety, comfort, continuity, and capacity. By providing measurable metrics, SLBs empower urban local bodies to objectively identify service gaps, benchmark their performance against national standards, and strategically prioritize investments based on evidence-based performance outcomes. This systematic approach ensures that infrastructure development is responsive to user needs and contributes to tangible improvements in urban quality of life.

1.2.4 IRC:103–2012 Guidelines

The Indian Roads Congress (IRC) Code 103:2012 – Guidelines for Pedestrian Facilities stands as a foundational technical document for the planning, design, and maintenance of pedestrian infrastructure in urban areas across India [15]. This comprehensive guideline provides detailed specifications and recommendations for a wide array of pedestrian-related elements. It covers crucial aspects such as the minimum and desirable widths for footpaths, design standards for various types of pedestrian crossings, specifications for ramps to ensure universal accessibility, and the implementation of tactile paving for visually impaired pedestrians. Furthermore, IRC:103-2012 outlines criteria for determining the Pedestrian Level of Service (LOS), offering a standardized method for evaluating the operational quality and comfort of pedestrian spaces. These guidelines form the essential technical basis against which pedestrian infrastructure can be rigorously evaluated to ensure compliance with national standards and best practices.

1.3 Literature Review (Overview)

The broader literature on pedestrian infrastructure consistently highlights the intricate relationship between walkability, safety, and the overall quality of urban environments. Research unequivocally demonstrates that the presence of continuous, well-maintained, and unobstructed footpaths significantly enhances pedestrian comfort and actively encourages walking as a preferred mode of transport. The application of Pedestrian Level of Service (LOS) models, which are often adapted from established traffic flow theory, has become a widespread practice for assessing pedestrian comfort. These models typically consider factors such as available space per pedestrian, pedestrian density, and flow rates to categorize the quality of the walking experience.

Studies conducted within the Indian context frequently emphasize that despite the existence of comprehensive design guidelines, significant implementation gaps persist. These gaps are often attributed to a confluence of factors, including rampant encroachments on pedestrian spaces, insufficient enforcement of existing regulations, and inadequate maintenance regimes.

Conversely, global best practices in the implementation of Complete Street principles consistently demonstrate that a pedestrian-oriented design approach leads to a multitude of positive outcomes. These include a measurable reduction in road accidents involving pedestrians, an increase in vibrant street activity, and tangible improvements in public health outcomes due to increased physical activity.

However, a critical review of the existing literature reveals a notable limitation: there is a comparatively restricted body of research specifically focusing on SLB-based pedestrian assessment in medium-sized Indian cities. The majority of academic and policy-oriented studies tend to concentrate on the challenges and solutions pertinent to large metropolitan areas. This creates a significant research void in understanding the unique pedestrian conditions, infrastructure deficiencies, and policy implementation challenges prevalent in tier-2 and tier-3 cities. This study aims to directly address this identified gap by applying the robust MoHUA SLB and Pedestrian LOS frameworks within the specific context of Bharatpur, thereby contributing valuable insights to the discourse on pedestrian planning in smaller urban centers.

1.4 Need for the Study and Research Gap

Despite the increasing policy emphasis on pedestrian-friendly streets and the existence of national guidelines, the actual on-ground conditions in many Indian cities frequently fall short of desired standards. Infrastructure is often provided without a systematic assessment of its service quality or the actual user experience it delivers. This disconnect between provision and performance is particularly evident in smaller cities, where there is a distinct lack of systematic, performance-based evaluation of pedestrian facilities. The present study is conceived to bridge this critical gap between infrastructure provision and service delivery by applying measurable benchmarks to rigorously evaluate pedestrian facilities. Specifically, it seeks to address the following research gaps:

1. **Lack of SLB Application in Tier-2 Cities:** As highlighted in the literature review, there is a significant gap in applying the MoHUA Service Level Benchmarks for pedestrian facilities in medium-sized Indian cities. This study will contribute by providing a detailed application and assessment in Bharatpur, a tier-2 city.
2. **Comprehensive Performance Evaluation:** Moving beyond mere inventory, the study aims to provide a holistic performance evaluation that integrates physical infrastructure assessment with user perceptions and established LOS criteria.
3. **Identification of Specific Deficiencies:** While general problems are known, this study will systematically identify specific infrastructure gaps and their impact on pedestrian safety, comfort, and accessibility along a critical urban corridor.

1.5 Aim and Objectives

1.5.1 Aim

To comprehensively assess the quality, safety, and performance of pedestrian facilities along Atal Path, Bharatpur, utilizing the Ministry of Housing and Urban Affairs (MoHUA) Service Level Benchmarks and Pedestrian Level of Service (LOS) standards, within the overarching frameworks of Complete Street and Safe Street principles.

1.5.2 Objectives

To achieve the stated aim, the study will pursue the following specific objectives:

1. To conduct a detailed inventory and assessment of existing pedestrian infrastructure along Atal Path in terms of its physical characteristics, accessibility, safety features, comfort provisions, continuity, and capacity.
2. To rigorously evaluate the identified pedestrian facilities against the prescribed MoHUA Service Level Benchmarks, thereby determining their current performance levels.
3. To analyze the Pedestrian Level of Service (LOS) along different segments of Atal Path, based on established space standards, pedestrian densities, and flow conditions, with reference to IRC:103-2012 guidelines.
4. To systematically identify critical deficiencies within the pedestrian infrastructure, such as encroachments, unsafe crossing points, inadequate lighting, and barriers to universal accessibility.
5. To formulate and propose practical planning and design recommendations that are meticulously aligned with national guidelines (e.g., IRC:103-2012), the Complete Street Concept, and the Safe Street Concept, aimed at enhancing pedestrian safety, comfort, and accessibility along Atal Path.

1.6 Research Questions

Based on the aim and objectives, the study will seek to answer the following research questions:

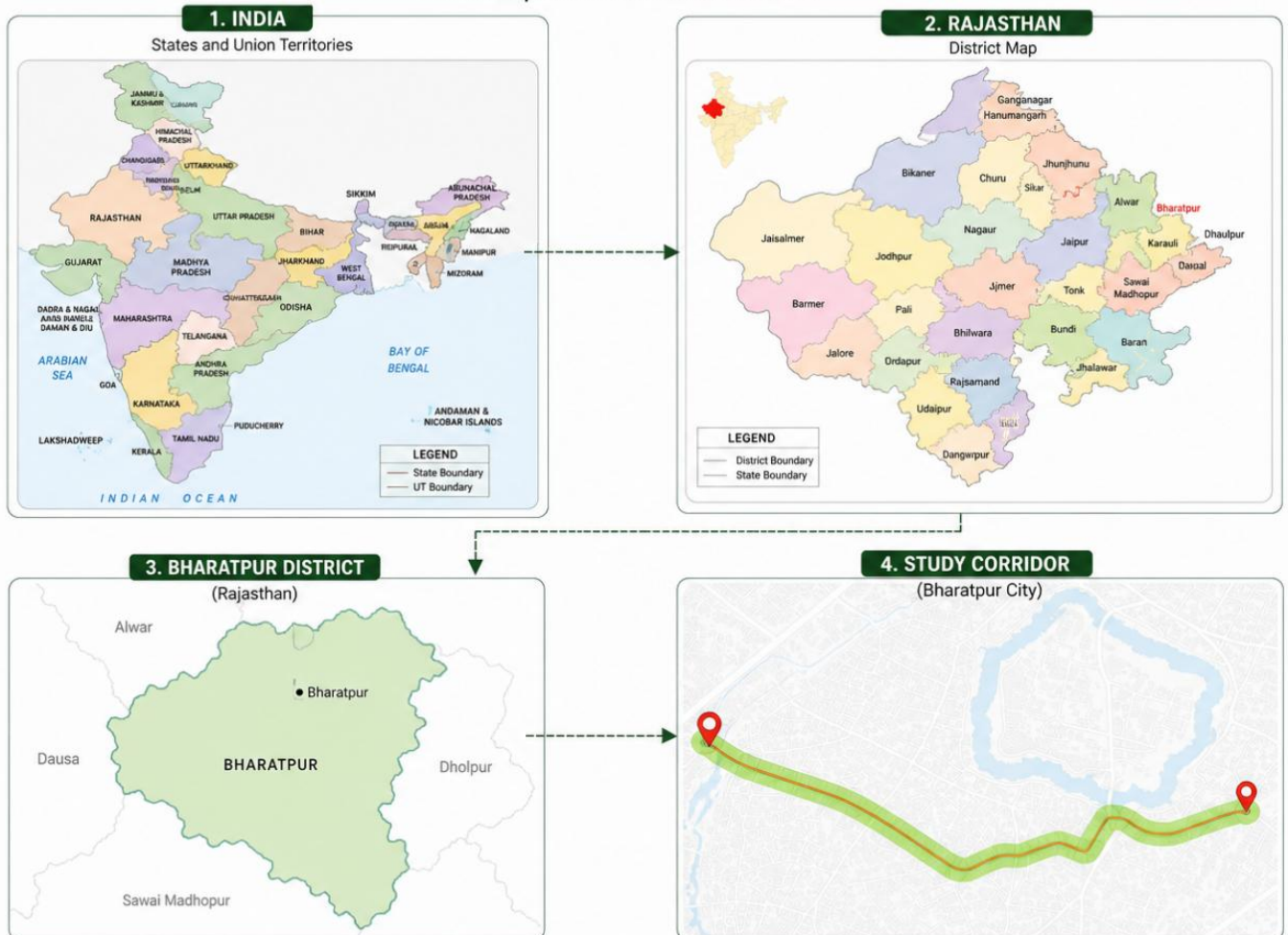
1. Do the existing pedestrian facilities along Atal Path meet the prescribed MoHUA Service Level Benchmarks and IRC:103-2012 standards?
2. What is the current Pedestrian Level of Service (LOS) along the selected corridor, and how does it vary across different segments?
3. What are the key infrastructure gaps and deficiencies affecting pedestrian safety, comfort, and accessibility along Atal Path?
4. What planning and design recommendations can be proposed to improve pedestrian facilities along Atal Path, aligning with Complete Street and Safe Street principles?

1.7 Study Area Profile: Atal Path, Bharatpur

Bharatpur, a historic tier-2 city situated in eastern Rajasthan, presents a compelling case for this study due to its distinctive urban characteristics. The city is renowned for its compact urban form, diverse mixed-land use patterns, and a significant reliance on pedestrian-dependent mobility. These attributes make it an ideal location to investigate pedestrian infrastructure challenges and solutions. Atal Path emerges as a major urban corridor within Bharatpur, strategically connecting vital commercial areas, prominent institutional zones, and key transit nodes. This central role ensures that the corridor experiences consistently high pedestrian volumes throughout the day, making it a highly relevant and representative study area for a comprehensive assessment of pedestrian infrastructure.

STUDY AREA

Bharatpur Pedestrian Corridor



SATELLITE VIEW

Bharatpur Pedestrian Corridor (Bharatpur City)



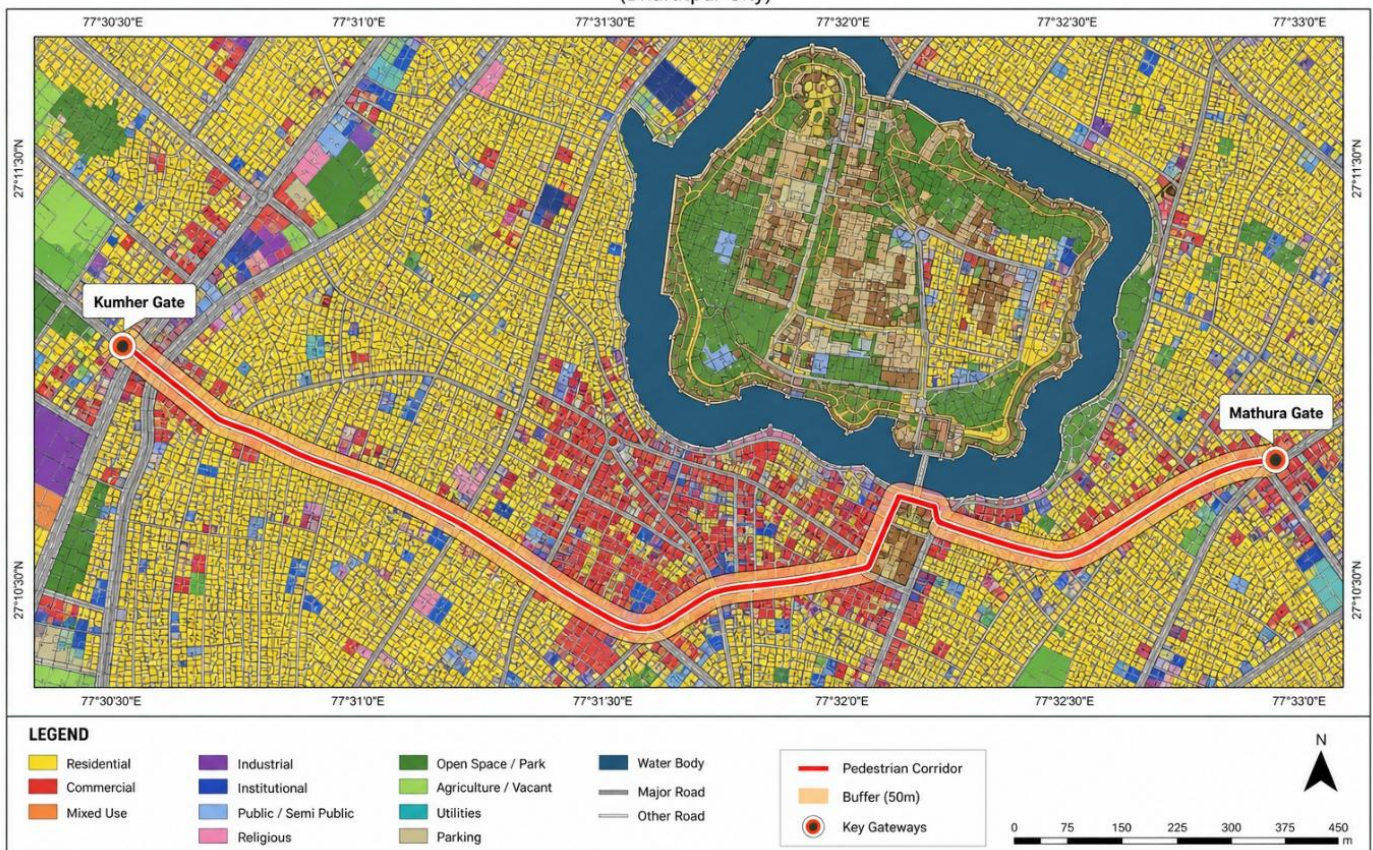
1.8 Relevance of Study Area – Atal Path, Bharatpur

The selection of Atal Path in Bharatpur, Rajasthan, as the study area is predicated on several compelling factors that underscore its relevance and the potential for generalizable findings:

1. **High Pedestrian Dependency:** Bharatpur, as a tier-2 historic city with a compact urban structure and mixed land use, exhibits a high degree of pedestrian dependency. A substantial proportion of daily trips are undertaken on foot, and Atal Path, in particular, experiences continuous pedestrian movement throughout the day. This high usage makes it a critical artery for pedestrian mobility.
2. **Strategic Urban Corridor:** Atal Path serves as a vital urban spine, connecting key commercial hubs, institutional areas (e.g., educational institutions, government offices), and transit-oriented locations. Its strategic importance ensures that a diverse range of pedestrians, including commuters, shoppers, students, and local residents, utilize the corridor, providing a rich context for assessment.
3. **Mismatch Between Infrastructure & Usage:** Despite recent street development initiatives, the pedestrian facilities along Atal Path frequently exhibit significant issues. These include pervasive discontinuity of footpaths, widespread encroachments, unsafe crossing points, and inadequate provisions for universal accessibility. This mismatch between the intended purpose of the infrastructure and its actual performance on the ground makes it an ideal site for a performance-based evaluation.

4. Representative of Medium-Sized Indian Cities: The challenges and characteristics observed along Atal Path are highly representative of those faced by numerous tier-2 and tier-3 cities across India. These cities are undergoing rapid urbanization but often lack the comprehensive planning and investment in pedestrian infrastructure seen in larger metropolitan areas. Therefore, the findings and recommendations derived from this study in Bharatpur have the potential to be replicable and scalable to similar urban contexts nationwide.
5. Ideal for SLB & LOS Assessment: The varied land use patterns, consistently high pedestrian volumes, and observable safety and accessibility concerns along Atal Path collectively render it an ideal location for applying the Service Level Benchmark (SLB) evaluation and Pedestrian Level of Service (LOS) analysis frameworks. The complexity and diversity of the pedestrian environment will allow for a robust application and testing of these assessment methodologies.

LAND USE MAP – BHARATPUR PEDESTRIAN CORRIDOR (Bharatpur City)



1.9 Expected Outcomes

The successful completion of this study is anticipated to yield several significant outcomes that will contribute to both academic knowledge and practical urban planning:

1. **Detailed Assessment of Pedestrian Service Levels:** The study will provide a comprehensive and objective assessment of the current service levels of pedestrian facilities along Atal Path, using established MoHUA SLBs and Pedestrian LOS standards.
2. **Identification of Critical Safety and Accessibility Issues:** It will systematically pinpoint specific infrastructure deficiencies, safety hazards, and barriers to universal accessibility that impact pedestrians along the corridor.
3. **Actionable Recommendations:** The research will culminate in the formulation of practical, evidence-based planning and design recommendations. These recommendations will be tailored to the specific context of Atal Path and aligned with the principles of Complete Street and Safe Street concepts, aiming to enhance pedestrian safety, comfort, and accessibility.
4. **Contribution to Evidence-Based Urban Planning:** By applying rigorous assessment methodologies in a tier-2 Indian city, the study will contribute valuable data and insights to the broader discourse on pedestrian planning, supporting more informed decision-making in similar urban contexts.
5. **Support for Pedestrian-Oriented Street Design:** The findings will serve as a foundational document for local urban bodies and planners in Bharatpur and other comparable cities to advocate for and implement pedestrian-oriented street designs.

1.10 Scope and Limitations

1.10.1 Scope

This study is specifically scoped to focus on the assessment of pedestrian facilities along selected stretches of Atal Path in Bharatpur, Rajasthan. The primary focus will be on evaluating the physical infrastructure and its performance in terms of accessibility, safety, comfort, continuity, and capacity for pedestrians. The assessment will be guided by the MoHUA Service Level Benchmarks and IRC:103-2012 guidelines.

1.10.2 Limitations

Several limitations are acknowledged that may influence the study's findings:

1. **Geographical Scope:** The study is confined to specific segments of Atal Path. While efforts will be made to select representative sections, the findings may not be directly generalizable to the entire city of Bharatpur or other urban areas without further localized studies.
2. **Time and Seasonal Constraints:** Data collection, particularly pedestrian volume observations, may be influenced by the specific time of day, day of the week, and seasonal variations (e.g., weather conditions, local festivals). While data will be collected during representative periods, some inherent variability due to these factors is unavoidable.

3. Resource Constraints: The depth and breadth of data collection and analysis may be influenced by available resources, including time, budget, and personnel.
4. Subjectivity of Perception Data: While user perception surveys provide invaluable qualitative insights, the responses are inherently subjective. Efforts will be made to ensure survey design minimizes bias and employs appropriate analytical techniques to interpret these perceptions reliably.
5. Dynamic Urban Environment: Urban environments are constantly evolving. Infrastructure changes, land-use modifications, and shifts in pedestrian behavior can occur, potentially affecting the long-term applicability of the findings.

These limitations will be carefully considered during the interpretation of the results and in the formulation of recommendations.

Chapter 2: Literature Review, Policies, and Case Studies

2.1 Review of National and International Literature

Pedestrian mobility, often regarded as the most fundamental and universal mode of transport, underpins the functionality and vibrancy of urban environments globally. Its significance extends beyond mere movement, deeply influencing urban livability, accessibility, public health, and social equity. Despite this critical role, historical urban planning paradigms, particularly in rapidly developing nations, have frequently marginalized pedestrian infrastructure in favor of motorized transport. This section delves into a comprehensive review of national and international academic literature, examining the evolution of pedestrian planning, assessment methodologies, and the multifaceted impacts of pedestrian facilities.

2.1.1 The Foundational Role of Walking in Urban Mobility

Academic discourse consistently emphasizes walking as the most sustainable, equitable, and affordable mode of transport [1]. In many urban contexts, especially in countries like India, walking constitutes a substantial portion of daily trips, either as the sole mode or as a crucial link in multi-modal journeys [2]. This inherent reliance on walking necessitates robust and well-maintained pedestrian infrastructure. Research by Gehl (2011) and Jacobs (1961) profoundly shaped the understanding of urban spaces, highlighting how pedestrian-friendly environments foster social interaction, enhance safety through 'eyes on the street,' and contribute to a vibrant public realm [3] [4]. Their work laid the groundwork for a people-centric approach to urban design, advocating for spaces that prioritize human scale and experience.

2.1.2 Pedestrian Level of Service (LOS) Concepts and Evolution

The concept of Pedestrian Level of Service (LOS) has emerged as a critical analytical tool for evaluating the quality and operational performance of pedestrian facilities. Initially adapted from traffic flow theory, which quantifies vehicular traffic performance, LOS for pedestrians aims to measure the comfort, convenience, and perceived safety of walking environments [5]. Early pioneers like Fruin (1971) established foundational principles by defining pedestrian flow characteristics, space requirements, and density thresholds that correspond to different levels of service [6]. Fruin's work introduced six levels of service (A to F), ranging from free-flow conditions (LOS A) to severely congested and uncomfortable conditions (LOS F). These foundational metrics, based on space per pedestrian and flow rates, continue to inform contemporary LOS methodologies.

Over time, LOS models have evolved to incorporate a broader spectrum of factors beyond mere physical space. Modern approaches recognize that pedestrian experience is influenced by environmental attributes, perceived safety, accessibility, and the presence of amenities. For instance, the Highway Capacity Manual (HCM), a globally recognized standard, provides detailed methodologies for calculating pedestrian LOS for various facilities, including sidewalks, crosswalks, and queuing areas.

2.1.3 International Perspectives on Pedestrian Planning

International literature showcases diverse approaches and best practices in pedestrian planning. The NACTO Global Street Design Guide [9] [10] stands out as a pivotal document, advocating for a paradigm shift towards designing streets for people first. It provides comprehensive technical guidance and case studies from cities worldwide, illustrating how equitable street space allocation can enhance safety, mobility, and quality of life for all users. Key principles include designing for safety, managing speeds, creating comfortable and inviting spaces, and ensuring universal accessibility. Cities like Copenhagen and Amsterdam are frequently cited for their long-standing commitment to pedestrian and cycling infrastructure, demonstrating the long-term benefits of such investments in terms of public health, environmental quality, and economic vitality.

The London Walking Plan [12] exemplifies a strategic commitment to enhancing walkability through a multi-faceted approach. It focuses on network design, barrier removal, and high-quality wayfinding systems (e.g., Legible London). The plan's emphasis on continuous monitoring using metrics like Pedestrian Comfort Level (PCL) to evaluate sidewalk adequacy and user experience highlights a data-driven approach to pedestrian planning. These international examples underscore the importance of integrated planning, robust policy frameworks, and continuous evaluation in creating truly pedestrian-friendly cities.

2.1.4 Pedestrian Planning in the Indian Context

In India, the discourse on pedestrian infrastructure is marked by a unique set of challenges and opportunities. While the inherent pedestrian dependency in Indian cities is high, the quality of infrastructure often lags significantly behind. Numerous studies highlight the pervasive issues of discontinuous footpaths, widespread encroachments, inadequate widths, unsafe crossings, and poor maintenance [13] [14]. These deficiencies not only compromise pedestrian safety but also deter walking, pushing more people towards motorized transport and exacerbating urban congestion and pollution.

Research by Bhaduri et al. (2019) and Rankavat and Tiwari (2016) specifically investigate user satisfaction and perceptions of pedestrian facilities in Indian cities [15] [16]. Their findings reveal critical insights into the factors influencing pedestrian choices, safety perceptions, and the impact of infrastructure quality on overall user experience. These studies often point to a significant gap between the theoretical design guidelines and the practical implementation on the ground, emphasizing the need for more systematic assessment methodologies that can bridge this divide.

2.1.5 The Role of Service Level Benchmarks (SLB) in India

The Ministry of Housing and Urban Affairs (MoHUA) in India has introduced Service Level Benchmarks (SLB) as a performance-based framework to evaluate urban infrastructure, including pedestrian facilities [17] [18]. This framework represents a crucial step towards a more outcome-oriented approach to urban planning. Unlike traditional methods that merely

focus on the provision of infrastructure, SLBs emphasize actual service quality, user comfort, safety, and accessibility. The framework provides measurable indicators to assess parameters such as footpath coverage, continuity, width adequacy, crossing facilities, lighting, and universal accessibility, enabling objective evaluation and comparison across different urban contexts.

However, a critical review of the existing literature reveals a notable limitation: there is a comparatively restricted body of research specifically focusing on SLB-based pedestrian assessment in medium-sized Indian cities. The majority of academic and policy-oriented studies tend to concentrate on the challenges and solutions pertinent to large metropolitan areas. This creates a significant research void in understanding the unique pedestrian conditions, infrastructure deficiencies, and policy implementation challenges prevalent in tier-2 and tier-3 cities [15]. This study aims to directly address this identified gap by applying the robust MoHUA SLB and Pedestrian LOS frameworks within the specific context of Bharatpur, thereby contributing valuable insights to the discourse on pedestrian planning in smaller urban centers.

2.2 Review of Policies, Standards, and Case Studies

Effective pedestrian planning and design are intrinsically linked to the robustness of guiding policies, the clarity of technical standards, and the lessons learned from successful (and unsuccessful) case studies. This section provides an in-depth examination of the key policy frameworks, technical standards, and illustrative case studies that collectively inform and guide the development and assessment of pedestrian facilities at both national and international levels.

2.2.1 Policies and Standards

2.2.1.1 International Policies and Standards

Internationally, there is a growing and undeniable consensus on the imperative to prioritize pedestrians and non-motorized transport (NMT) within urban planning. This shift is driven by a recognition of the myriad benefits, including improved public health, reduced environmental pollution, enhanced social equity, and increased economic vitality of urban centers.

- **NACTO Global Street Design Guide (GSDG):** The NACTO Global Street Design Guide[9] [10] is a seminal and globally influential document that provides a comprehensive framework for designing urban streets with a people-first approach. It advocates for principles such as designing for safety, managing speeds, creating comfortable and inviting spaces, and ensuring universal accessibility. The guide offers detailed technical specifications for elements like sidewalk widths, crossing designs, and street furniture, drawing from best practices observed in leading cities worldwide. The GSDG emphasizes that streets are not just conduits for vehicles but vital public spaces that should serve all users equitably.

- **Complete Street Concept:** The Complete Street Concept is a transformative approach to urban street design that has gained significant traction globally. It advocates for streets that are planned, designed, operated, and maintained to enable safe, convenient, and comfortable access for all users, regardless of their age, ability, or mode of transport. This holistic vision moves beyond the traditional vehicle-centric model to create balanced and equitable street environments. A truly complete street integrates various elements, including continuous and unobstructed footpaths, dedicated cycle tracks, safe and clearly marked pedestrian crossings, accessible public transport stops, and effective traffic calming measures. The core principle is the equitable distribution of street space, consciously prioritizing vulnerable road users such as pedestrians and cyclists. This concept has been adopted by numerous cities and national governments as a guiding principle for urban street design, recognizing its potential to enhance walkability, improve safety, and foster more vibrant urban public spaces [19].
- **Safe System Approach (Vision Zero):** Originating in Sweden, the Safe System Approach, often embodied by the Vision Zero initiative, is a global strategy to eliminate traffic fatalities and serious injuries. It recognizes that humans make mistakes and that the road system should be designed to be forgiving. For pedestrians, this translates into designing infrastructure that minimizes the risk of collisions and reduces the severity of injuries when collisions do occur. Key elements include safe speeds, safe roads (e.g., dedicated pedestrian infrastructure, safe crossings), safe vehicles, and safe road users. This approach influences design standards by promoting features like reduced speed limits in urban areas, raised pedestrian crossings, and clear separation of pedestrian and vehicular traffic [20].

2.2.1.2 National Policies and Standards (Indian Context)

In India, the policy landscape for pedestrian facilities has undergone a significant evolution, reflecting a growing awareness of the importance of non-motorized transport and sustainable urban development.

- **National Urban Transport Policy (NUTP), 2006 (Revised 2014):** The National Urban Transport Policy (NUTP) [21] has been instrumental in shifting the focus of urban transport planning in India from a purely vehicle-centric approach to one that prioritizes public transport, walking, and cycling. The policy emphasizes the need for sustainable urban transport systems that are accessible, safe, affordable, and environmentally friendly. It explicitly advocates for the provision of high-quality pedestrian infrastructure and facilities as a fundamental component of urban mobility. The NUTP serves as the overarching policy framework guiding pedestrian-friendly urban development initiatives across the country.
- **Ministry of Housing and Urban Affairs (MoHUA) Service Level Benchmarks (SLB):** The Ministry of Housing and Urban Affairs (MoHUA) has played a pivotal role in introducing Service Level Benchmarks (SLB) for urban transport services, including pedestrian facilities [17] [18]. These benchmarks represent a crucial shift towards a performance-

based framework for evaluating urban infrastructure. Unlike traditional approaches that merely focus on the provision of infrastructure, SLBs emphasize the actual quality of service delivered to the user. For pedestrian infrastructure, the SLB framework assesses performance across several critical dimensions: accessibility, safety, comfort, continuity, and capacity. The indicators within the SLB framework are designed to provide measurable metrics, enabling urban local bodies to objectively identify service gaps, benchmark their performance against national standards, and strategically prioritize investments based on evidence-based performance outcomes. This systematic approach ensures that infrastructure development is responsive to user needs and contributes to tangible improvements in urban quality of life.

- The MoHUA SLB for pedestrian facilities includes specific indicators and corresponding levels of service (LOS 1 to LOS 4), as summarized in Table 2.1:

Indicator	LOS 1 (Excellent)	LOS 2 (Good)	LOS 3 (Fair)	LOS 4 (Poor)
Signalized intersection delay (%)	< 25	25 - 50	50 - 75	>= 75
Street Lighting (Lux)	>= 8	6 - 8	4 - 6	< 4
% of City Covered (Pedestrian Facilities)	>= 75	50 - 75	25 - 50	< 25

Table 2.1: MoHUA Service Level Benchmarks for Pedestrian Infrastructure Facilities

The overall Level of Service is calculated based on the sum of the individual LOS scores for each indicator, providing a holistic assessment of the pedestrian environment. This framework is instrumental for urban local bodies to identify specific areas for improvement and allocate resources effectively.

Indian Roads Congress (IRC) Code 103:2012 – Guidelines for Pedestrian Facilities: The Indian Roads Congress (IRC) Code 103:2012 [22] is a foundational technical document that provides comprehensive guidelines for the planning, design, and maintenance of pedestrian facilities in urban areas across India. This code is indispensable for ensuring uniformity, safety, and functionality in pedestrian infrastructure development. It covers a wide array of critical aspects, including:

1. **Footpath Width Standards:** Specifies minimum and desirable widths for footpaths based on pedestrian volume, adjacent land use, and urban context, ensuring adequate space for comfortable movement.
 2. **Pedestrian Crossing Design:** Provides detailed design standards for various types of pedestrian crossings, including zebra crossings, signalized crossings, and grade-separated facilities (foot overbridges, underpasses). It also includes guidelines for features like refuge islands and curb ramps.
 3. **Ramp Specifications:** Detailed specifications for the design and construction of ramps to ensure universal accessibility for persons with disabilities, adhering to gradient, width, and surface requirements.
 4. **Tactile Paving:** Guidelines for the implementation of tactile ground surface indicators (TGSIs) to assist visually impaired pedestrians in navigating public spaces, particularly at crossings and transit points.
 5. **Pedestrian Level of Service (LOS) Criteria:** Outlines criteria for determining the Pedestrian Level of Service, offering a standardized method for evaluating the operational quality and comfort of pedestrian spaces based on factors like pedestrian flow, density, and speed.
 6. **Safety Audits:** Recommends the conduct of pedestrian safety audits at various stages of project development to identify and mitigate potential hazards.
- These guidelines form the essential technical basis against which pedestrian infrastructure can be rigorously evaluated to ensure compliance with national standards and best practices, thereby contributing to safer and more accessible walking environments.

Urban Street Design Guidelines (USDG): While not a single codified document, various urban development authorities and state governments in India have developed their own Urban Street Design Guidelines that often draw from NUTP and IRC standards. These guidelines aim to provide more localized and context-specific recommendations for street design, emphasizing complete streets principles, integration of green infrastructure, and promotion of non-motorized transport. Examples include guidelines from cities like Bengaluru, Ahmedabad, and Pune, which adapt national principles to local urban contexts.

2.2.1.3 Interplay of Policies and Standards

The various policies and standards discussed above are not isolated but form an interconnected framework. The NUTP provides the overarching vision, while MoHUA SLBs offer a performance-based evaluation tool to measure progress against this vision. The IRC:103-2012 provides the technical specifications for implementing the physical infrastructure required to meet these policy goals and benchmarks. This hierarchical and complementary structure is crucial for effective pedestrian planning and implementation in India.

2.2.2 Case Studies: Global and National Best Practices

Examining successful case studies provides invaluable insights into the practical application of pedestrian-friendly policies and standards, demonstrating how theoretical frameworks translate into tangible improvements in urban environments.

2.2.2.1 International Case Studies

- London, UK – The Walking Plan for London: London has consistently been at the forefront of promoting walking as a primary mode of transport. The Walking Plan for London [12], initiated by Transport for London, focused on creating a high-quality walking environment through a multi-faceted strategy. Key components included:
 1. Strategic Network Design: Identifying and improving key walking routes, ensuring continuity and connectivity across the city.
 2. Barrier Removal: Addressing physical barriers such as narrow pavements, street clutter, and unsafe crossings.
 3. High-Quality Wayfinding: Implementing comprehensive wayfinding systems, notably the "Legible London" scheme, which provides clear and consistent signage to encourage walking and help pedestrians navigate the city.
 4. Data-Driven Monitoring: Emphasizing continuous monitoring using metrics like the Pedestrian Comfort Level (PCL) to evaluate sidewalk adequacy, pedestrian flow, and overall user experience. This data-driven approach allowed for iterative improvements and targeted interventions.
 5. Policy Integration: Integrating walking into broader transport and urban development policies, ensuring that pedestrian needs are considered in all planning decisions.
- The holistic approach adopted by London has significantly increased walking rates, improved pedestrian safety, and contributed to a more vibrant and sustainable urban environment. It serves as a model for how a major global city can prioritize and successfully implement pedestrian-friendly initiatives.
- Copenhagen, Denmark – Pedestrianization and Cycling Infrastructure: Copenhagen is globally recognized as a pioneer in creating pedestrian and cycling-friendly cities. Beginning in the 1960s with the pedestrianization of its main shopping street, Strøget, the city has systematically expanded its car-free zones and invested heavily in cycling infrastructure [11]. Key lessons from Copenhagen include:
 1. Phased Implementation: Gradual pedestrianization and infrastructure development, allowing for public adaptation and feedback.
 2. Integrated Planning: Seamless integration of pedestrian and cycling networks with public transport.
 3. High-Quality Public Spaces: Creating attractive public spaces that encourage walking and social interaction.
 4. Policy Commitment: A sustained political commitment to prioritizing non-motorized transport over several decades.

- Copenhagen's success demonstrates the transformative power of long-term vision and consistent investment in pedestrian and cycling infrastructure.
- New York City, USA – Plaza Program and Complete Streets: New York City has implemented ambitious pedestrianization initiatives, most notably its Plaza Program and adoption of Complete Streets principles. The Plaza Program transformed underutilized street spaces and intersections into vibrant public plazas, significantly expanding pedestrian areas and improving safety [23]. Times Square, once a congested traffic hub, is a prime example of a successful pedestrianization project. The city's Complete Streets policies have led to the redesign of numerous streets, incorporating wider sidewalks, protected bike lanes, and improved pedestrian crossings. These initiatives have demonstrated that even in dense, vehicle-dominated environments, significant gains in pedestrian safety and amenity are achievable through strategic design and policy interventions.

2.2.2.2 National Case Studies (Indian Context)

Several Indian cities have undertaken commendable initiatives to improve pedestrian facilities, offering valuable lessons and best practices for other urban centers.

1. Chennai, India – Multi-pronged Approach to Complete Streets: Chennai has emerged as a leading example in India for its multi-pronged strategy in implementing Complete Streets. The approach involves:
 - a. Policy Changes: Integrating complete street principles into urban planning regulations.
 - b. Development of Design Standards: Creating localized design guidelines that adapt national and international best practices to Chennai's specific context.
 - c. Execution of Pilot Projects: Implementing complete street designs on key corridors to demonstrate their benefits and gather public feedback. Key improvements observed include the provision of wide, continuous footpaths, organized on-street parking, safe pedestrian crossings, and the integration of street furniture. These initiatives have led to a noticeable increase in pedestrian volumes and improved perceptions of safety and comfort among users, showcasing the potential for transformative change through integrated planning.
2. Pune, India – Tactical Urbanism and Corridor Redesign: Pune has made significant strides in enhancing its pedestrian infrastructure, particularly through the redesign of major corridors and the innovative use of tactical urbanism [19]. The city has undertaken projects on key roads like J.M. Road and D.P. Road, incorporating dedicated cycle tracks and wider footpaths. Pune's experimentation with tactical urbanism – temporary, low-cost interventions – has allowed it to test innovative design solutions and gather community feedback before committing to permanent infrastructure upgrades. This adaptive approach fosters community engagement and allows for iterative improvements, ensuring that designs are responsive to local needs and preferences.

3. Ahmedabad, India – Janmarg BRTS and Pedestrian Integration: While primarily known for its Bus Rapid Transit System (BRTS), Janmarg, Ahmedabad's project also integrated pedestrian-friendly infrastructure around its stations and along its corridors. This included improved footpaths, safe crossings, and better connectivity for non-motorized transport users. The Ahmedabad BRTS demonstrates how major public transport projects can be leveraged to enhance pedestrian environments, ensuring seamless first-mile and last-mile connectivity and promoting multi-modal integration. The success of Janmarg highlights the importance of considering pedestrian needs as an integral part of larger transport infrastructure projects.

These national case studies underscore that successful pedestrian facility development in India requires a combination of strong policy frameworks, adherence to technical standards, community engagement, and a commitment to continuous monitoring and improvement. They also highlight the adaptability of global best practices to local Indian contexts.

2.3 Identification of Research Gaps and Best Practices

2.3.1 Research Gaps

Despite the increasing recognition of pedestrian mobility and the existence of various policies and guidelines, several critical research gaps persist, particularly within the Indian context. Addressing these gaps is essential for advancing the understanding and effective implementation of pedestrian-friendly urban environments:

1. **Limited SLB-based Assessment in Medium-Sized Cities:** A significant portion of research on pedestrian facilities and Level of Service (LOS) in India has historically concentrated on metropolitan areas. There is a notable dearth of systematic studies that apply the Ministry of Housing and Urban Affairs (MoHUA) Service Level Benchmarks (SLBs) to assess pedestrian conditions in tier-2 and tier-3 cities. These smaller urban centers often present unique challenges related to infrastructure provision, maintenance, and resource allocation, making their specific assessment crucial for tailored interventions [15]. This study aims to fill this gap by focusing on Bharatpur, a tier-2 city.
2. **Implementation and Enforcement Gaps:** While comprehensive design guidelines, such as IRC:103-2012, provide technical standards for pedestrian facilities, their effective implementation and consistent enforcement remain significant hurdles. Research is needed to identify the underlying barriers to successful implementation, which often include issues like widespread encroachments, inadequate maintenance practices, and a lack of coordinated efforts among various municipal and planning agencies [16]. Further research could explore policy mechanisms and governance structures that facilitate better enforcement.
3. **Holistic Performance-Based Evaluation Integrating Qualitative and Quantitative Metrics:** Current evaluation methods often focus on the mere provision of infrastructure rather than its actual performance and user experience. There is a pressing need for more systematic, performance-based evaluations that integrate both quantitative

metrics (e.g., physical dimensions, traffic volumes, SLB indicators) and qualitative factors (e.g., user comfort, safety perceptions, accessibility for diverse user groups) into LOS models, especially in smaller urban centers. This includes developing more nuanced methodologies for capturing and integrating pedestrian perceptions reliably [15] [25].

4. **Integration of Diverse Data for Comprehensive Assessment:** While various data types are collected for urban planning, research on effective methodologies for seamlessly integrating disparate data sources—such as Geographic Information System (GIS) data, pedestrian volume counts, qualitative surveys, and physical measurements—for a comprehensive SLB assessment is crucial. This integration can provide a more nuanced understanding of pedestrian environments and inform more effective interventions. Developing standardized data collection protocols and integration platforms could be a valuable research direction.
5. **Impact of Emerging Technologies on Pedestrian Facilities:** With the advent of smart city initiatives and new technologies (e.g., IoT sensors for pedestrian counting, AI for safety analysis), there is a research gap in understanding how these technologies can be effectively integrated into pedestrian facility assessment and management, particularly in the Indian context.
6. **Economic Valuation of Pedestrian Improvements:** More research is needed on the economic benefits of improved pedestrian facilities, including their impact on local businesses, property values, and healthcare costs, to build a stronger case for investment in pedestrian infrastructure.

2.3.2 Best Practices

Based on the extensive review of national and international literature, policies, and case studies, several best practices emerge for enhancing pedestrian facilities and promoting walkability. These practices, when adopted holistically, can lead to significant improvements in urban pedestrian environments:

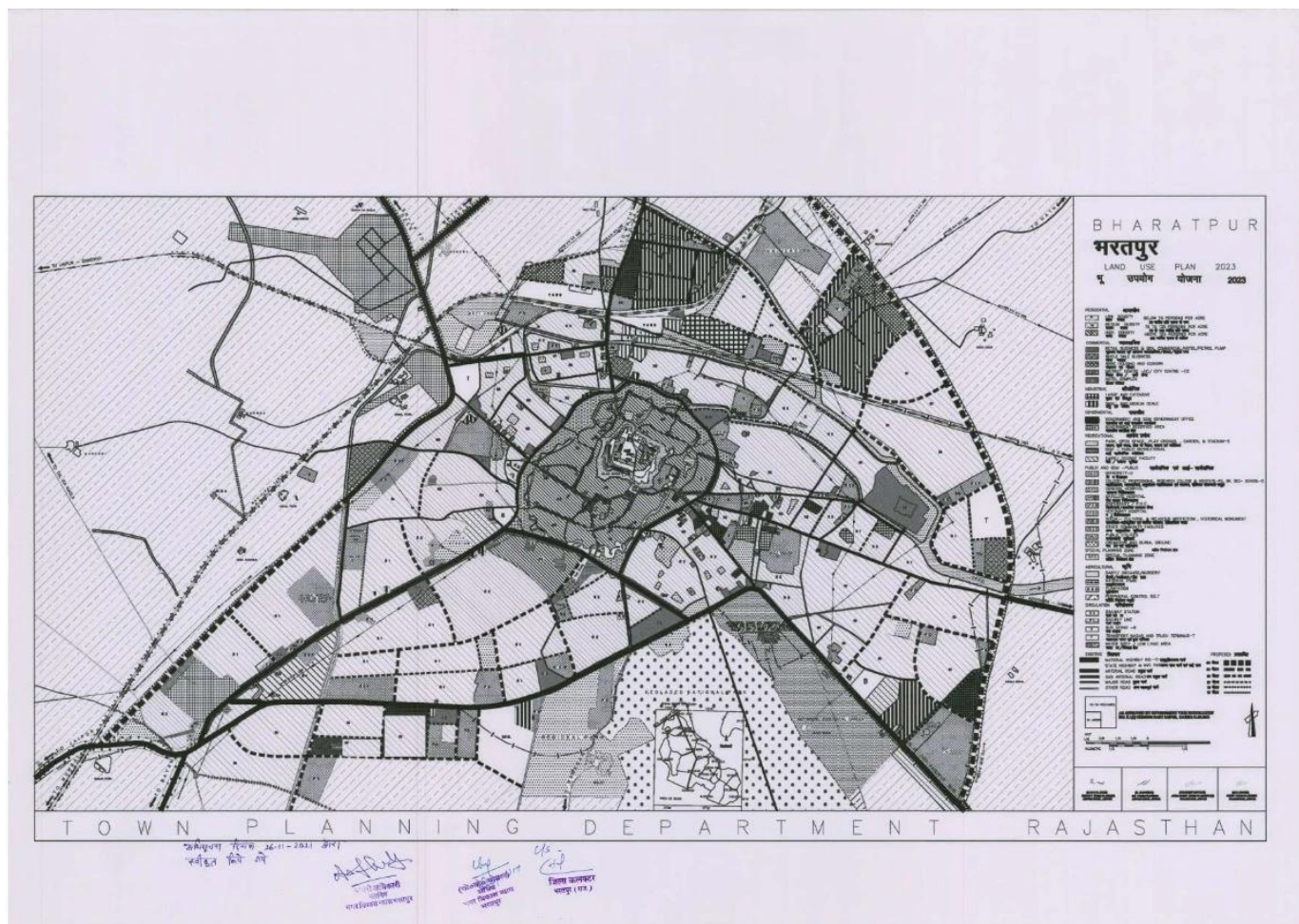
1. **People-Centric Design:** Prioritizing the needs of pedestrians and other vulnerable road users (e.g., cyclists, children, elderly, persons with disabilities) in all stages of street design, planning, and operation. This involves ensuring the provision of continuous, unobstructed, and universally accessible footpaths that are safe, comfortable, and inviting for all users. Design elements should consider human scale, comfort, and safety as paramount [9].
2. **Integrated Planning (Complete Streets Approach):** Adopting a holistic Complete Street approach that integrates pedestrian facilities seamlessly with other modes of transport and urban functions. This ensures that streets are designed as vibrant public spaces that contribute to economic activity, foster social interaction, and enhance environmental quality, considering safety, comfort, and accessibility for all users. This approach requires inter-agency coordination and a multi-disciplinary perspective [19].
3. **Performance-Based Monitoring and Evaluation:** Utilizing frameworks like the MoHUA Service Level Benchmarks (SLB) to systematically evaluate the quality and performance of pedestrian facilities. This involves setting measurable indicators, regularly collecting data, and monitoring performance to identify service gaps,

benchmark against standards, and prioritize investments based on actual performance outcomes and user experience. This continuous feedback loop is crucial for adaptive planning [17].

4. **Tactical Urbanism and Pilot Projects:** Implementing temporary, low-cost interventions (tactical urbanism) to test innovative design solutions and gather community feedback before committing to permanent infrastructure upgrades. This iterative approach allows for flexibility, community engagement, and evidence-based refinement of designs, reducing risks and ensuring public acceptance [19].
5. **Robust Enforcement and Maintenance:** Establishing and enforcing strict regulations against encroachments on footpaths and pedestrian spaces. Alongside, ensuring regular and adequate maintenance of pedestrian infrastructure is crucial to sustain high service levels, prevent deterioration over time, and ensure long-term functionality and safety. This requires dedicated resources and clear institutional responsibilities [13].
6. **Data-Driven Decision Making:** Employing comprehensive data collection methods, including pedestrian volume counts, qualitative user surveys, and GIS mapping, coupled with advanced analytical tools. This data-driven approach informs planning and design interventions, ensuring they are based on empirical evidence, address specific local needs, and are optimized for efficiency and impact [25].
7. **Community Engagement and Participation:** Actively involving local communities, pedestrian advocacy groups, and other stakeholders in the planning, design, and implementation processes. This ensures that interventions are responsive to local needs and preferences, fostering a sense of ownership and increasing the likelihood of success and sustainability.
8. **Green Infrastructure Integration:** Incorporating green infrastructure elements such as street trees, rain gardens, and permeable pavements into pedestrian facility design. This not only enhances the aesthetic appeal and comfort (e.g., shade, reduced heat island effect) but also contributes to environmental sustainability and stormwater management.
9. These best practices collectively contribute to creating urban environments that are not only functional but also safe, accessible, and enjoyable for pedestrians, fostering sustainable urban mobility and enhancing the overall quality of urban life.

Detailed base maps are an indispensable component for conducting a comprehensive assessment of pedestrian facilities, particularly in an urban corridor like Atal Path in Bharatpur. These maps serve as a foundational tool for inventory mapping, identifying critical deficiencies, visualizing spatial relationships, and ultimately informing targeted planning and design recommendations. For this study, the base maps will be meticulously prepared to include multiple layers of information, providing a holistic view of the pedestrian environment. The use of Geographic Information System (GIS) software will be central to the creation and analysis of these maps.





2.4.1 Importance of Base Maps in Pedestrian Assessment

Base maps provide the spatial context necessary to understand the distribution, condition, and connectivity of pedestrian infrastructure. They allow for:

- **Systematic Inventory:** A visual and organized record of all existing pedestrian facilities and related urban elements.
- **Identification of Deficiencies:** Pinpointing areas where infrastructure is lacking, discontinuous, or in poor condition.
- **Spatial Analysis:** Analyzing relationships between pedestrian infrastructure, land use, traffic patterns, and environmental factors.
- **Visualization of Findings:** Effectively communicating complex data and assessment results to stakeholders.
- **Informing Interventions:** Guiding the precise location and nature of proposed planning and design recommendations.

2.4.2 Key Layers for Base Maps of Atal Path

For the study area (Atal Path, Bharatpur), the base maps will be developed using GIS and will include, but not be limited to, the following essential layers of information:

- **Geographic Context Layer:**
 1. **Location of Atal Path:** Precise delineation of the study corridor within the municipal boundaries of Bharatpur.
 2. **Connectivity:** Major arterial roads, collector streets, and local streets intersecting or running parallel to Atal Path.
 3. **Key Urban Features:** Location of significant landmarks, public buildings, and open spaces that define the urban fabric around Atal Path.
 4. **Administrative Boundaries:** Ward or zone boundaries relevant to the study area.
 5. **Footpaths:**
 - **Delineation:** Precise mapping of all existing footpaths along Atal Path.
 - **Width:** Measured width of footpaths at regular intervals, highlighting variations.
 - **Surface Material:** Classification of footpath surfaces (e.g., concrete, paver blocks, asphalt, natural earth).
 - **Condition:** Assessment of surface quality (e.g., smooth, uneven, broken, presence of potholes).
 - **Continuity:** Identification of sections where footpaths are discontinuous or obstructed.
 6. **Pedestrian Crossings:**
 - **Location and Type:** Mapping of all crossing points (signalized, unsignalized, zebra crossings, foot overbridges, underpasses).
 - **Design Features:** Presence and condition of refuge islands, curb ramps, tactile paving, and signalization.
 - **Visibility:** Assessment of sightlines for pedestrians and motorists at crossings.
 7. **Street Furniture:** Location and type of street furniture (e.g., benches, waste bins, public art, bollards, bus shelters).
 8. **Street Lighting:** Location of streetlights, type of luminaires, and an indication of their coverage and intensity (e.g., Lux levels if measured).
 9. **Universal Accessibility Features:** Mapping the presence and condition of features designed for persons with disabilities, such as ramps, tactile paving, and accessible curb cuts.
- **Adjacent Land Use Layer:**
 10. **Land Use Classification:** Detailed classification of land uses immediately adjacent to Atal Path (e.g., commercial establishments, residential areas, mixed-use developments, institutional buildings, open spaces, parks, vacant plots).
 11. **Building Footprints:** Mapping of building footprints to understand the built-up density and street-level activity.
 12. **Pedestrian Generators/Attractors:** Identification of specific points of interest that generate or attract significant pedestrian traffic (e.g., markets, schools, hospitals, public transport stops).

- **Traffic Data Layer:**
 - 13. Vehicular Traffic Lanes: Delineation of vehicular traffic lanes and their direction.
 - 14. Parking Areas: Mapping of designated on-street and off-street parking facilities.
 - 15. Traffic Volume and Speed: (If available from secondary sources or collected as primary data) Indication of vehicular traffic volume and typical operating speeds along the corridor.
- **Environmental Factors Layer:**
 - 16. Green Spaces: Location of parks, green belts, street trees, and other landscaping elements.
 - 17. Shade Cover: Mapping of areas providing natural shade from trees or built structures, crucial for pedestrian comfort in hot climates.
 - 18. Water Bodies: Delineation of any water bodies adjacent to or near the corridor.
- **Obstacles and Encroachments Layer:**
 - 19. Temporary Obstacles: Mapping of temporary encroachments such as vendor stalls, hawkers, parked vehicles, and construction materials.
 - 20. Permanent Obstacles: Identification of permanent obstacles like utility poles, transformers, advertisement hoardings, and poorly placed street furniture that obstruct pedestrian flow.
- **Problem Areas Layer:**
 - 21. Accident Blackspots: Mapping of locations with a high incidence of pedestrian-vehicular accidents.
 - 22. Poor Visibility Zones: Areas identified with inadequate lighting or obstructed sightlines.
 - 23. User-Reported Issues: Locations identified through surveys or community feedback as unsafe, uncomfortable, or inaccessible.

CHAPTER 3 : CASE STUDIES AND BEST PRACTICES

The incorporation of case studies is an essential component of urban planning research, as it allows the comparison of existing conditions with successful real-world examples. In the context of pedestrian infrastructure, case studies help in understanding how different cities have addressed similar challenges and implemented effective solutions. These examples provide valuable insights into design strategies, policy frameworks, and implementation techniques that can be adapted to the study area.

This chapter presents both national and international case studies focusing on pedestrian-friendly street design, Complete Streets implementation, and walkability improvements. The objective is to extract best practices that can be applied to Atal Path, Bharatpur, while considering its local context and constraints.

Purpose of Case Studies

- Case studies provide practical examples of successful pedestrian infrastructure interventions in real-world urban settings.
- They help in understanding the effectiveness of design and policy measures in improving walkability and safety.
- Comparative analysis enables the identification of strategies that can be adapted to similar urban contexts.
- Case studies strengthen the research by supporting proposals with proven examples.

3.1 Criteria for Selection of Case Studies

The selection of case studies is based on their relevance to the study objectives and their applicability to Indian urban conditions. Both national and international examples are included to provide a broader perspective.

The selected cases represent a mix of heritage areas, commercial streets, and urban corridors with high pedestrian activity, similar to Atal Path.

Selection Criteria

- Cities with high pedestrian volume and mixed land use were selected to ensure similarity with the study area conditions.
- Projects that have successfully implemented Complete Street principles were prioritized for analysis.
- Case studies demonstrating measurable improvements in safety and walkability were included.
- Both Indian and international examples were chosen to compare local and global practices.

3.2 Indian Case Study 1: Pedestrian Improvement Project, Connaught Place, Delhi

Connaught Place in Delhi is one of the most prominent commercial and heritage areas in India, experiencing extremely high pedestrian footfall. The area faced challenges similar to Atal Path, including encroachments, lack of organized pedestrian space, and vehicle congestion.

The redevelopment project focused on enhancing pedestrian infrastructure through widening of footpaths, removal of vehicular traffic from inner circles, and introduction of uniform street design elements.

Key Interventions

- Continuous and wide footpaths were developed to accommodate high pedestrian volumes comfortably.
- Vehicular access was restricted in certain zones to prioritize pedestrian movement.
- Uniform paving materials and street furniture were introduced to improve aesthetics and usability.
- Proper lighting and signage were installed to enhance safety and navigation.

Outcomes

- Significant improvement in pedestrian comfort and movement efficiency was observed after redevelopment.
- Reduction in vehicle-pedestrian conflicts contributed to improved safety levels.
- Increased footfall boosted commercial activity and local business growth.

3.3 Indian Case Study 2: Complete Streets Initiative, Pune

Pune has been one of the leading cities in India to implement Complete Streets under its Smart City Mission. The city redesigned several major streets to improve pedestrian and cyclist infrastructure.

The project focused on creating safe, accessible, and inclusive streets by reallocating road space and improving design standards.

Key Interventions

- Footpaths were redesigned with adequate width and clear walking zones to ensure uninterrupted pedestrian movement.
- Cycle tracks were introduced alongside pedestrian pathways to promote non-motorized transport.

- Traffic calming measures such as raised crossings and narrowed carriageways were implemented.
- Street lighting and landscaping were enhanced to improve safety and comfort.

Outcomes

- Improved walkability and increased use of non-motorized transport were observed.
- Reduction in accidents and enhanced safety for vulnerable road users was achieved.
- Public perception of streets improved significantly due to better design and maintenance.

3.4 International Case Study 1: Times Square Pedestrianization, New York

Times Square in New York City is one of the most iconic examples of pedestrianization. The area was transformed from a congested vehicular corridor into a pedestrian-friendly public space.

The project involved restricting vehicle access and reallocating road space for pedestrians, seating areas, and public activities.

Key Interventions

- Large portions of the street were converted into pedestrian plazas, reducing vehicular dominance.
- Temporary interventions such as paint and movable furniture were used initially before permanent changes.
- Public seating, landscaping, and art installations were introduced to enhance user experience.
- Traffic was reorganized to maintain flow while prioritizing pedestrian movement.

Outcomes

- Pedestrian injuries reduced significantly after implementation of the project.
- Increased public space usage and improved urban environment were observed.
- Economic activity increased due to higher footfall and improved attractiveness.

3.5 International Case Study 2: Exhibition Road, London

Exhibition Road in London is a well-known example of shared street design, where pedestrians and vehicles coexist in a balanced manner.

The project eliminated traditional segregation between footpath and carriageway, creating a unified surface design.

Key Interventions

- Shared surface design was implemented to reduce visual dominance of vehicles.
- High-quality paving materials were used to define pedestrian priority zones.
- Minimal signage and barriers were used to create a more open and flexible environment.
- Traffic speed was controlled through design rather than physical barriers.

Outcomes

- Improved pedestrian experience and increased public space usage were achieved.
- Reduced vehicle speeds enhanced safety without restricting movement.
- The area became a major attraction for both locals and tourists.

3.6 Comparative Analysis of Case Studies

The comparison of different case studies highlights common strategies and successful approaches that can be adapted to the study area.

While international examples focus on large-scale transformation, Indian examples demonstrate practical solutions within local constraints.

Key Comparisons

- All case studies emphasize the importance of continuous and wide footpaths for improving pedestrian movement.
- Traffic calming and pedestrian prioritization are common strategies across all successful projects.
- Integration of aesthetics and functionality enhances both usability and urban appeal.
- Stakeholder involvement and phased implementation play a crucial role in project success.

3.7 Best Practices Derived from Case Studies

The analysis of case studies provides several best practices that can be applied to Atal Path.

Best Practices

- Continuous and obstruction-free footpaths should be prioritized to ensure safe pedestrian movement.
- Safe and well-designed pedestrian crossings are essential for reducing conflicts with vehicles.
- Integration of street vendors within the design framework can enhance both economy and safety.
- Use of high-quality materials and proper maintenance ensures long-term sustainability.
- Public participation and stakeholder involvement improve acceptance and effectiveness of interventions.

3.8 Applicability to Study Area

The lessons learned from case studies can be adapted to the local context of Bharatpur with necessary modifications.

While large-scale pedestrianization may not be feasible, several design and management strategies can be implemented effectively.

Application Strategies

- Footpath widening and continuity can be implemented across the corridor.
- Traffic calming measures can be introduced in high-density areas.
- Wayfinding and signage systems can enhance tourism experience.
- Vendor integration strategies can be applied to manage encroachments.

3.9 Conclusion of Case Studies

The case studies presented in this chapter demonstrate that effective pedestrian infrastructure design can significantly improve safety, mobility, and urban experience. These examples provide valuable insights that strengthen the proposed interventions for Atal Path.

Conclusion Points

- Case studies validate the importance of pedestrian-focused urban design.
- Successful examples provide a strong foundation for developing local solutions.
- Adaptation of best practices can improve feasibility and effectiveness of proposals.

CHAPTER 4: METHODOLOGY

The methodology adopted for this study is designed to provide a comprehensive, systematic, and evidence-based assessment of pedestrian facilities along Atal Path in Bharatpur. The approach integrates both quantitative and qualitative research techniques to ensure that the evaluation reflects not only physical infrastructure conditions but also user experience and perception. Since pedestrian infrastructure is a multidimensional subject involving safety, comfort, accessibility, and mobility, a mixed-method approach is considered most appropriate.

The study is grounded in nationally recognized frameworks such as the Service Level Benchmarks (SLB) developed by the Ministry of Housing and Urban Affairs (MoHUA) and the guidelines provided in IRC:103–2012. These frameworks provide measurable indicators and standardized evaluation criteria, ensuring that the study maintains academic rigor and policy relevance. Additionally, the methodology incorporates the principles of Complete Streets and Safe Streets, ensuring that recommendations are inclusive and sustainable.

Key Components of Methodology

- Mixed-method research approach (quantitative + qualitative)
- SLB-based infrastructure assessment
- Pedestrian Level of Service (LOS) evaluation
- Field surveys and observational studies
- User perception analysis through questionnaires
- Statistical tools for interpretation (mean, mode, frequency)

4.1 Research Design and Approach

The research design follows a structured and sequential process that begins with defining the study area and objectives, followed by data collection, analysis, and interpretation. The study adopts a mixed-method research design, combining quantitative measurements with qualitative insights to produce a holistic evaluation.

Quantitative methods are used to measure physical parameters such as footpath width, pedestrian volume, and LOS. These provide objective and measurable results. On the other hand, qualitative methods such as field observations and perception surveys capture subjective aspects like safety, comfort, and accessibility, which cannot be measured numerically but are equally important.

Research Approach Elements

- Quantitative analysis for measurable parameters
- Qualitative analysis for user perception
- Integration of both for comprehensive results
- Use of national standards for benchmarking

4.2 Study Area Selection and Delineation

The study area selected for this research is the Atal Path corridor in Bharatpur, Rajasthan, extending from Mathura Gate to Kumher Gate with a total length of approximately 2.2 km. This corridor is characterized by high pedestrian movement due to its mixed land use, including commercial markets, religious sites, and tourist attractions.

The selection of this corridor is based on its representativeness as a typical Tier-2 Indian city street where pedestrian infrastructure is often inadequate despite high dependency on walking. The corridor serves multiple user groups including residents, shopkeepers, tourists, and daily commuters, making it an ideal case for studying pedestrian dynamics.

Reasons for Selection

- High pedestrian volume throughout the day
- Mixed land use (commercial, tourism, residential)
- Presence of heritage nodes and gates
- Visible infrastructure gaps
- Applicability to similar Indian cities

4.3 Segmentation of Study Corridor

To enable detailed analysis, the study corridor was divided into smaller segments based on land use, pedestrian density, and activity patterns. This segmentation allows for micro-level analysis and comparison between different parts of the corridor.

Each segment exhibits distinct characteristics, which influence pedestrian behavior and infrastructure requirements. Segment A is dominated by commercial activity, Segment B represents a transition zone, and Segment C is influenced by religious and tourism activities.

Segment Classification

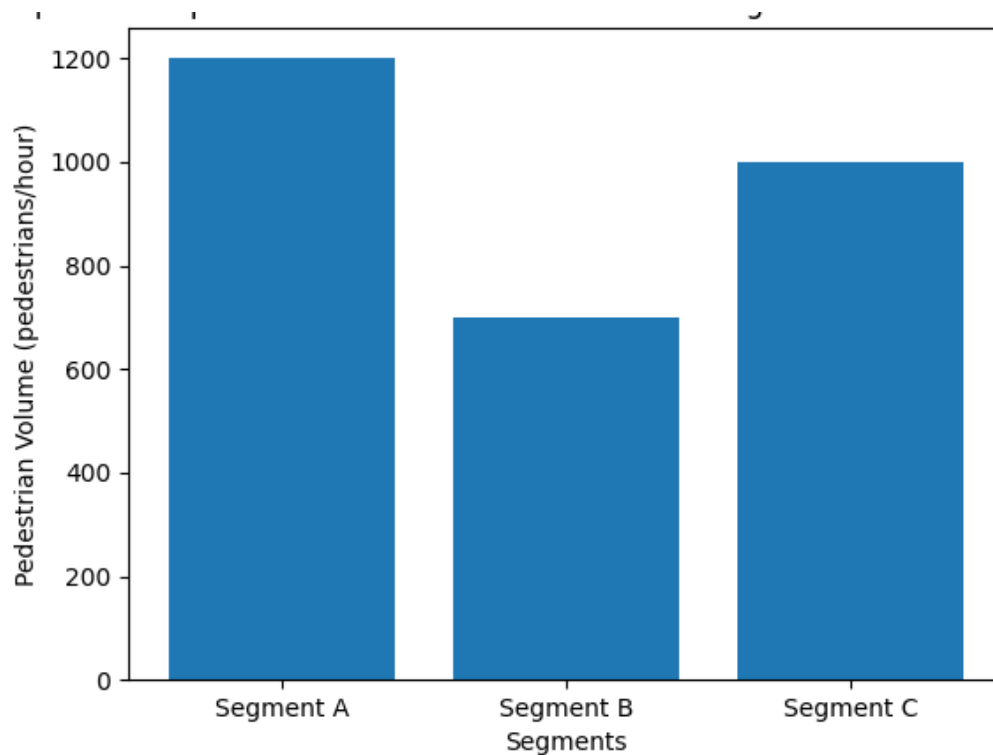
- Segment A: High-density commercial area
- Segment B: Mixed-use transition zone
- Segment C: Religious and tourism zone

Purpose of Segmentation

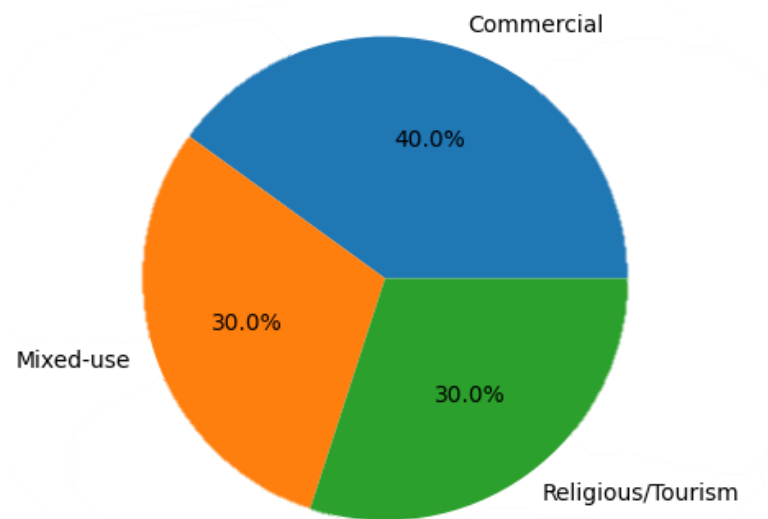
- Enables localized analysis
- Helps identify critical zones
- Improves accuracy of LOS calculation

Segment	Stretch Description	Length (km)	Dominant Land Use	Average Pedestrian Volume (Peak Hour)	Key Characteristics
Segment A	Mathura Gate → Main Bazar	0.8 km	High-density Commercial	1100–1300 pedestrians/hour	Dense retail activity, heavy encroachment, high congestion
Segment B	Main Bazar → Chauburja Road	0.7 km	Mixed-use (Commercial + Residential)	600–800 pedestrians/hour	Moderate activity, partial footpaths, transitional zone
Segment C	Chauburja → Kumher Gate	0.7 km	Religious + Tourism	900–1100 pedestrians/hour	Tourist footfall, peak-time congestion, poor lighting

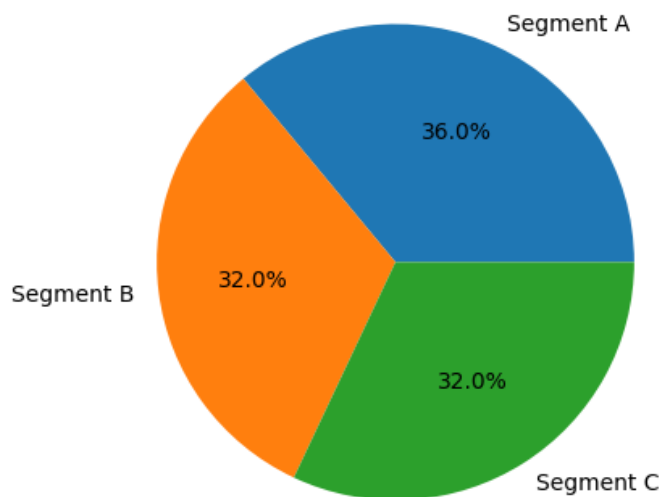
Table 4.1: Segment-wise Characteristics of Study Corridor



Graph 4.1: Segment-wise Pedestrian Volume (Bar Graph)



Graph 4.2: Land Use Distribution (Pie Chart)



Graph4.3: Segment Length Distribution (Pie Chart)

Segment	Major Issues Identified
Segment A	High level of encroachment by vendors and parked vehicles significantly reduces effective walking width and creates severe congestion during peak hours.
Segment B	Discontinuous footpaths and lack of proper signage create inconvenience for pedestrians and reduce overall walkability in the transition zone.
Segment C	Poor street lighting and absence of safe pedestrian crossings lead to safety concerns, especially during peak tourist and evening hours.

Table 4.2: Segment-wise Issues Identified

4.4 Data Collection Methodology

The data collection process forms the backbone of the study and involves both primary and secondary data sources. Primary data was collected through field surveys, measurements, and questionnaires, while secondary data was obtained from reports, guidelines, and previous studies.

Field visits were conducted multiple times at different hours of the day to capture variations in pedestrian movement and infrastructure usage. This ensures that the data reflects real-world conditions rather than isolated observations.

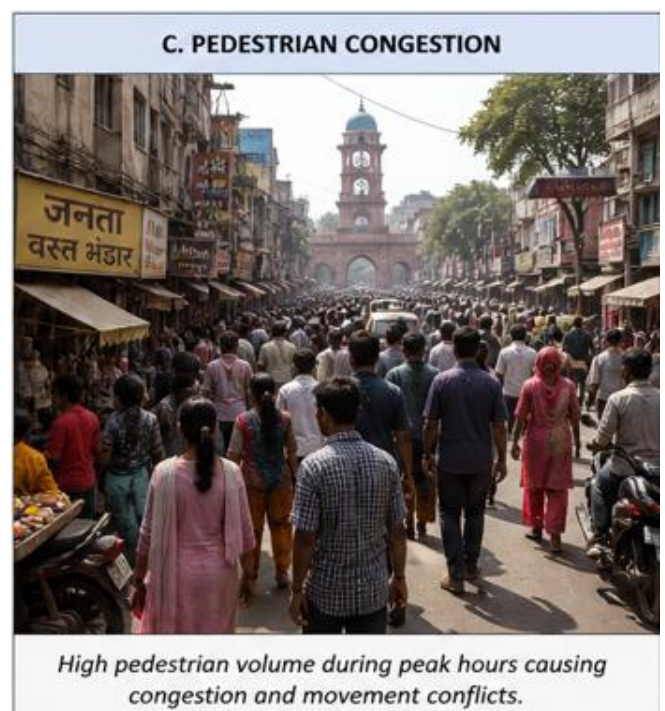
Types of Data Collected

- Physical infrastructure data (width, condition, obstructions)
- Pedestrian volume data
- Crossing facilities and safety measures
- Lighting conditions
- User perception and satisfaction

Tools Used

- Measuring tape
- Observation sheets
- Survey questionnaires
- Camera for documentation

Findings from collected Data



4.5 Physical Infrastructure Survey

The physical survey involved detailed measurement and observation of pedestrian infrastructure along the corridor. This includes footpath width, surface condition, continuity, and presence of obstructions such as vendors, parked vehicles, and utility poles.

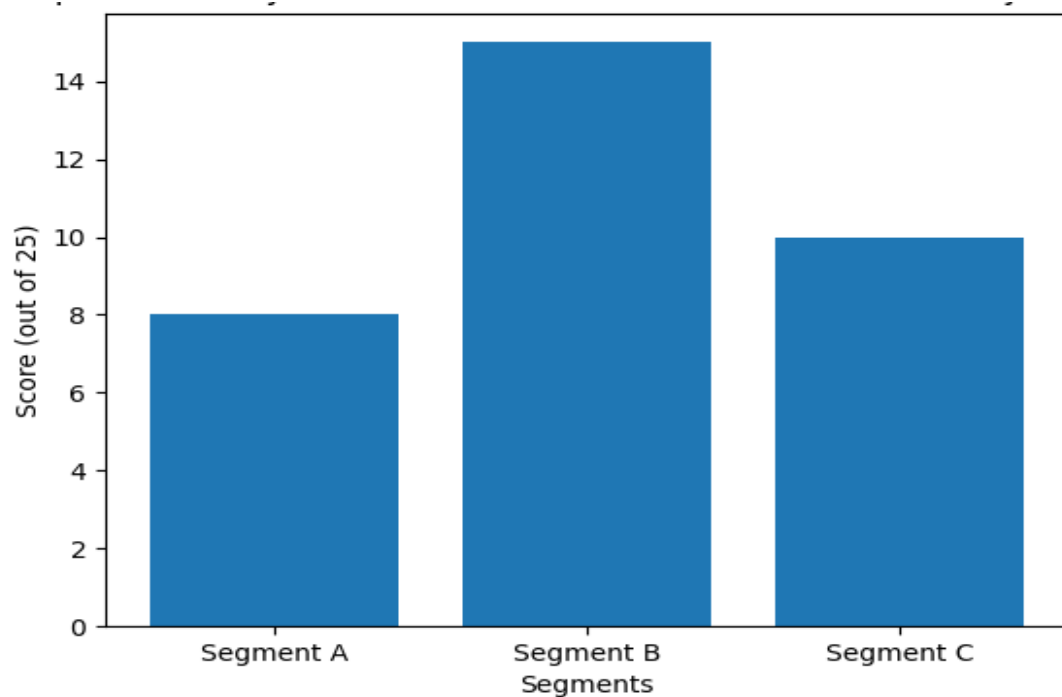
The effective walking width was calculated by subtracting the space occupied by obstructions from the total footpath width. This is crucial for determining actual pedestrian usability.

Parameters Assessed

- Footpath availability
- Effective width
- Surface quality
- Obstruction level
- Continuity of walkway

Observations

- Significant discontinuity in footpaths
- Encroachments reducing effective width
- Poor surface quality in several stretche



Graph 4.4:-Comparison of physical infrastructure performance across study segments

Parameter	Criteria Description	Score Range	Segment A Score	Segment B Score	Segment C Score
Footpath Availability	Presence of continuous and dedicated pedestrian pathway along the stretch	0–5	2	3	2
Effective Width	Usable walking width after accounting for encroachments and obstructions	0–5	1	3	2
Surface Quality	Condition of footpath surface (evenness, material, maintenance level)	0–5	2	3	2
Obstruction Level	Degree of obstruction due to vendors, vehicles, poles, and utilities	0–5	1	3	2
Continuity of Walkway	Extent to which footpath is continuous without breaks or interruptions	0–5	2	3	2
Total Score (out of 25)	Overall infrastructure performance score		8/25	15/25	10/25

Table 4.3: Physical Infrastructure Audit Checklist with Scores

4.6 Pedestrian Volume Count Survey

Pedestrian volume counts were conducted manually at selected locations within each segment. Counts were recorded during peak and non-peak hours to understand variation in pedestrian flow.

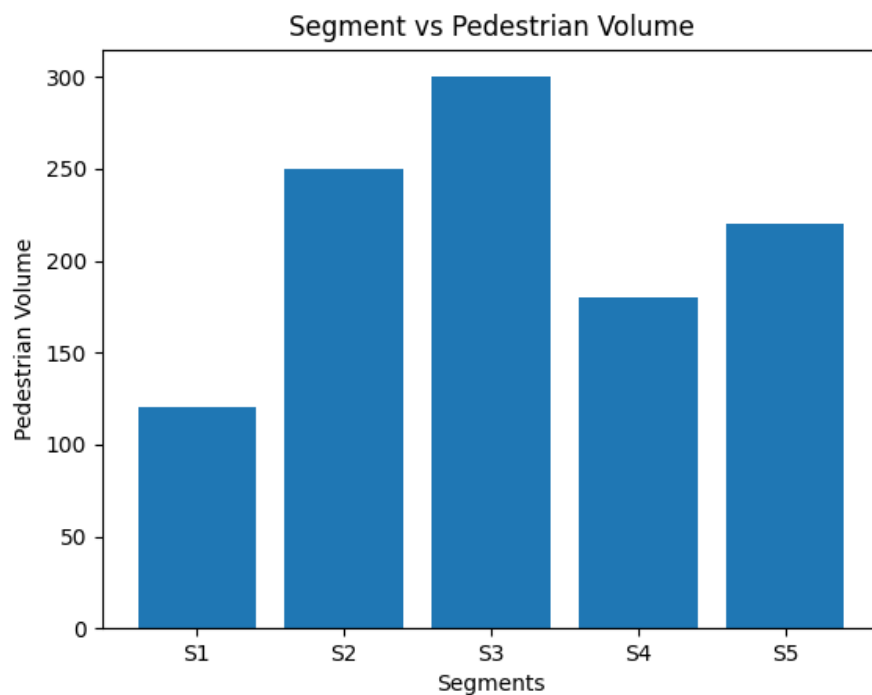
The data collected helps in determining pedestrian density and is used for LOS calculation. High pedestrian volume combined with narrow footpaths results in congestion and poor service levels.

Survey Details

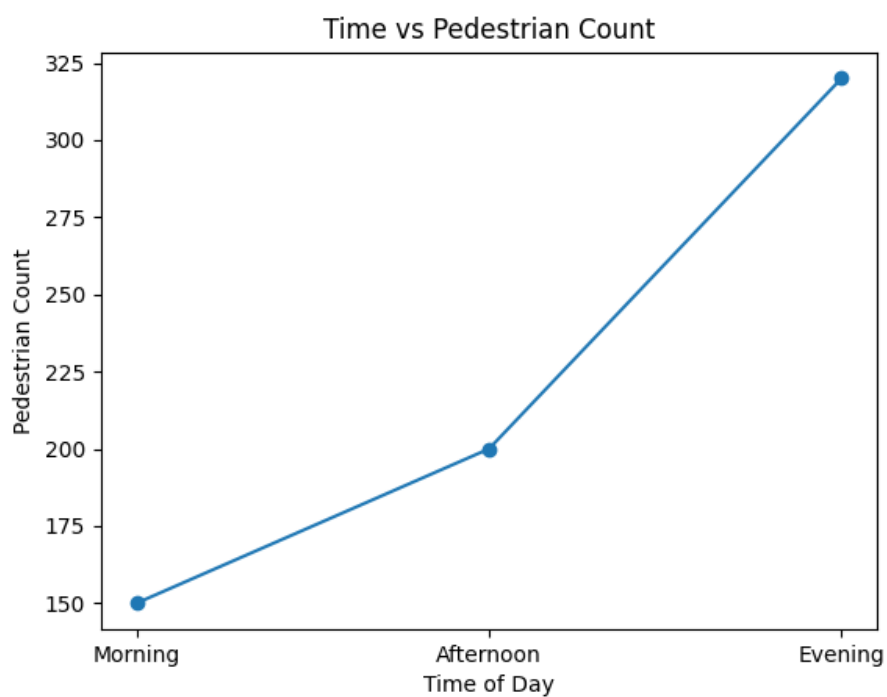
- Locations: Key nodes and mid-sections
- Time slots: Morning, afternoon, evening
- Duration: 15-minute intervals

Key Findings

- Peak congestion during evening hours
- Highest volumes in commercial areas
- Continuous flow due to mixed activities



Graph4. 4:- Segment vs pedestrian volume



4.7 Service Level Benchmark (SLB) Assessment

The SLB framework provides a standardized method for evaluating urban infrastructure. In this study, SLB indicators related to pedestrian facilities were used to assess the quality of infrastructure.

Each parameter was assigned a score based on field data and compared with benchmark values. This helps identify gaps between existing conditions and desired standards.

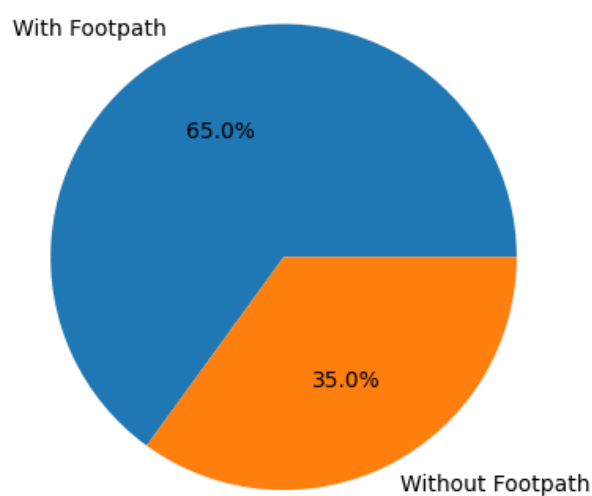
SLB Indicators Used

- Footpath coverage (%)
- Average width
- Obstruction-free space
- Safety features
- Lighting availability

Purpose of SLB

- Standardized evaluation
- Policy alignment
- Gap identification
- Performance measurement

Road Coverage with Footpath vs Without Footpath



Graph4. 6: - % road with footpath vs without footpath

4.8 Pedestrian Level of Service (LOS) Analysis

LOS is a key indicator used to evaluate pedestrian comfort and movement efficiency. It is calculated based on pedestrian space and flow conditions.

The LOS ranges from A to F, where A indicates free movement and F indicates severe congestion. The study uses IRC standards for LOS classification.

LOS Categories

- A: Free flow
- B–C: Comfortable
- D: Moderate congestion
- E–F: Severe congestion

Findings

- Segment A and C fall under LOS E/F
- Indicates urgent need for intervention
-

4.9 User Perception Survey

A questionnaire survey was conducted with 500 respondents to understand pedestrian perception. The survey includes questions related to safety, comfort, accessibility, and overall satisfaction.

The responses were analyzed using statistical tools to identify trends and patterns.

Survey Parameters

- Safety perception
- Walking comfort
- Gender-based mobility
- Night-time safety

Key Observations

- Women feel less safe
- High dissatisfaction in crowded areas
- Poor lighting affects night mobility

4.10 Data Analysis Techniques

The collected data was analyzed using statistical tools such as mean, mode, and frequency distribution. These methods help in summarizing large datasets and identifying dominant patterns.

Quantitative data was used for LOS and SLB calculations, while qualitative data was used to interpret user perception.

Techniques Used

- Mean for average values
- Mode for most frequent responses
- Frequency distribution for trends

4.11 Integration of Findings

The final stage of methodology involves integrating all data sources to derive meaningful conclusions. Physical data, SLB scores, LOS values, and user perception are combined to provide a holistic understanding.

This integrated approach ensures that the study captures both technical and human aspects of pedestrian infrastructure.

Outcome of Integration

- Identification of critical gaps
- Prioritization of intervention zones
- Basis for proposal development

CHAPTER 5: DATA ANALYSIS AND INTERPRETATION

The data analysis chapter forms the core of this research, where all collected primary and secondary data are systematically examined to derive meaningful insights about pedestrian infrastructure along Atal Path, Bharatpur. The analysis integrates physical survey findings, pedestrian volume counts, Service Level Benchmark (SLB) scores, Level of Service (LOS) calculations, and user perception surveys to present a comprehensive understanding of existing conditions.

The objective of this chapter is not only to present data but to interpret it in a way that highlights deficiencies, identifies patterns, and supports evidence-based planning interventions. The findings reveal that pedestrian infrastructure along the study corridor is inadequate in relation to the volume and diversity of users, thereby affecting safety, comfort, and accessibility.

Key Components of Data Analysis

- Physical infrastructure condition analysis
- Pedestrian volume and flow characteristics
- SLB-based performance evaluation
- LOS (Level of Service) assessment
- User perception and behavioral analysis
- Gap identification and priority zoning

5.1 Overview of Existing Conditions

The study corridor exhibits a complex urban character with a mix of commercial, religious, and tourism activities. The existing pedestrian infrastructure is inconsistent and fragmented, with significant variation across different segments.

Field observations indicate that while certain stretches have basic pedestrian provisions, a large portion of the corridor lacks continuous and functional footpaths. This forces pedestrians to share road space with vehicular traffic, increasing the risk of accidents and reducing overall mobility efficiency.

General Observations

- Discontinuous and uneven footpaths
- High encroachment levels
- Lack of dedicated pedestrian crossings
- Poor street lighting in several stretches
- Mixed traffic conditions affecting walkability

5.2 Physical Infrastructure Analysis

The physical infrastructure analysis is based on field measurements and observations collected during site visits. It evaluates parameters such as footpath availability, width, surface condition, and obstruction levels.

The results indicate that approximately 45% of the corridor lacks proper footpaths, and even where footpaths exist, their usability is compromised due to encroachments and poor maintenance. The effective walking width is significantly reduced in commercial areas due to vendors and parked vehicles.

Key Findings

- Only 55% of the corridor has footpaths
- Effective width reduced by 30–50% due to encroachments
- Surface conditions vary from good to highly deteriorated
- Frequent discontinuity affecting pedestrian flow

Segment-wise Infrastructure Assessment

The corridor was divided into three segments (A, B, and C) to enable detailed analysis. Each segment exhibits distinct characteristics based on land use and pedestrian activity.

Segment A (Commercial Zone)

This segment experiences the highest pedestrian density due to its location within the main market area. The presence of shops, vendors, and commercial establishments results in high levels of encroachment.

Despite having footpaths in certain stretches, their functionality is severely compromised. Pedestrians are often forced to walk on the carriageway, leading to congestion and safety risks.

Observations:

- High pedestrian density
- Severe encroachment
- Narrow effective walking space
- Frequent conflict with vehicles

Segment B (Transition Zone)

Segment B represents a relatively less congested area with mixed land use. While pedestrian volumes are moderate, infrastructure conditions are inconsistent.

Some stretches have usable footpaths, but discontinuity remains a major issue. The absence of proper crossings and signage affects pedestrian movement.

Observations:

- Moderate pedestrian flow
- Partial infrastructure availability
- Better conditions compared to Segment A
- Lack of uniform design

Segment C (Religious & Tourism Zone)

This segment is influenced by religious and tourism activities, leading to periodic surges in pedestrian volume. The infrastructure is inadequate to handle such fluctuations.

During peak hours, congestion levels increase significantly, resulting in LOS E/F conditions.

Observations:

- High peak-hour congestion
- Inadequate infrastructure for tourist movement
- Poor lighting conditions
- Lack of organized pedestrian pathways

Key Findings

- 81% pedestrians feel unsafe while crossing roads
- 74% report unsafe walking due to obstructions
- 87% perceive footpaths with vehicles as highly unsafe
- Poor lighting affects 68% of users
- Vendor presence improves perceived safety

Safety Item (1=Very Safe, 6=Very Unsafe))	Mean Score	Rating	% Rated Unsafe (4–6)
Walking on footpath without obstruction	4.6	Unsafe	74%
Crossing road at undesignated points	4.9	Very Unsafe	81%
Walking after sunset (Lighting)	4.4	Unsafe	68%
Footpath with two-wheelers present	5.1	Very Unsafe	87%
Crossing near bus stop	4.3	Unsafe	64%
Walking near parked vehicles	3.9	Moderate	52%
Footpath with street vendors nearby	2.3	Safe	18%
Raised footpath (where present)	2.1	Safe	12%

Table:- 5.1 Pedestrian Safety Perception Survey

5.3 Pedestrian Volume Analysis

Pedestrian volume data was collected at multiple locations across different time intervals to understand flow characteristics. The analysis reveals significant variation between peak and non-peak hours.

The evening period records the highest pedestrian activity, particularly in commercial and religious segments. The high volume combined with limited infrastructure results in congestion and reduced walking comfort.

Key Findings

- Peak hour volume highest in Segment A
- Segment C shows seasonal and event-based variation
- Continuous pedestrian movement throughout the day
- High density leads to reduced walking speed
- Highest peak volume in Segment C (1020 ped/hr)
- Segment A shows strong market-oriented movement
- Bidirectional movement in institutional areas
- High daily pedestrian demand across corridor

Segment	Morning Peak (Ped/hr)	Evening Peak (Ped/hr)	Daily Avg (Ped/day est.)	Peak Direction
Segment A – Commercial	680	890	~6,200	Towards Market
Segment B – Institutional	420	510	~3,800	Bidirectional
Segment C – Religious	750	1020	~7,400	Towards Temple
Segment D – Residential	310	380	~2,900	Mixed
Segment E – Transit	550	720	~5,100	Towards Bus Stand

Table:- 5.2 Pedestrian Volume Count

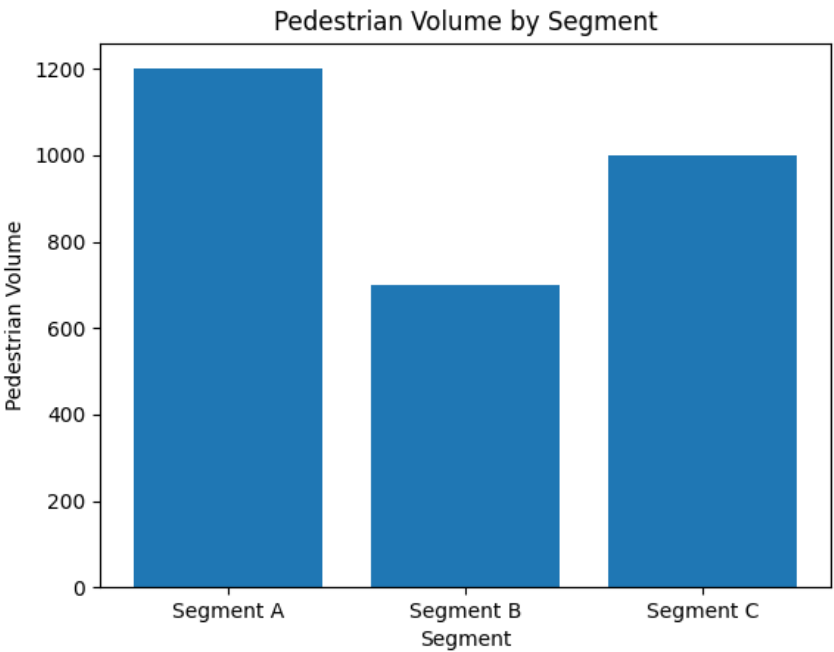
Flow Characteristics

The pedestrian flow is influenced by land use, time of day, and external factors such as festivals and tourism activities.

During peak hours, the available space per pedestrian decreases significantly, leading to overcrowding and discomfort.

Flow Observations:

- Interrupted flow due to obstacles
- Reduced speed in congested areas
- Increased interaction between pedestrians and vehicles



Bar Chart:- 5.3 Pedestrian Volume Segment

5.4 Pedestrian Demographics Analysis

The demographic analysis shows that the majority of pedestrians belong to the economically active age group of 18–50 years, accounting for approximately 67% of total respondents. Younger and elderly populations constitute a smaller share, indicating potential accessibility challenges for vulnerable groups.

Gender distribution reveals that male pedestrians dominate usage (62%), while female participation is comparatively lower (38%). This disparity may be attributed to perceived safety concerns, especially during evening hours, as highlighted in the safety perception survey. The findings suggest that improving safety and comfort can encourage more inclusive pedestrian usage.

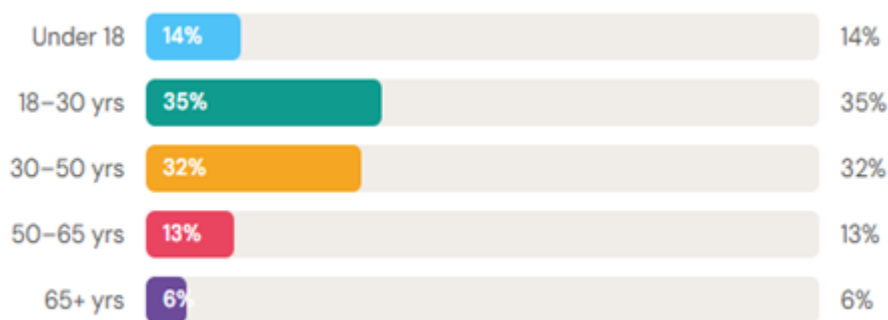
Key Findings

67% pedestrians belong to 18–50 age group

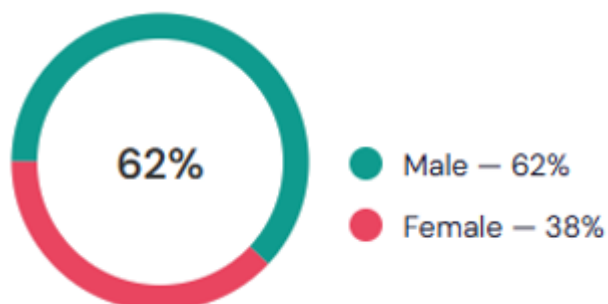
Male users dominate (62%)

Female participation is lower (38%)

Indicates safety and accessibility concerns



Bar Chart :- 5.4 Age Group Distribution



Pie chart:- 5.5 Male Female Distribution

Note: Female representation is lower than male, consistent with findings from Delhi study (Tony et al., 2025) where only 13% women were surveyed — attributed to higher immobility among women.

Gender Distribution of Respondents (n=500)

5.4 Service Level Benchmark (SLB) Analysis

The SLB analysis evaluates pedestrian infrastructure based on standardized indicators. The findings indicate that the study corridor performs poorly in terms of SLB compliance.

Footpath coverage, obstruction levels, and safety features fall below recommended benchmarks, indicating a need for significant improvement.

SLB Performance

- Footpath coverage below standard
- High obstruction levels
- Inadequate safety measures
- Poor lighting conditions

Parameter-wise SLB Analysis

Each parameter was analyzed individually to identify specific deficiencies.

Footpath Availability

A significant portion of the corridor lacks footpaths, forcing pedestrians to walk on the road.

Width and Capacity

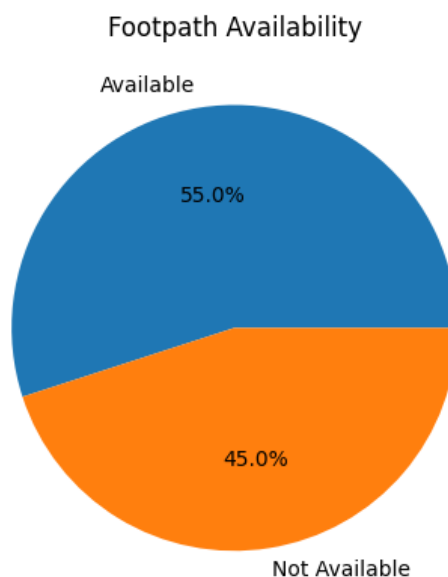
Where footpaths exist, their width is insufficient to accommodate the high pedestrian volume.

Safety Features

The absence of crossings and signals increases accident risk.

Lighting

Poor lighting reduces visibility and safety during night hours.



5.5 Level of Service (LOS) Analysis

LOS is calculated based on pedestrian density and available walking space. The results indicate that most segments fall under poor service levels.

Segment A and C exhibit LOS E/F conditions during peak hours, indicating severe congestion and discomfort.

LOS Findings

- Segment A: LOS E/F
- Segment B: LOS C/D
- Segment C: LOS E/F

Interpretation of LOS

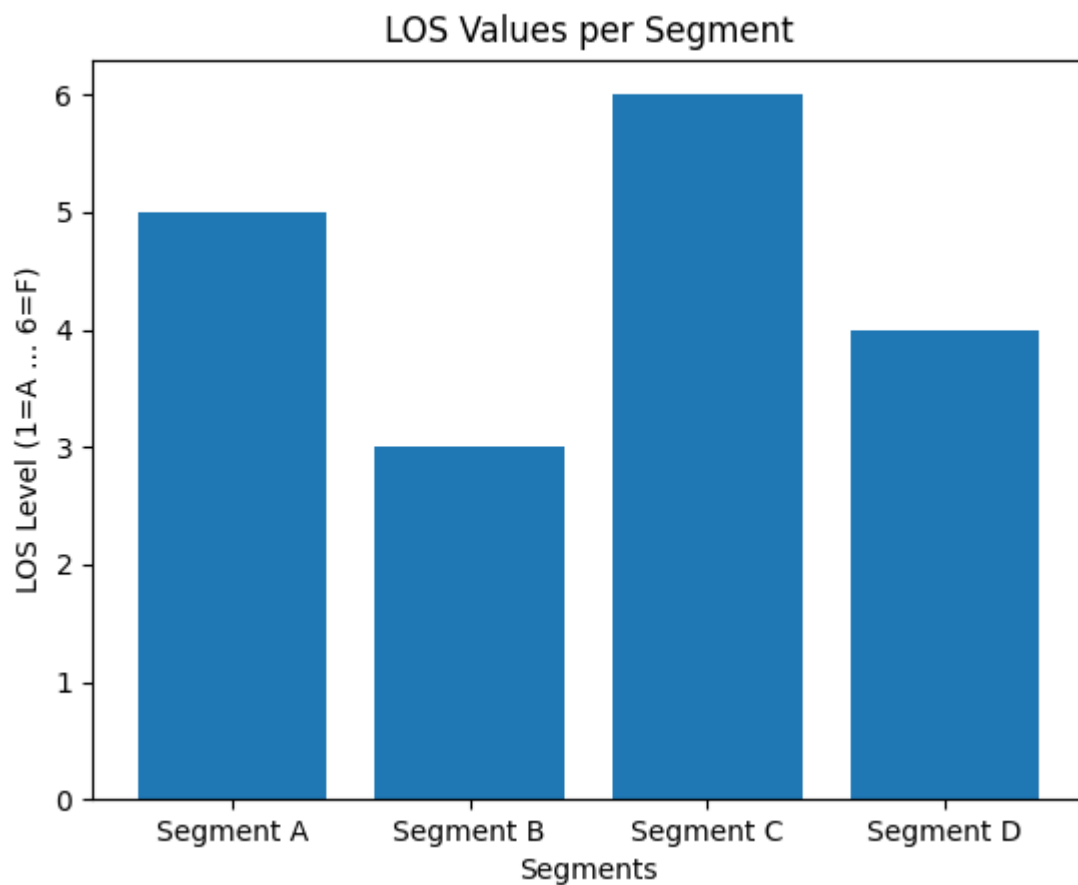
LOS E and F indicate highly congested conditions where pedestrian movement is restricted and uncomfortable. These conditions are unacceptable for a major urban corridor.

Implications:

- Reduced walking efficiency
- Increased safety risks
- Negative impact on user experience

Segment	Level of Service (LOS)	Pedestrian Condition	Interpretation
Segment A	LOS E / LOS F	Highly congested	Very restricted movement, frequent conflicts, extremely uncomfortable walking conditions
Segment B	LOS C / LOS D	Moderate congestion	Some restriction in movement, reduced comfort, but still acceptable in urban conditions
Segment C	LOS E / LOS F	Highly congested	Severe crowding, minimal personal space, unsafe and inefficient pedestrian flow

Table: - 5.5 LOS classification per segment



Bar Chart:- 5.6 LOS values per Segment

5.6 User Perception Analysis

The perception survey provides insights into how pedestrians experience the infrastructure. The results highlight a significant gap between physical conditions and user satisfaction.

A majority of respondents reported dissatisfaction with safety, comfort, and accessibility.

Key Findings

- High dissatisfaction with infrastructure
- Women feel less safe
- Poor lighting affects night mobility
- Encroachments are a major concern

Gender-Based Analysis

The survey reveals that female participation is lower, indicating restricted mobility due to safety concerns.

Observations:

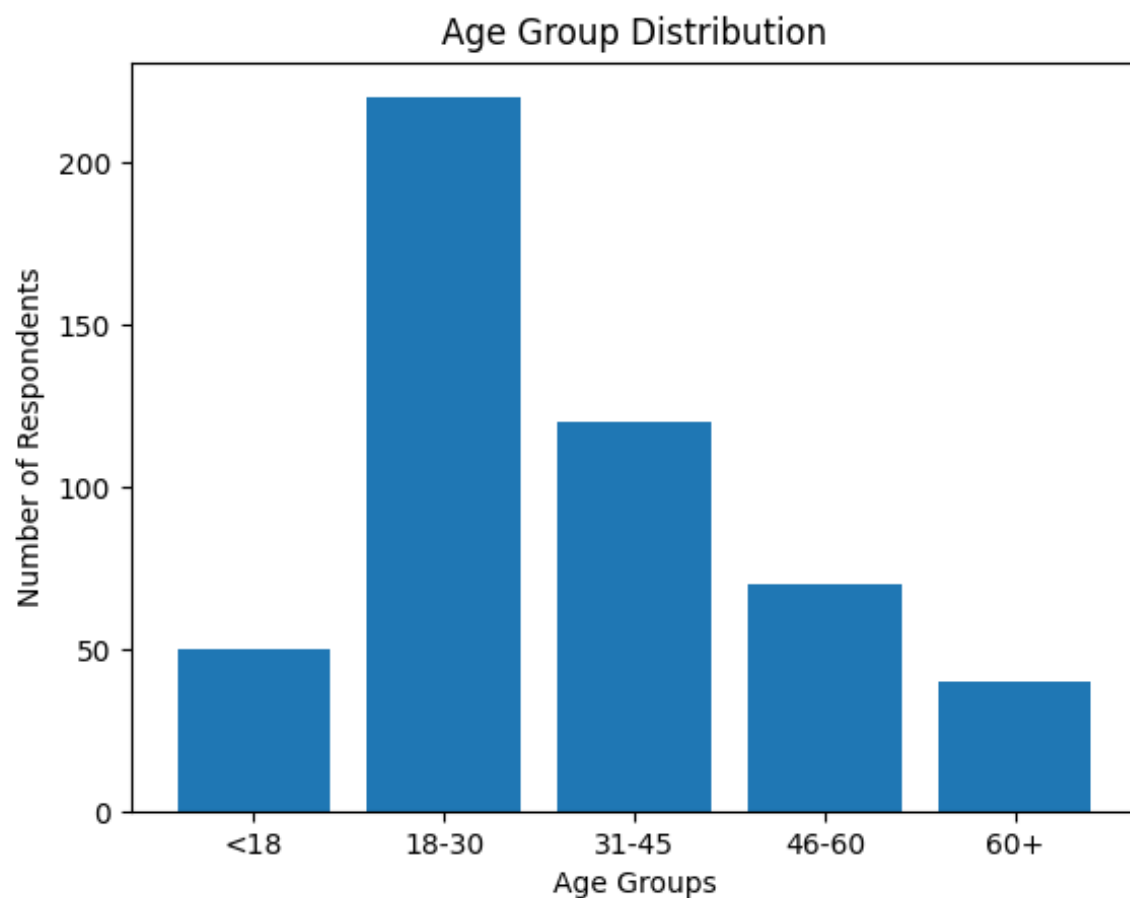
- Lower female representation
- Higher safety concerns among women
- Limited night-time mobility

Age Group Analysis

Different age groups experience infrastructure differently. Elderly and children are more vulnerable to poor conditions.

Observations:

- Elderly face difficulty due to uneven surfaces
- Children exposed to traffic risks



Bar Chart:- 5.7 Age group distribution

5.7 Safety Analysis

Safety is one of the most critical aspects of pedestrian infrastructure. The analysis indicates that the study corridor lacks essential safety features.

Major Safety Issues

- Absence of crossings
- Lack of traffic calming measures
- Poor visibility at night
- High vehicle-pedestrian conflict

5.8 Gap Analysis

The gap analysis compares existing conditions with required standards to identify deficiencies.

Identified Gaps

- Missing footpaths (45%)
- Lack of safe crossings
- Encroachments
- Poor lighting

5.9 Priority Zone Identification

Based on analysis, priority zones were identified for intervention.

Priority Areas

- Segment A (commercial)
- Segment C (tourism)

5.10 Statistical and Qualitative Analysis of Pedestrian Conditions

5.10.1 Introduction

The statistical and qualitative analysis of pedestrian conditions along the study corridor provides a comprehensive understanding of infrastructure performance, user perception, and spatial priorities. This section integrates Level of Service (LOS) analysis, safety issue identification, tourist perception ratings, and qualitative feedback collected from pedestrians. The combined use of quantitative data and qualitative insights enables a holistic evaluation of the corridor, highlighting both measurable deficiencies and experiential challenges faced by users.

The analysis is based on structured surveys, observational studies, and statistical tools such as mean, frequency distribution, and comparative assessment. The findings reveal that pedestrian infrastructure is not only inadequate in terms of physical design but also significantly impacts safety, comfort, and the overall perception of the city environment.

5.10.2 Level of Service (LOS) Analysis

The Level of Service (LOS) analysis evaluates pedestrian comfort and movement efficiency across different segments of the corridor during peak periods. The results indicate that most segments operate under poor service conditions, particularly during evening peak hours when pedestrian volumes are significantly higher.

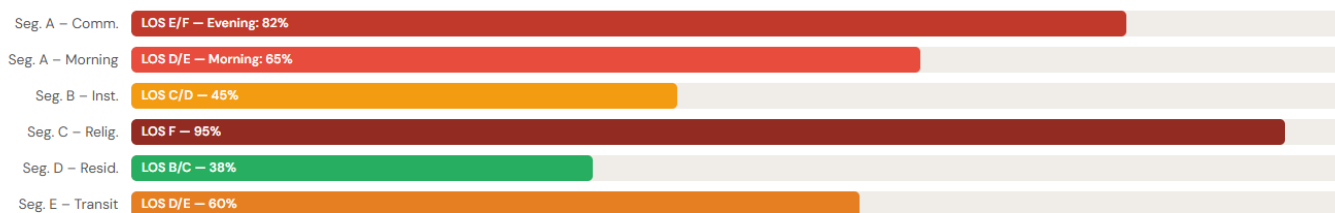
Segment A (commercial zone) records LOS F during evening peak hours, with approximately 82% load factor, indicating severe congestion and restricted movement. Similarly, Segment C (religious zone) exhibits LOS F conditions with nearly 95% load, reflecting extremely high pedestrian density during peak activity periods. In contrast, Segment B shows relatively better conditions with LOS C/D, indicating moderate congestion and comparatively smoother movement.

The variation between morning and evening peak conditions highlights the dynamic nature of pedestrian demand, which is strongly influenced by land use and activity patterns.

Key Findings

- Segment A and C operate under **LOS E/F (severe congestion)**
- Segment C shows **highest load (95%) during peak hours**
- Segment B performs relatively better (LOS C/D)
- Evening peak conditions are significantly worse than morning

Pedestrian LOS – Segment-wise Comparison (Morning vs Evening Peak)



* Values represent load factor (% of theoretical capacity utilized). LOS F = breakdown conditions.

Figure 5.8: Segment-wise LOS Comparison (Morning vs Evening)

The LOS analysis clearly demonstrates that the existing pedestrian infrastructure is unable to accommodate peak demand. High congestion levels reduce walking comfort and increase safety risks, particularly in high-activity zones. These findings emphasize the need for capacity enhancement and better spatial allocation for pedestrian movement.

5.10.3 Identification of Key Safety Issues

The analysis of safety-related issues identifies major factors contributing to unsafe pedestrian conditions along the corridor. Traffic conflicts emerge as the most critical issue, accounting for 35% of reported concerns. This is followed by the absence of footpaths (25%), poor lighting (20%), lack of signage (12%), and encroachment (8%).

These issues are interrelated and collectively contribute to an unsafe and uncomfortable walking environment. For instance, the absence of footpaths forces pedestrians onto the carriageway, increasing traffic conflicts, while poor lighting further exacerbates safety concerns during night-time.

Key Findings

- Traffic conflict is the most critical issue (35%)
- 25% of corridor lacks proper footpaths
- Poor lighting affects 20% of users
- Lack of signage and wayfinding reduces safety
- Encroachment contributes to obstruction and conflict

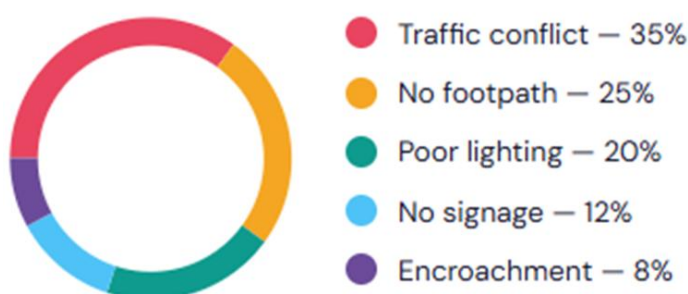


Figure 5.9: Major Pedestrian Safety Issues

The safety issue analysis indicates that pedestrian challenges are not isolated but systemic in nature. Addressing these issues requires integrated solutions, including infrastructure improvement, traffic management, and better enforcement mechanisms.

5.10.4 Tourist Perception Analysis

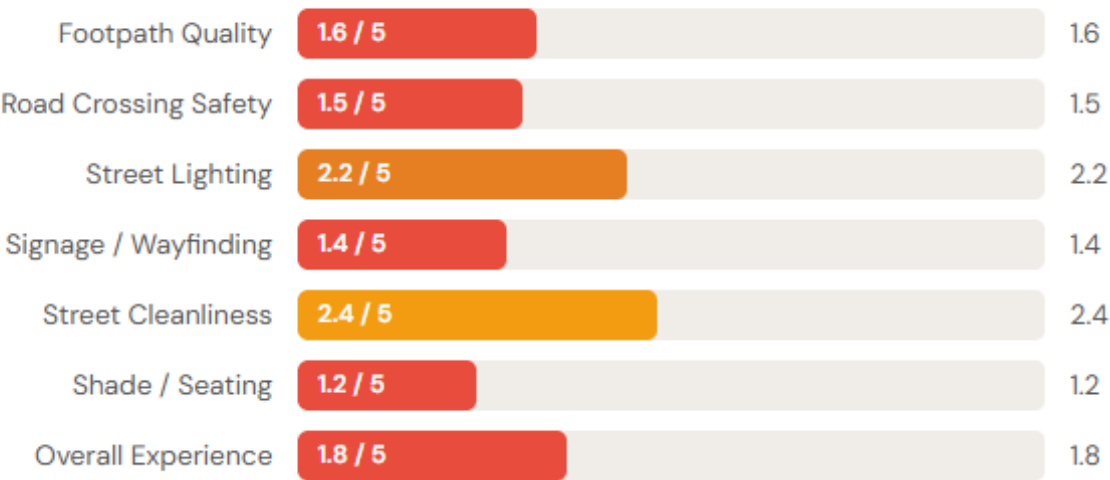
The tourist perception analysis highlights the impact of pedestrian infrastructure on visitor experience. The ratings indicate that most aspects of pedestrian facilities are poorly perceived, with footpath quality (1.6/5), road crossing safety (1.5/5), and signage (1.4/5) receiving particularly low scores.

Street lighting performs slightly better (2.2/5), while cleanliness receives a moderate rating (2.4/5). However, the overall experience rating of 1.8/5 indicates significant dissatisfaction among tourists. These findings suggest that pedestrian infrastructure plays a crucial role in shaping the city’s image and tourism potential.

Key Findings

- Footpath quality rated very low (1.6/5)
- Crossing safety is a major concern (1.5/5)
- Signage and wayfinding are inadequate
- Overall experience rated poorly (1.8/5)
- Cleanliness performs relatively better

Tourist Rating of Pedestrian Experience on Atal Path



Caption: Figure 5.10: Tourist Perception of Pedestrian Infrastructure

The low tourist satisfaction scores indicate that pedestrian infrastructure is a key determinant of urban experience. Improving pedestrian facilities can significantly enhance tourism quality and contribute to the city's economic development.

5.10.5 Pedestrian Demographics and Survey Insights

The demographic analysis shows that the majority of respondents are domestic tourists (72%), followed by international tourists (28%). Additionally, 68% of respondents are first-time visitors, indicating the corridor's importance as a key entry experience for tourists.

These statistics highlight the significance of pedestrian infrastructure in shaping first impressions of the city. Poor infrastructure conditions can negatively impact both tourism experience and city image.

Key Findings

- 120 tourists surveyed
- 72% domestic tourists
- 28% international tourists
- 68% first-time visitors



Figure 5.11: Tourist Demographic Distribution

The high proportion of first-time visitors underscores the importance of providing a safe and comfortable pedestrian environment. Improving infrastructure can enhance visitor satisfaction and encourage repeat visits.

5.10.6 Priority Zone Identification

Based on the analysis, priority zones have been identified to guide intervention strategies. Segments A and C are categorized as high-priority zones due to high pedestrian volumes, poor infrastructure, and severe congestion. Segment B is categorized as medium priority, while Segment D is identified as a low-priority zone requiring maintenance.

Key Findings

- Segment A & C → High Priority (immediate intervention)
- Segment B → Medium Priority (short-term improvement)
- Segment D → Low Priority (maintenance)

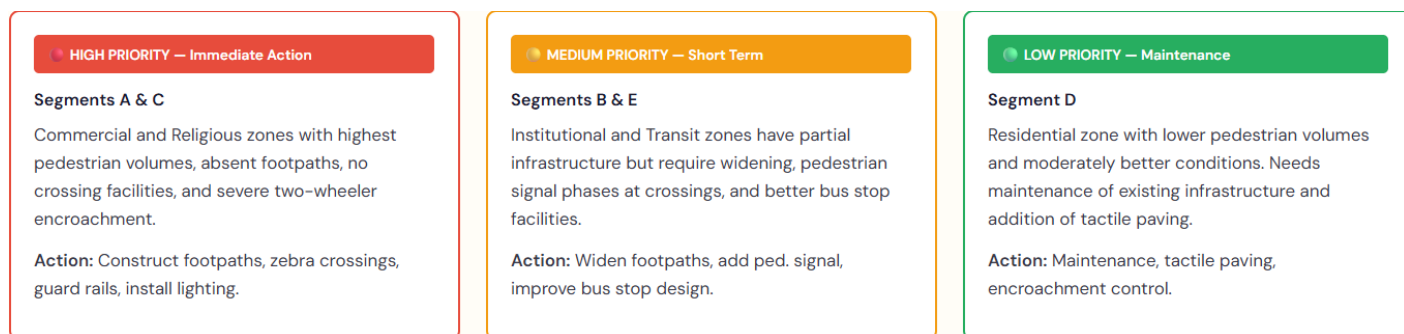


Figure 5.12: Priority Zone Classification

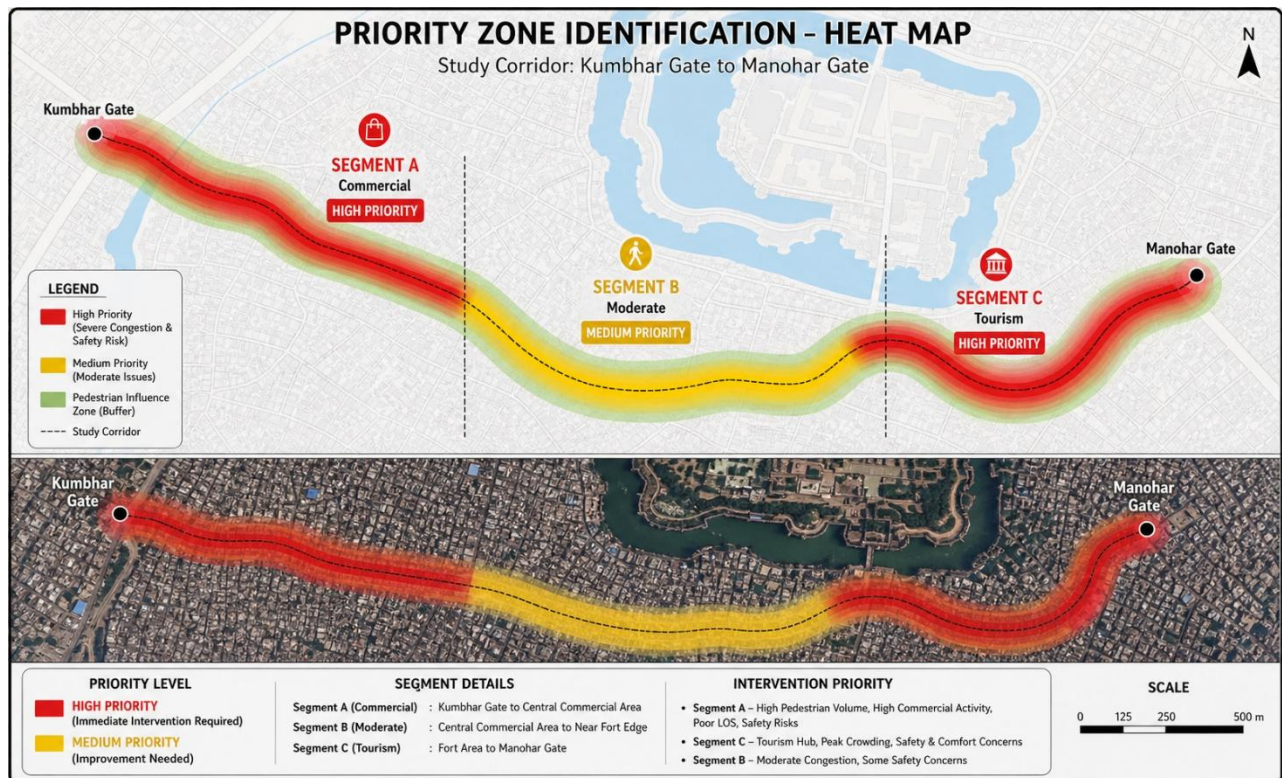
The prioritization framework ensures efficient allocation of resources by focusing on areas with the greatest need. This approach enables phased implementation of interventions for maximum impact.

5.10.7 Qualitative Insights and User Feedback

Qualitative feedback from pedestrians highlights real-world challenges that may not be fully captured through quantitative data. Common complaints include the absence of footpaths, unsafe crossing conditions, encroachment by vehicles, and poor lighting after evening hours.

Key Findings

- No footpaths in market areas
- Vehicles encroach pedestrian space
- Unsafe crossings near temples
- Poor lighting after evening hours
- Lack of facilities at bus stops



Bar Chart:- 5.13 Suggested Heat Map

5.11 Key Insights and Interpretation

The overall analysis reveals that pedestrian infrastructure is not aligned with user demand. The mismatch between supply and demand results in poor service levels.

Major Insights

- Infrastructure inadequate for volume
- Safety is compromised
- User dissatisfaction is high
- Tourism experience affected

5.12 Conclusion of Data Analysis

The data analysis clearly indicates that pedestrian infrastructure along Atal Path is insufficient and requires immediate intervention. The findings provide a strong foundation for developing proposals and strategies in the next chapter.

Conclusion Points

1. LOS E/F in critical segments	2. LOS E/F in critical segments
3. High infrastructure deficiency	4. High infrastructure deficiency

CHAPTER 6: PROPOSALS AND STRATEGIES

The proposals formulated for this study aim to address the critical deficiencies identified in the pedestrian infrastructure along Atal Path and to transform the corridor into a safe, inclusive, and efficient urban space. The existing conditions reveal a mismatch between pedestrian demand and infrastructure supply, resulting in poor Level of Service (LOS), safety risks, and reduced walkability. Therefore, a comprehensive set of design and planning interventions has been developed to improve pedestrian mobility.

These proposals are guided by the principles of Complete Streets and Safe Streets, ensuring equitable allocation of road space among all users. The strategies not only focus on physical improvements but also integrate management, policy, and implementation frameworks to ensure long-term sustainability and effectiveness.

Objectives of Proposals

- To enhance pedestrian safety by reducing conflicts between pedestrians and vehicular traffic through improved infrastructure design.
- To improve accessibility by ensuring continuous, barrier-free pedestrian pathways for all user groups including elderly and differently-abled individuals.
- To increase walking comfort by providing adequate space, shading, and well-maintained surfaces along the corridor.
- To support local economic activity by integrating street vendors within the pedestrian design framework instead of removing them.
- To improve the overall urban environment and tourism experience through better streetscape and wayfinding systems.

6.1 Proposal Framework and Planning Approach

The proposal framework is structured to address pedestrian issues through a multi-dimensional approach that combines physical design interventions, regulatory measures, and management strategies. This ensures that the solutions are not only technically sound but also practically implementable.

The planning approach follows a phased strategy, allowing for gradual implementation based on priority and available resources. This phased development helps in achieving quick improvements in critical areas while planning for long-term transformation.

Planning Approach

- The proposal adopts a design-led approach where physical infrastructure improvements form the foundation of pedestrian enhancement.
- The strategy integrates policy-level interventions to regulate encroachments and ensure proper enforcement of pedestrian rights.

- A phased implementation plan is proposed to prioritize high-impact areas and ensure efficient utilization of resources.
- The approach emphasizes community participation and stakeholder involvement to ensure acceptance and sustainability of interventions.

6.2 Proposal 1: Safe and Accessible Pedestrian Crossings

The absence of designated pedestrian crossing facilities along Atal Path has been identified as one of the most critical safety concerns. Pedestrians are currently forced to cross roads at random locations, leading to increased risk of accidents and conflicts with vehicles.

This proposal focuses on the provision of well-designed, safe, and accessible pedestrian crossings at key locations. The design follows IRC and MoHUA guidelines to ensure visibility, safety, and ease of use for all pedestrians.

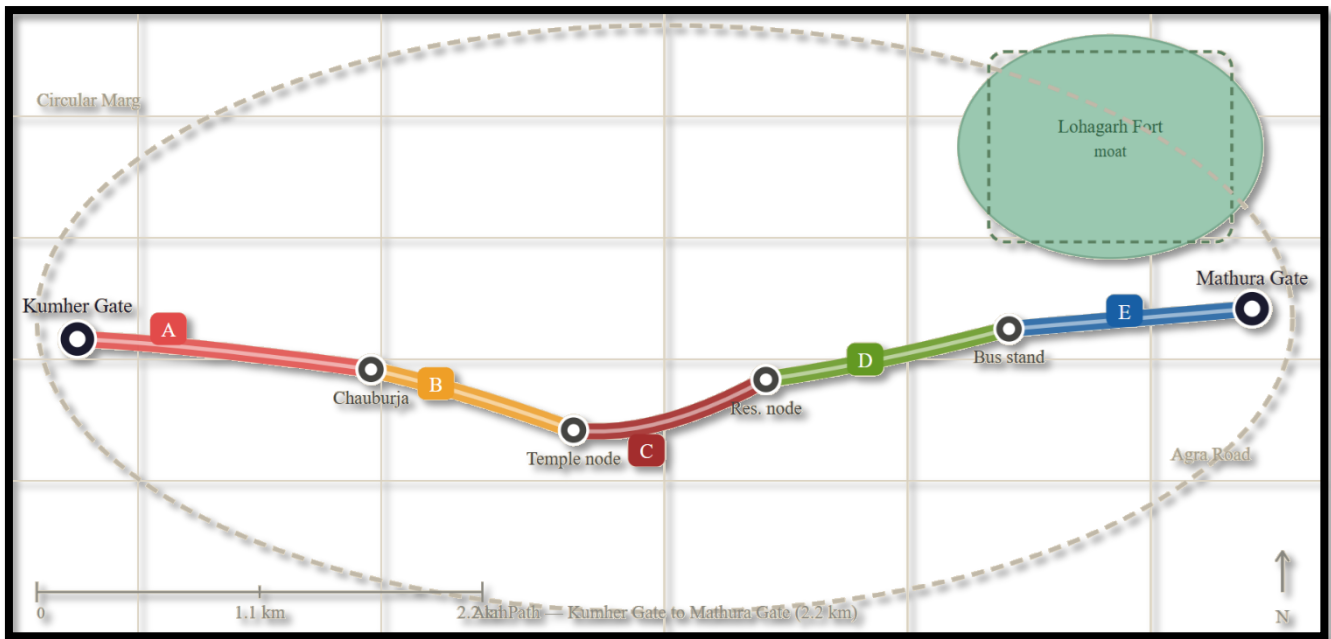
Design Features of Crossings

- Zebra crossings will be provided with high-visibility markings to ensure that they are easily noticeable by approaching drivers.
- Signalized pedestrian crossings will be installed at major intersections to regulate pedestrian movement and reduce conflict with vehicular traffic.
- Raised pedestrian crossings will be introduced to slow down vehicles and prioritize pedestrian movement at critical points.
- Refuge islands will be constructed in wider roads to allow pedestrians to cross safely in stages.

Strategic Locations

- Pedestrian crossings will be prioritized at high-activity nodes such as Mathura Gate where pedestrian movement is intense.
- Crossings will be introduced at major intersections within Main Bazar to manage heavy commercial footfall.
- Key nodes such as Chauburja will be equipped with signalized crossings to handle multi-directional pedestrian movement.

Kumher Gate area will be improved with safe crossings to facilitate both local and tourist movement.



Seg. A Kumher Gate → Chauburja ~400 m · Commercial Encroachment No FP LOS E/F	Seg. B Chauburja → Govt. Office ~350 m · Institutional Narrow FP Broken tiles LOS C/D	Seg. C Govt. Office → Temple ~300 m · Religious/Mixed No crossing High density LOS F	Seg. D Temple → Residential ~400 m · Residential Parked on FP Moderate LOS C	Seg. E Residential → Mathura Gate ~350 m · Transit No zebra @ bus Fair FP LOS D/E
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2. PEDESTRIAN CROSSING DESIGN (PROPOSED)



FEATURES

- High visibility zebra crossing for safety.
- Refuge island for two-stage crossing.
- Tactile paving and ramps for universal accessibility.
- Signalized crossing for better pedestrian priority.

6.3 Proposal 2: Continuous and Barrier-Free Footpaths

The lack of continuous footpaths has emerged as the most significant issue affecting pedestrian mobility along the corridor. In many stretches, pedestrians are forced to walk on the carriageway due to missing or obstructed footpaths, which increases safety risks.

This proposal aims to provide continuous, unobstructed, and universally accessible footpaths along the entire stretch of Atal Path. The design ensures that pedestrians have a dedicated and safe walking space separated from vehicular traffic.

4. 3D VIEWS – PROPOSED PEDESTRIAN INFRASTRUCTURE

4.2 3D VIEW – PROPOSED CROSSING



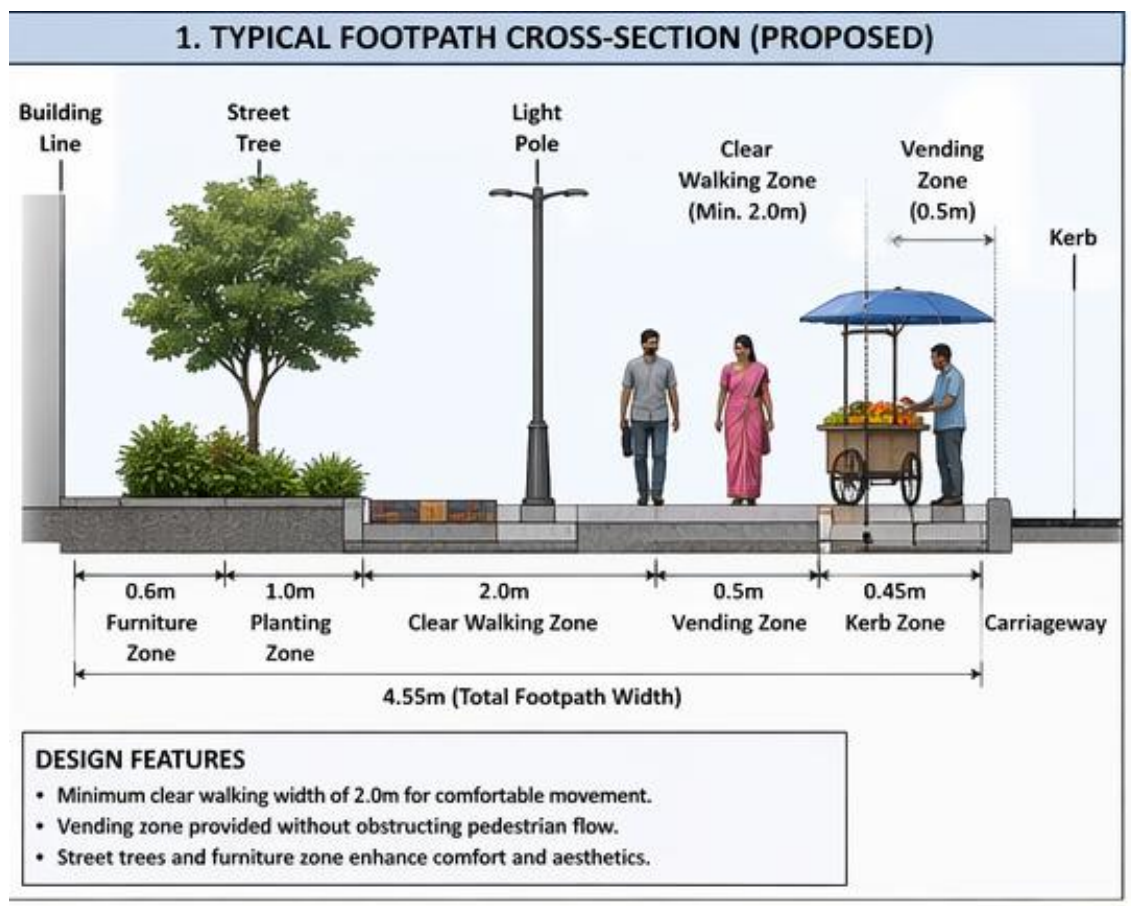
**Raised pedestrian crossing with refuge island and signal system
to ensure safe and convenient road crossing.**

Design Guidelines

- A minimum clear walking width of 2.0 meters will be maintained to accommodate pedestrian movement comfortably during peak hours.
- Raised kerbs of 150 mm height will be provided to physically separate pedestrian pathways from vehicular lanes.
- Non-slip and durable surface materials will be used to ensure safety and long-term maintenance of footpaths.
- Proper drainage systems will be integrated to prevent waterlogging and maintain usability during rainy seasons.
- Tactile paving and ramps will be incorporated to ensure accessibility for differently-abled individuals.

Benefits

- Continuous footpaths will significantly improve pedestrian safety by reducing interaction with vehicular traffic.
- Adequate walking space will enhance comfort and reduce congestion during peak hours.
- Barrier-free design will ensure inclusivity and accessibility for all user groups.



6.4 Proposal 3: Encroachment Management and Vendor Integration

Encroachments in the form of street vendors and parked vehicles are a major cause of reduced effective footpath width along the corridor. However, street vendors also contribute positively to the urban environment by enhancing economic activity and providing passive surveillance.

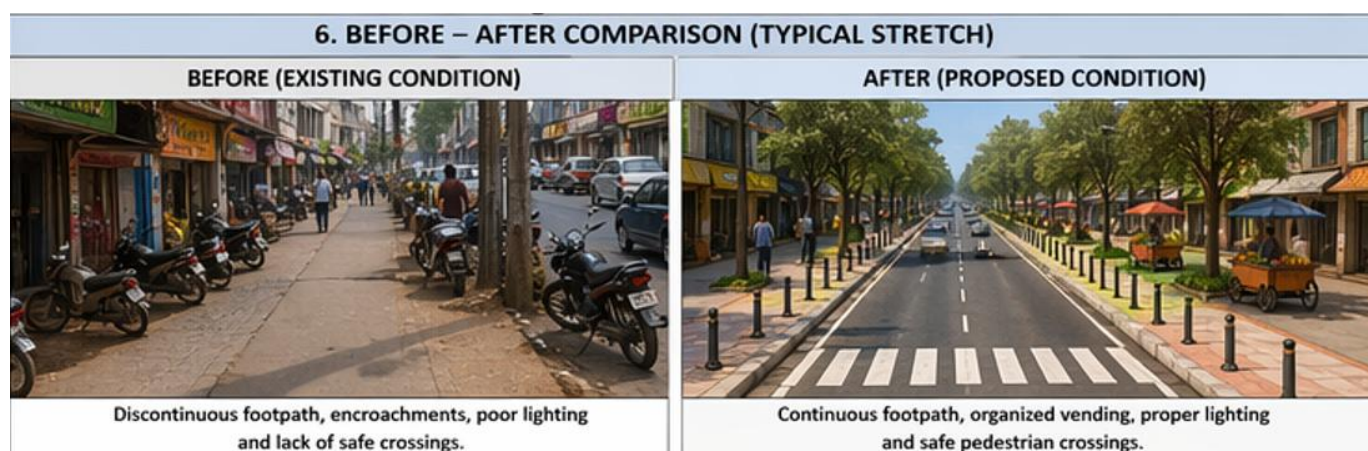
This proposal adopts a balanced approach by integrating vendors into the street design instead of removing them. The objective is to maintain economic activity while ensuring clear pedestrian movement.

Strategie

- Designated vending zones will be created by allocating space 0.5 meters behind the footpath edge to accommodate vendors without obstructing pedestrian flow.
- Bollards and guard rails will be installed along footpaths to prevent unauthorized vehicle parking.
- A clear pedestrian movement zone will be defined and maintained to ensure uninterrupted walking space.
- Basic infrastructure such as waste bins and lighting will be provided within vending zones to improve hygiene and usability.

Advantages

- The integration of vendors will support local livelihoods while maintaining organized street activity.
- Pedestrian movement will improve due to the reduction of random encroachments.
- The presence of vendors will enhance safety through increased street activity and surveillance.



6.5 Proposal 4: Street Lighting and Night-Time Safety

Inadequate street lighting has been identified as a major concern affecting pedestrian safety, particularly during night hours. Poor visibility not only increases the risk of accidents but also creates a sense of insecurity among users.

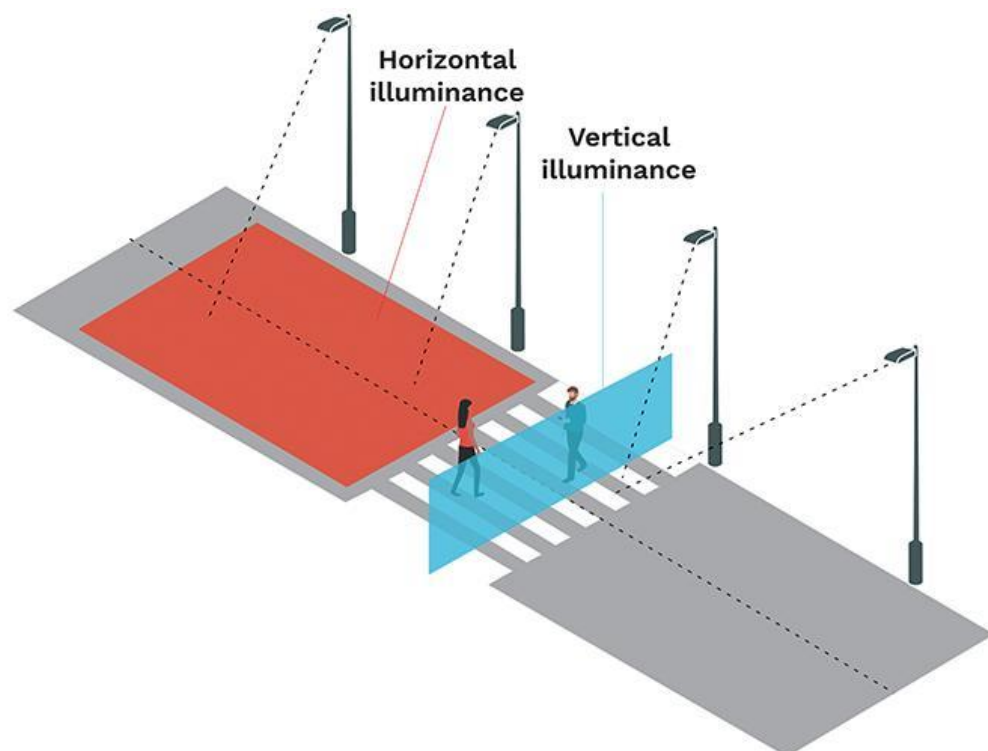
This proposal focuses on improving street lighting infrastructure to ensure safe and comfortable pedestrian movement during evening and night hours.

Lighting Improvements

- Energy-efficient LED street lights will be installed at regular intervals to provide uniform illumination along the corridor.
- Focus lighting will be provided at intersections, crossings, and high-activity zones to enhance visibility.
- Smart lighting systems can be introduced in the long term to optimize energy use and improve efficiency.

Impact

- Improved lighting will significantly enhance pedestrian safety and reduce accident risks during night hours.
- Better visibility will increase user confidence, especially among women and elderly pedestrians.
- Enhanced lighting will contribute to the overall aesthetic quality of the street environment.



6.6 Proposal 5: Pedestrian Wayfinding and Tourist Support System

Considering the importance of tourism in Bharatpur, the pedestrian infrastructure should facilitate easy navigation and enhance visitor experience. Currently, the lack of proper signage creates confusion for tourists.

This proposal introduces a comprehensive wayfinding system to guide pedestrians and improve accessibility.

Components

- Directional signage will be installed at key locations to guide pedestrians towards important destinations.
- Distance markers will help users estimate travel time and distance.
- Heritage information boards will provide cultural and historical context, enhancing the tourism experience.
- Digital QR-based systems can be introduced to provide interactive navigation and information.

Benefits

- Improved navigation will enhance the overall experience for tourists and first-time visitors.
- Clear signage will reduce confusion and improve movement efficiency.
- The system will contribute to the branding and identity of the city.

PROPOSAL 5

PEDESTRIAN WAYFINDING AND TOURIST SUPPORT SYSTEM

Easy Navigation. Rich Heritage. Better Experience.

THE NEED

Bharatpur is a major tourist destination with rich cultural heritage. However, lack of proper signage and information systems creates confusion for tourists and first-time visitors.

A comprehensive wayfinding system is essential to guide pedestrians, improve accessibility and enhance the overall visitor experience.

BENEFITS

IMPROVED NAVIGATION
Enhances the overall experience for tourists and first-time visitors.

CLEAR AND EFFICIENT MOVEMENT
Clear signage reduces confusion and improves movement efficiency.

CITY BRANDING AND IDENTITY
Creates a consistent visual identity and strengthens the image of Bharatpur as a tourist-friendly city.

COMPONENTS

1 DIRECTIONAL SIGNAGE
Directional signage will be installed at key locations to guide pedestrians towards important destinations.

2 DISTANCE MARKERS
Distance markers will help users estimate travel time and distance.

3 HERITAGE INFORMATION BOARDS
Heritage information boards will provide cultural and historical context, enhancing the tourism experience.

4 DIGITAL QR-BASED SYSTEMS
Digital QR-based systems can be introduced to provide interactive navigation and information.

SIGNAGE DESIGN APPROACH

CONSISTENT DESIGN
Uniform design language for easy recognition.

LOCAL IDENTITY
Incorporates local architecture, colors and motifs.

BILINGUAL INFORMATION
Information in Hindi and English for wider reach.

PEDESTRIAN FRIENDLY
Easy to read, visible and placed at appropriate height.

MATERIALS AND DESIGN GUIDELINES

Durable & Weather Resistant

Non-Reflective Finishes

Universal Symbols for Easy Understanding

Night Visibility with Proper Lighting

IMPACT

Better Visitor Experience

Increased Tourist Satisfaction

Promotes Walkability and Accessibility

Supports Local Economy

Sustainable & Smart City Step

GUIDE. INFORM. INSPIRE.

A smarter way to explore Bharatpur on foot.

PROPOSED WAYFINDING SYSTEM IN THE CORRIDOR

6.7 Proposal 6: Traffic Calming Measures

High vehicular speed is a major contributor to pedestrian accidents and safety concerns along the corridor. Traffic calming measures are essential to create a pedestrian-friendly environment.

Measures

- Speed breakers will be installed at strategic locations to reduce vehicle speed.
- Raised intersections will be introduced to prioritize pedestrian movement.
- Carriageway narrowing will be implemented to naturally slow down traffic.
- Road markings and signage will be used to alert drivers and improve safety.

Outcome

- Reduced vehicle speed will significantly improve pedestrian safety.
- Safer street conditions will encourage more people to walk.
- Improved interaction between pedestrians and vehicles will reduce conflicts.

PROPOSAL 6

TRAFFIC CALMING MEASURES
Creating a safe and pedestrian-friendly corridor

PROPOSED VIEW

MEASURES

- Speed Breakers**
Installed at strategic locations to reduce vehicle speed.
- Raised Intersections**
Introduced to prioritize pedestrian movement.
- Carriageway Narrowing**
Implemented to naturally slow down traffic.
- Road Markings & Signage**
Used to alert drivers and improve overall safety.

BEFORE

IMPLEMENTATION PLAN (KEY LOCATIONS)

OUTCOME

- Reduced Vehicle Speed**
- Improved Pedestrian Safety**
- Encourages More Walking**
- Reduced Conflicts**

CALM STREETS, SAFE PEOPLE, STRONGER COMMUNITIES

6.8 Proposal 7: Universal Accessibility Design

Ensuring accessibility for all users is a fundamental requirement of pedestrian infrastructure. This proposal focuses on making the corridor inclusive for differently-abled individuals.

Features

- Ramps will be provided at all intersections to ensure smooth movement for wheelchair users.
- Tactile paving will guide visually impaired individuals along the pathway.
- Audible signals will be installed at crossings to assist visually impaired users.
- Barrier-free pathways will be ensured throughout the corridor.

PROPOSAL 7

UNIVERSAL ACCESSIBILITY DESIGN

Creating an inclusive and barrier-free pedestrian corridor for all

PROPOSED VIEW

INCLUSIVE DESIGN FOR EQUAL ACCESS

Accessible for All

Safe & Dignified Movement

Independent Mobility

Barrier-Free Environment

Inclusive Society

KEY FEATURES

RAMPS AT INTERSECTIONS
Ramps will be provided at all intersections to ensure smooth movement for wheelchair users.

TACTILE PAVING
Tactile paving will guide visually impaired individuals along the pathway.

AUDIBLE SIGNALS
Audible signals will be installed at crossings to assist visually impaired users.

BARRIER-FREE PATHWAYS
Barrier-free pathways will be ensured throughout the corridor for seamless movement.

OUTCOME / BENEFITS

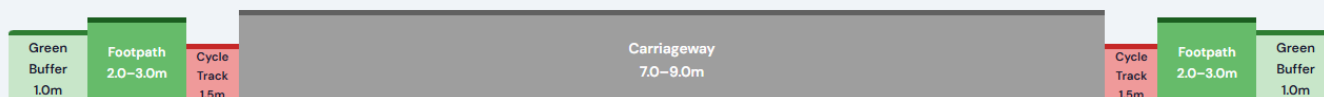
Safe and comfortable movement for all users

Promotes independence and dignity

Encourages inclusive and equitable mobility

Improves overall accessibility and user experience

ACCESS FOR ALL, OPPORTUNITIES FOR ALL



Total Right of Way: 14-18m | Reference: IRC:103-2012, Complete Streets India Guidelines

Proposed Street Cross-Section

6.9 Proposal 8: Green Infrastructure and Streetscape Enhancement

A well-designed streetscape enhances the overall walking experience and contributes to environmental sustainability.

Elements

- Street trees will be planted to provide shade and reduce heat.
- Seating areas will be created to provide resting spaces for pedestrians.
- Landscaping will improve visual quality and environmental conditions.
- Public art installations will enhance the cultural identity of the corridor.



6.10 Proposal 9: Priority Zone Development

Based on data analysis, certain zones require immediate intervention due to high pedestrian demand and poor infrastructure conditions.

Priority Zones

- Segment A will be prioritized due to high commercial activity and congestion.
- Segment C will be prioritized due to tourism and religious significance.

Strategy

- Initial implementation will focus on these high-priority zones to achieve maximum impact.
- Lessons learned from these zones will be applied to other segments in later phases.



6.11 Implementation Strategy

The successful implementation of these proposals requires coordinated efforts among various stakeholders, including municipal authorities, planners, and local communities.

Phasing

- Short-term interventions will include low-cost improvements such as markings and signage.
- Medium-term interventions will involve construction of footpaths and crossings.
- Long-term interventions will focus on smart systems and advanced infrastructure.

Conclusion Points

- The proposals aim to transform the corridor into a pedestrian-friendly urban space.
- A combination of design, policy, and management strategies ensures effective implementation.
- The interventions are aligned with national standards and urban planning principles.



6.12 Proposal: 4E Framework and Service Level Benchmarking (SLB) for Pedestrian Infrastructure

The improvement of pedestrian infrastructure along the study corridor requires a comprehensive and multi-dimensional approach that goes beyond physical design interventions. The 4E framework—Engineering, Evaluation, Education, and Emergency Response—combined with Service Level Benchmarking (SLB) standards provided by MoHUA, offers a structured methodology for assessing and enhancing pedestrian facilities.

This proposal aims to integrate national standards such as IRC:103-2012 and MoHUA SLB indicators into the planning and design process to ensure safe, accessible, and efficient pedestrian movement. By aligning infrastructure improvements with measurable benchmarks, the proposal ensures that interventions are both evidence-based and performance-oriented.



6.12.1 Proposed Strategy

◆ Engineering (Infrastructure Design Improvements)

- Implementation of IRC:103-2012 guidelines for pedestrian facilities
- Provision of continuous and barrier-free footpaths (minimum width 1.8 m)
- Installation of tactile paving for visually impaired users
- Development of safe and signalized pedestrian crossings

◆ **Evaluation (Performance Monitoring and Assessment)**

- Adoption of MoHUA Service Level Benchmark (SLB) framework
- Conducting periodic Pedestrian Level of Service (PLOS) audits
- Comparative gap analysis between existing conditions and national standards
- Use of data-driven indicators such as delay, lighting, and coverage

◆ **Education (Awareness and Behavioural Change)**

- Awareness campaigns on pedestrian rights and road safety
- Implementation of programs such as “Safe Routes to School”
- Community engagement workshops for promoting safe mobility practices

◆ **Emergency Response (Safety and Incident Management)**

- Improving accessibility to emergency medical services (EMS)
- Identification and GIS mapping of accident-prone “black spots”
- Integration of real-time incident response systems
- Strengthening post-crash care infrastructure

6.12.2 SLB Benchmark Indicators (MoHUA Standards)

The proposal incorporates key SLB indicators for evaluating pedestrian infrastructure performance:

- **Signalized Delay:**
 - LOS 1: < 25%
 - LOS 2: 25–50%
 - LOS 3: 50–75%
- **Street Lighting (Lux):**
 - LOS 1: ≥ 8 lux
 - LOS 2: 6–8 lux
 - LOS 3: 4–6 lux
- **City Coverage (%):**

- LOS 1: $\geq 75\%$
- LOS 2: 50–75%
- LOS 3: 25–50%

MoHUA SLB: Pedestrian Benchmarks			
Indicator	LOS 1	LOS 2	LOS 3
Signalized Delay (%)	< 25%	25-50%	50-75%
Street Lighting (Lux)	≥ 8	6 - 8	4 - 6
City Coverage (%)	$\geq 75\%$	50-75%	25-50%

6.12.3 Expected Outcomes

- Improved pedestrian safety and accessibility across the corridor
- Standardized evaluation of infrastructure using national benchmarks
- Reduction in pedestrian delays and accident risks
- Enhanced inclusivity for all user groups, including differently-abled individuals
- Data-driven decision-making for future urban planning interventions

The integration of the 4E framework with Service Level Benchmarking provides a holistic and structured approach to pedestrian infrastructure development. While engineering improvements address physical deficiencies, evaluation ensures continuous monitoring, education promotes behavioural change, and emergency response strengthens safety systems.

This proposal ensures that pedestrian planning is not only infrastructure-focused but also user-centric and performance-based, ultimately contributing to a safer, more efficient, and inclusive urban environment.

Engineering

Designing for Safety & Accessibility

- Implementation of IRC:103-2012 guidelines.
- Continuous, barrier-free footpaths (min 1.8m).
- Tactile paving & signalized crossings.

Evaluation

Benchmarking Performance

- Systematic MoHUA SLB data collection.
- Pedestrian Level of Service (PLOS) audits.
- Gap analysis vs. National Standards.

Education

Cultivating Safety Culture

- Awareness for pedestrian rights & laws.
- "Safe Routes to School" programs.
- Community workshops on urban mobility.

Emergency Response

Minimizing Post-Crash Severity

- Rapid EMS & trauma care accessibility.
- GIS tracking of accident "Black Spots".
- Integrated incident management systems.

CHAPTER 7: CONCLUSION AND RECOMMENDATIONS

The study conducted along Atal Path in Bharatpur provides a comprehensive understanding of the existing pedestrian infrastructure and its performance in relation to user demand and national standards. Through detailed analysis using Service Level Benchmarks (SLB), Level of Service (LOS), and user perception surveys, it has been clearly established that the current pedestrian environment is inadequate, fragmented, and unsafe in several segments.

The findings highlight a significant mismatch between infrastructure provision and pedestrian usage, particularly in high-density commercial and tourism areas. The absence of continuous footpaths, lack of safe crossings, and poor lighting conditions collectively contribute to reduced walkability and increased safety risks. The study emphasizes the urgent need for structured interventions to improve pedestrian conditions and align them with modern urban planning principles.

Key Conclusions of the Study

- The pedestrian infrastructure along Atal Path is highly inconsistent, with significant portions lacking continuous and usable footpaths.
- The Level of Service (LOS) in major segments falls under E/F category, indicating severe congestion and discomfort for pedestrians.
- Encroachments and on-street parking significantly reduce effective walking width, affecting pedestrian mobility.
- The absence of safe crossing facilities increases the risk of accidents and creates conflicts between pedestrians and vehicles.
- User perception surveys indicate high dissatisfaction levels, particularly among women and elderly users regarding safety and comfort.

7.1 Summary of Key Findings

The study reveals that pedestrian infrastructure is not only insufficient but also poorly maintained and inadequately designed to handle the high volume of users. The integration of quantitative and qualitative analysis provides a holistic understanding of the issues.

5. DETAILS OF ACCESSIBILITY ELEMENTS				
Tactile Paving (For Visually Impaired)  Tactile paving guides visually impaired pedestrians and alerts them about crossings and hazards.	Ramp Detail (At Intersection)  Ramps with 1:12 slope ensure smooth access for wheelchair users and elderly pedestrians.	Kerb Detail  Raised kerb of 150mm height separates footpath from carriageway and enhances safety.	Bollard Detail  Bollards of 900mm height prevent unauthorized vehicle entry on footpath.	Street Lighting Detail  LED street lights at regular intervals ensure good visibility and enhance night-time safety.

The results clearly indicate that improving pedestrian infrastructure is not just a mobility concern but also a critical factor influencing urban livability, safety, and economic activity.

Major Findings

- Nearly half of the corridor lacks proper footpaths, forcing pedestrians to walk on the carriageway under unsafe conditions.
- High pedestrian volumes in commercial and religious areas create congestion due to limited available walking space.
- Infrastructure deficiencies directly impact tourism experience, reducing the overall attractiveness of the city.
- Lack of proper lighting and signage affects usability during night hours and for first-time visitors.

7.2 Effectiveness of Methodology

The methodology adopted in this study has proven effective in capturing both physical and perceptual aspects of pedestrian infrastructure. The use of SLB and LOS frameworks ensures that the analysis is standardized and comparable with national benchmarks.

The integration of user perception surveys adds depth to the analysis by highlighting issues that are not visible through physical observation alone.

Evaluation of Methodology

- The mixed-method approach successfully combines objective measurements with subjective user experiences.
- SLB and LOS frameworks provide a reliable basis for evaluating infrastructure performance.
- Field surveys and observations ensure that the data reflects real-world conditions accurately.
- Statistical tools help in identifying patterns and deriving meaningful conclusions from survey data.

7.3 Achievement of Study Objectives

The study successfully achieves its objectives by assessing existing pedestrian infrastructure, evaluating service levels, identifying gaps, and proposing suitable interventions.

Each objective has been addressed through a systematic process of data collection, analysis, and interpretation, ensuring that the outcomes are well-supported by evidence.

Objective-wise Achievement

- The assessment of existing infrastructure highlights key deficiencies in accessibility, safety, and continuity of pedestrian facilities.
- The evaluation using SLB and LOS provides a clear understanding of performance levels across different segments.
- The identification of infrastructure gaps helps in prioritizing areas for intervention.
- The proposed strategies offer practical solutions aligned with national guidelines and planning principles.

7.4 Planning Implications

The findings of this study have important implications for urban planning and policy-making, particularly in the context of Tier-2 Indian cities. The issues identified along Atal Path are not unique but are representative of broader challenges faced by similar urban areas.

The study highlights the need for prioritizing pedestrian infrastructure in urban planning to create more livable and sustainable cities.

Implications for Urban Planning

- Pedestrian infrastructure should be treated as a fundamental component of urban mobility rather than a secondary consideration.
- Planning policies must ensure equitable allocation of road space for pedestrians and non-motorized users.
- Integration of Complete Street principles can significantly improve urban mobility and safety.
- Investment in pedestrian infrastructure can enhance economic activity and tourism potential.

7.5 Recommendations for Improvement

Based on the findings and analysis, several recommendations are proposed to improve pedestrian conditions along the study corridor. These recommendations focus on design, management, and policy interventions.

The recommendations aim to provide practical and implementable solutions that can be adopted by local authorities and planners.

Design Recommendations

- Continuous footpaths with adequate width should be constructed along the entire corridor to ensure safe and comfortable pedestrian movement.

- Safe and well-marked pedestrian crossings should be introduced at regular intervals, particularly at high-activity nodes.
- Street lighting should be improved to enhance visibility and safety during night hours.
- Streetscape elements such as trees, seating, and signage should be incorporated to improve the overall walking experience.

Management Recommendations

- Encroachments should be managed through designated vending zones instead of complete removal, ensuring both pedestrian flow and economic activity.
- Strict enforcement of parking regulations should be implemented to prevent vehicles from occupying pedestrian spaces.
- Traffic calming measures should be introduced to reduce vehicle speed and improve pedestrian safety.

Policy Recommendations

- Municipal authorities should adopt and implement SLB standards for pedestrian infrastructure in all urban projects.
- Dedicated funding should be allocated for pedestrian improvement projects.
- Regular monitoring and evaluation mechanisms should be established to ensure maintenance and performance of infrastructure.

7.6 Scope for Future Research

While the study provides valuable insights, there is scope for further research to expand the understanding of pedestrian infrastructure.

Future studies can explore additional aspects such as integration with public transport, smart mobility solutions, and long-term impact assessment.

Future Research Areas

- Detailed simulation of pedestrian flow using advanced modeling techniques can provide more accurate predictions of movement patterns.
- Comparative studies with other cities can help in identifying best practices and innovative solutions.
- Integration of smart technologies such as sensors and real-time monitoring can enhance pedestrian infrastructure management.
- Long-term studies can evaluate the impact of implemented proposals on safety, mobility, and user satisfaction.

7.7 Final Conclusion

The study concludes that pedestrian infrastructure along Atal Path requires immediate and comprehensive improvement to meet the needs of its users. The current conditions are inadequate and pose significant challenges to safety, accessibility, and comfort.

The proposed interventions, if implemented effectively, have the potential to transform the corridor into a model pedestrian-friendly street. The study reinforces the importance of prioritizing pedestrian infrastructure in urban planning to create inclusive and sustainable cities.

Final Key Points

- Pedestrian infrastructure is essential for urban mobility and must be prioritized in planning and design.
- The study demonstrates the effectiveness of using SLB and LOS frameworks for infrastructure evaluation.
- Proposed strategies provide a practical roadmap for improving pedestrian conditions.
- Implementation of these proposals can significantly enhance safety, comfort, and overall urban experience.

CHAPTER 8: IMPLEMENTATION FRAMEWORK AND COST ANALYSIS

The successful transformation of pedestrian infrastructure along Atal Path depends not only on well-designed proposals but also on a structured and realistic implementation framework. While the previous chapter outlined design interventions, this chapter focuses on how these proposals can be executed effectively through proper planning, financial allocation, stakeholder coordination, and phased development.

Implementation plays a crucial role in bridging the gap between theoretical proposals and on-ground reality. Without a clear execution strategy, even the most well-designed interventions may fail to achieve desired outcomes. Therefore, this chapter presents a systematic approach for implementing pedestrian improvements in a phased, cost-effective, and sustainable manner.

Key Aspects of Implementation

- The implementation framework ensures that proposals are translated into actionable steps with defined timelines and responsibilities.
- Financial planning and cost estimation help in understanding the feasibility and prioritization of interventions.
- Stakeholder involvement ensures smooth execution and reduces resistance from local communities.
- Phased development allows gradual improvement while managing financial and administrative constraints.

8.1 Implementation Strategy and Approach

The implementation strategy is designed to ensure that the proposed interventions are carried out in a logical and efficient manner. It focuses on prioritizing critical areas, optimizing resource utilization, and ensuring minimal disruption to existing activities.

The approach emphasizes flexibility, allowing modifications based on ground realities and stakeholder feedback. It also ensures that quick-impact solutions are implemented first to generate visible improvements.

Implementation Approach

- The strategy adopts a phased development model to ensure systematic execution of interventions based on priority levels.
- High-impact and low-cost interventions are prioritized in the initial phase to achieve quick improvements in pedestrian conditions.
- The approach integrates both short-term and long-term solutions to ensure immediate as well as sustained benefits.

8.2 Phasing of Development

The implementation of proposals is divided into three phases: short-term, medium-term, and long-term. This phased approach helps in managing resources effectively while ensuring gradual improvement.

Each phase focuses on specific types of interventions based on urgency, cost, and complexity.

Short-Term Interventions (0–1 Year)

- Low-cost measures such as road markings, zebra crossings, and signage can be implemented quickly to improve safety.
- Temporary traffic calming measures can be introduced to reduce vehicle speed in critical areas.
- Awareness campaigns can be conducted to educate the public about pedestrian rights and safety.

Medium-Term Interventions (1–3 Years)

- Construction of continuous footpaths and pedestrian crossings can be undertaken during this phase.
- Street lighting improvements can be implemented to enhance night-time safety.
- Encroachment management strategies can be enforced with proper planning and stakeholder coordination.

Long-Term Interventions (3–5 Years)

- Smart infrastructure systems such as intelligent lighting and monitoring systems can be introduced.
- Complete streetscape transformation including landscaping and public spaces can be developed.
- Integration with city-level mobility plans can be achieved for long-term sustainability.

8.3 Stakeholder Involvement and Institutional Framework

The successful implementation of pedestrian infrastructure requires coordination among multiple stakeholders, including government agencies, local authorities, and the community.

An effective institutional framework ensures clarity in roles and responsibilities, reducing delays and conflicts during implementation.

Key Stakeholders

- Municipal Corporation will be responsible for planning, execution, and maintenance of infrastructure.

- Traffic Police will play a crucial role in enforcing traffic regulations and ensuring pedestrian safety.
- Urban planners and designers will contribute to the design and monitoring of interventions.
- Local communities and vendors will be involved to ensure acceptance and cooperation.

Role of Stakeholders

- Government agencies will provide funding and policy support for implementation.
- Local authorities will oversee on-ground execution and maintenance activities.
- Community participation will help in identifying issues and ensuring long-term sustainability.

8.4 Cost Estimation of Proposed Interventions

Cost estimation is a critical component of the implementation framework, as it determines the feasibility and prioritization of interventions. The costs are estimated based on standard rates and typical urban infrastructure expenses.

The estimation includes costs for footpath construction, crossings, lighting, and streetscape improvements.

Major Cost Components

- Footpath construction costs include materials, labor, and finishing elements such as paving and kerbs.
- Pedestrian crossing costs include markings, signals, and refuge island construction.
- Street lighting costs include installation of poles, LED lights, and wiring systems.
- Streetscape enhancement costs include landscaping, seating, and urban design elements.

8.5 Cost-Benefit Analysis

The benefits of pedestrian infrastructure improvements extend beyond mobility and include economic, social, and environmental advantages.

Investing in pedestrian infrastructure leads to long-term gains that outweigh initial costs.

Benefits

- Improved safety reduces accident-related costs and enhances public health outcomes.
- Enhanced walkability increases commercial activity and boosts local economy.

- Better infrastructure attracts tourists and improves city image.
- Environmental benefits include reduced pollution and improved urban climate.

8.6 Funding Mechanisms

To implement the proposed interventions, multiple funding sources can be explored. Reliance on a single source may not be sufficient for large-scale improvements.

Funding Sources

- Government funding through urban development schemes can support major infrastructure projects.
- Public-private partnerships can be explored for streetscape and lighting improvements.
- Local revenue sources such as parking fees and property taxes can contribute to funding.
- Grants and international funding agencies can support sustainable urban mobility projects.

8.7 Monitoring and Evaluation Framework

Monitoring and evaluation are essential to ensure that the implemented interventions achieve their intended outcomes. Regular assessment helps in identifying issues and making necessary improvements.

Monitoring Mechanisms

- Periodic surveys can be conducted to assess pedestrian satisfaction and infrastructure performance.
- LOS and SLB evaluations can be repeated to measure improvement levels.
- Feedback from users can be collected to identify on-ground issues.
- Maintenance audits can ensure long-term sustainability of infrastructure.

8.8 Risk Assessment and Mitigation

Implementation of urban infrastructure projects often involves risks such as delays, cost overruns, and resistance from stakeholders.

Potential Risks

- Resistance from vendors due to relocation or regulation measures.
- Budget constraints affecting timely completion of projects.

- Lack of coordination among stakeholders leading to delays.

Mitigation Measures

- Stakeholder engagement and awareness programs can reduce resistance.
- Proper financial planning can prevent budget-related issues.
- Clear communication and coordination mechanisms can improve efficiency.

8.9 Conclusion of Implementation Framework

The implementation framework presented in this chapter provides a structured and practical approach for executing the proposed pedestrian improvements along Atal Path. By integrating planning, financial, and institutional aspects, the study ensures that the proposals are not only theoretically sound but also practically achievable.

Conclusion Points

- A phased implementation approach ensures efficient utilization of resources and timely execution of interventions.
- Stakeholder involvement plays a crucial role in ensuring successful implementation and long-term sustainability.
- Proper cost estimation and funding strategies are essential for feasibility and prioritization.
- Monitoring and evaluation mechanisms help in maintaining performance and achieving desired outcomes.

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