

**PLANNING AND DESIGN OF A PEDESTRIAN-FOCUSED NON-
MOTORIZED ZONE IN NAGWA-ASSI CORRIDOR VARANASI,
INDIA**

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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May 2026

DECLARATION

I **SHIVAM KUMAR BHARTY**, Scholar No **2211002111** hereby declare that the thesis titled **Planning And Design Of A Pedestrian-Focused Non-Motorized Zone In Nagwa-Assi Corridor Varanasi, India** 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.

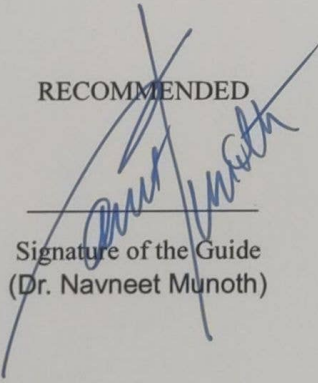

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CERTIFICATE

This is to certify that the declaration of **SHIVAM KUMAR BHARTY** 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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ACKNOWLEDGEMENT

The completion of this thesis was made possible through the support and guidance of many individuals.

I extend my deepest gratitude to my guide, Department of Architecture and Planning, MANIT Bhopal, for their scholarly insights, patience, and constructive feedback throughout this journey. I am also thankful to the **Head of the Department**, the **Thesis Coordinator**, and the **faculty at MANIT Bhopal** for providing the necessary academic environment and resources.

I acknowledge the invaluable cooperation of the **Varanasi Nagar Nigam**, **Varanasi Smart City Ltd.**, **VDA**, and the **local police of Bhadaini Ward** for facilitating access to critical data and maps.

Special thanks go to the **residents, vendors, and pilgrims of the Nagwa-Assi corridor** who participated in my surveys and interviews during February and March 2026. Their insights provided the empirical backbone of this research.

Finally, I am grateful to my **family, classmates, and seniors** for their unwavering encouragement and critical reviews, and to the scholars whose work formed the foundation of this study.

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ABSTRACT

Varanasi, one of the world's oldest living cities, faces growing conflict between its cultural heritage and increasing motorized traffic. The Nagwa-Assi corridor, a key access route to Assi Ghat, experiences severe congestion due to narrow road widths, illegal parking, informal vending, and mixed traffic conditions. Despite pedestrians and cyclists forming a major share of movement, walking spaces are highly inadequate during peak hours.

This thesis proposes a pedestrian-oriented and Non-Motorized Transport (NMT) framework for the corridor. The study is based on traffic volume surveys, pedestrian conflict mapping, activity mapping, geometric street analysis, and case studies of Chandni Chowk, Heritage Street Amritsar, and Slovenska Street Ljubljana. Findings reveal that traffic volume on Nagwa Road exceeds its design capacity during peak periods, resulting in Level of Service (LOS) F and high pedestrian-vehicle conflict zones near the BHU Gate junction and Assi Ghat entrance.

To address these issues, the study suggests three major interventions: street rationalization with wider footpaths and vending zones, development of off-street parking with last-mile NMT connectivity, and a time-restricted pedestrian-only zone near Assi Ghat. The proposals aim to improve walkability, reduce pollution, enhance public space quality, and preserve the cultural identity of the area while supporting local livelihoods.

The study concludes that pedestrianization of the Nagwa–Assi corridor is both feasible and necessary, and provides a replicable framework for heritage precincts in Indian cities.

Keywords: Pedestrianization, NMT, Heritage Urban Design, Traffic Calming, Varanasi, Assi Ghat.

सारांश

वाराणसी विश्व के सबसे प्राचीन जीवित शहरों में से एक है, जहाँ सांस्कृतिक विरासत और बढ़ते मोटर वाहनों के बीच लगातार संघर्ष देखा जा रहा है। नागवा-अस्सी कॉरिडोर, जो अस्सी घाट तक पहुँचने का प्रमुख मार्ग है, संकरी सड़कों, अवैध पार्किंग, अनौपचारिक दुकानों और मिश्रित यातायात के कारण अत्यधिक भीड़भाड़ का सामना कर रहा है। पैदल यात्री और साइकिल उपयोगकर्ता बड़ी संख्या में होने के बावजूद सुरक्षित एवं पर्याप्त पैदल मार्ग उपलब्ध नहीं हैं।

यह शोध नागवा-अस्सी कॉरिडोर के लिए पैदल यात्री एवं गैर-मोटर चालित परिवहन (NMT) आधारित योजना प्रस्तुत करता है। अध्ययन में ट्रैफिक सर्वे, पैदल यात्री संघर्ष मैपिंग, गतिविधि विश्लेषण, सड़क माप अध्ययन तथा चांदनी चौक, हेरिटेज स्ट्रीट अमृतसर और स्लोवेंस्का स्ट्रीट ल्युब्ल्याना जैसे उदाहरणों का विश्लेषण किया गया। परिणामों से पता चलता है कि पीक समय में यातायात क्षमता से अधिक हो जाता है, जिससे Level of Service (LOS) 'F' की स्थिति उत्पन्न होती है तथा BHU गेट और अस्सी घाट प्रवेश क्षेत्र सबसे अधिक संघर्ष वाले स्थान हैं।

समस्या के समाधान हेतु अध्ययन में तीन प्रमुख प्रस्ताव दिए गए हैं—फुटपाथों का विस्तार एवं सड़क पुनर्गठन, ऑफ-स्ट्रीट पार्किंग और NMT आधारित अंतिम-मील कनेक्टिविटी, तथा समय-सीमित पैदल यात्री क्षेत्र का निर्माण। इन प्रस्तावों का उद्देश्य पैदल आवागमन को सुरक्षित बनाना, प्रदूषण कम करना, सार्वजनिक स्थानों की गुणवत्ता बढ़ाना तथा क्षेत्र की सांस्कृतिक पहचान को सुरक्षित रखना है।

अध्ययन निष्कर्ष देता है कि नागवा-अस्सी कॉरिडोर का pedestrianization व्यवहारिक, आवश्यक और अन्य भारतीय ऐतिहासिक शहरों के लिए भी उपयोगी मॉडल सिद्ध हो सकता है।

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LIST OF ABBREVIATIONS

Abbreviation	Full Form
BHU	Banaras Hindu University
CMP	Comprehensive Mobility Plan
GIS	Geographic Information System
IRC	Indian Roads Congress
LOS	Level of Service
MLP	Multi-Level Parking
MoHUA	Ministry of Housing and Urban Affairs
NMT	Non-Motorized Transport
NUTP	National Urban Transport Policy
PCU	Passenger Car Unit
PHF	Peak Hour Factor
PM 2.5	Particulate Matter, 2.5 micrometres
ROW	Right of Way
TOD	Transit Oriented Development
TVC	Traffic Volume Count
UHI	Urban Heat Island
V/C	Volume to Capacity Ratio
VDA	Varanasi Development Authority
VSCL	Varanasi Smart City Limited

GLOSSARY OF TERMS

Term	Definition
Bottleneck	A localized constriction in the carriageway or footpath where width drops below the upstream and downstream condition, producing concentrated congestion and safety risk.
Carriageway	The portion of a road designated for vehicular movement, exclusive of footpaths, kerbs, and verges.
Conflict point	A location at which the trajectories of pedestrians and motorized vehicles intersect, generating risk of collision or near-miss interaction.
Effective walking width	The clear width of the footpath usable for pedestrian movement after deduction of permanent obstructions, parked vehicles, vending units, and shopfront encroachment.
Footfall	The total number of pedestrians passing a given point or visiting a given area in a defined period.
Galli	A narrow lane in the historic core of a North Indian city, typically bounded by tightly packed buildings on both sides, characterized by mixed residential, commercial, and religious use.
Ghat	A series of steps leading down to a riverbank, used in Varanasi for ritual bathing, cremation, and cultural assembly.
Heritage facade discipline	A coordinated approach to the visual treatment of building frontages along a designated heritage corridor, achieving uniformity in proportion, material, and detail without imposing strict architectural pastiche.
Level of Service (LOS)	A qualitative measure of traffic operational quality on a road segment, ranging from A (free flow) to F (forced flow), based on the Volume to Capacity ratio and other indicators.
NMT (Non-Motorized Transport)	All forms of human-powered movement, including walking, cycling, cycle-rickshaws, and animal-drawn carts.

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Term	Definition
Passenger Car Unit (PCU)	A standardized unit of traffic flow used to convert mixed traffic streams into a comparable basis, with one car equivalent to 1.0 PCU and other vehicles assigned conversion factors per IRC 106-1990.
Pedestrianization	The reorganization of a street, area, or precinct to give pedestrians priority over motorized traffic, ranging from full closure to time-restricted access.
Right of Way (ROW)	The total width of land available for road and footpath construction, between property boundaries on either side.
Streetscape	The visual character of a street as experienced by pedestrians, encompassing carriageway, footpath, frontage, signage, lighting, and street furniture.
Volume to Capacity ratio (V/C)	The ratio of observed traffic volume to the design service capacity of a road, used to compute Level of Service and identify congestion conditions.

CHAPTER 1

INTRODUCTION

1.0 Background of the Study

Varanasi, also known as Kashi or Banaras, is among the oldest continuously inhabited urban settlements in the world. Its identity is inseparable from the river Ganga and the chain of approximately eighty-four ghats that line the western riverbank. The historic core of the city, organized around the ghats and the temple precincts, is characterized by a compact urban form, narrow lanes locally referred to as galis, and a high degree of mixed land use in which residential, commercial, religious, and recreational functions overlap continuously through the day. This morphology, formed organically over centuries, predates modern motorized transport. Its lane geometry, surface treatment, and boundary conditions were calibrated for pedestrians, animal-drawn carts, and palanquins, not for the volume of two-wheelers, auto-rickshaws, and private cars that today contest its limited carriageway space.

The contemporary pressure on this fabric is the consequence of three converging trends. First, intra-city motorization has grown sharply over the last two decades, driven by rising household incomes and the relative affordability of two-wheelers. Second, religious tourism has intensified following the redevelopment of the Kashi Vishwanath Corridor in 2021 and the broader positioning of Varanasi as a flagship Smart City under the Government of India's Smart Cities Mission. Footfall at the principal ghats, particularly Dashashwamedh and Assi, has multiplied during festivals and weekends, exposing pedestrian infrastructure to volumes for which it was never designed. Third, the informal economy that supports both residents and visitors, ranging from flower sellers to tea stalls and souvenir vendors, occupies critical street edges in the absence of a formal vending policy implementation, further reducing effective pedestrian width.

Within this larger urban condition, the Nagwa-Assi corridor occupies a strategic position. It is the principal land approach to Assi Ghat from the south and from the BHU side, connecting the Assi Road and the area near the BHU Gate to the riverfront via Nagwa Road. The corridor falls within Ward 54 (Bhadaini) of Varanasi Municipal Corporation. Its location adjacent to BHU on one side and to Assi Ghat on the other

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generates sustained pedestrian movement throughout the day and a sharp evening peak coincident with the daily Subah-e-Banaras and Ganga Aarti rituals.

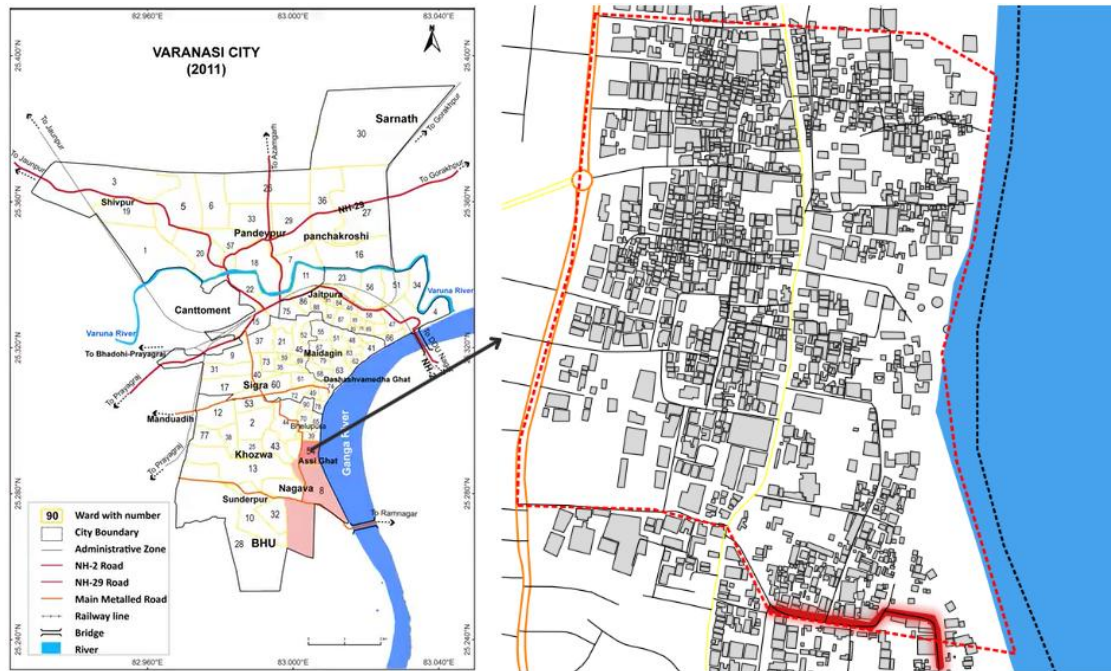


Figure 1.1: Contextual Site Plan for Proposed Non-Motorized Transport (NMT) Zone: Assi Ward and Surroundings.

Source : 'Map prepared using Toposheet No. 63 K/15 and 63 O/3 on ArcGIS 10 and based on data available from Varanasi city'.

Yet the same corridor exhibits the most acute symptoms of the city's broader transport-livability conflict. Carriageway widths fluctuate from 8 m at the entry to a 5 m bottleneck mid-block. Effective walking width drops below 1 m at multiple pinch points due to a combination of unauthorized two-wheeler parking, stationary vending carts, and encroachment by adjoining shopfronts. Pedestrian-vehicle conflict is acute, with internal records suggesting that approximately 70 percent of road incidents in the corridor involve pedestrians. The deterioration of walking quality, in turn, undermines the very experience of place that draws pilgrims and tourists to Assi in the first place.

1.1 Need for Pedestrianization in Indian Historic Cities

The case for pedestrianization in Indian historic cities rests on four converging arguments: heritage protection, public health, road safety, and economic vitality.

1.1.1 Heritage Protection

Heritage value in cities like Varanasi, Amritsar, Pushkar, Madurai, and Ujjain resides not only in monumental structures but also in the lived street experience of the historic core. Continuous mixed motorized traffic produces vibration damage to old masonry, accelerates surface soiling from particulate deposition, and visually fragments the streetscape with parked vehicles and signage. Restricting motorized access in the immediate precincts of religious and heritage assets restores the perceptual and physical conditions under which the heritage was originally meant to be experienced (Tiwari, 2014).

1.1.2 Public Health

Indian urban centres consistently report ambient PM 2.5 concentrations in excess of the National Ambient Air Quality Standard of 60 micrograms per cubic metre on a 24-hour mean basis. In dense historic cores with narrow streets and low wind ventilation, localized concentrations can exceed this threshold by a factor of two or more during peak traffic windows. Pedestrianization, supplemented by green infrastructure, has been demonstrated in international literature to deliver measurable reductions in localized particulate and black carbon levels (Brand et al., 2021).

1.1.3 Road Safety

The Ministry of Road Transport and Highways' Road Accidents in India report consistently identifies pedestrians as one of the most vulnerable road user categories, accounting for a rising share of total road fatalities since 2018. In dense urban precincts where pedestrians are forced to share the carriageway with motorized traffic due to encroached or absent footpaths, the conflict translates directly into injury and fatality risk. Physical separation of pedestrian and motorized flows, supplemented by traffic calming, is the single most effective infrastructural intervention for reducing pedestrian fatality risk (WHO, 2018).

1.1.4 Economic Vitality

Empirical studies from Chandni Chowk, Amritsar Heritage Street, and the New Road precinct in Kathmandu indicate that well-executed pedestrianization is associated with measurable increases in retail footfall, dwell time, commercial property values, and small-business turnover. The Amritsar case documented an 18 to 22 percent increase in prime property prices and a 30 percent increase in commercial spaces around the Golden Temple following the Heritage Street redevelopment. The relationship between walkable streets and economic value is now sufficiently well-established to justify pedestrianization on commercial grounds alone.

1.2 Statement of the Problem

The Nagwa-Assi corridor today functions neither as an efficient motorized link nor as a humane pedestrian environment. The empirical condition can be summarized along five dimensions:

- Geometric inadequacy: Carriageway widths fluctuate between 3.5 m and 8 m, with a critical 5 m bottleneck mid-block, and footpath provision is fragmented or absent, with effective functional width averaging only 1 m.
- Capacity exceedance: Sunday peak-hour traffic on Nagwa Road records 1,532.6 PCU per hour against a design capacity of approximately 1,500 PCU per hour, yielding a V/C ratio of 1.02 and a Level of Service of F.
- Modal mismatch: Pedestrians and bicycles together account for 47.1 percent of total raw movement on the corridor, yet receive less than 25 percent of the right-of-way as exclusive infrastructure.
- Pedestrian-vehicle conflict: Approximately 70 percent of recorded road incidents on the corridor involve pedestrians, with conflict points clustered at the geometric bottleneck and the Assi Ghat entrance plaza.
- Informality without management: Approximately 35 to 45 vending units operate without designated locations, occupying critical walking edges and creating pinch points that halt both pedestrian and NMT flow.

The problem is not the presence of pedestrians, vehicles, or vendors in isolation. It is the absence of a planned spatial reconciliation between the three. The thesis addresses this gap.

1.3 Aim

To develop a comprehensive planning and design framework for a pedestrian-centric, non-motorized transport (NMT) zone in the Nagwa-Assi corridor that enhances urban livability and cultural preservation while achieving a low-carbon footprint and universal accessibility.

1.4 Objectives

The aim is operationalized through four specific objectives:

- **Pedestrian Mobility and Traffic Calming:** To restructure the existing street hierarchy by prioritizing non-motorized transport and designing collision-free walking environments through strategic vehicular restrictions and physical traffic-calming measures.
- **Cultural Preservation and Streetscape Design:** To integrate the architectural heritage of the site with modern streetscape elements, ensuring that pedestrianization enhances the traditional market character and protects the unique socio-cultural identity of the historic core.
- **Environmental Sustainability and Micro-climate:** To improve local environmental quality by proposing green infrastructure, permeable paving surfaces, and high-albedo materials to reduce the urban heat island effect and lower localized CO₂ and PM 2.5 emissions.
- **Economic Integration and Vending Management:** To balance the requirements of local commerce and informal trade by designing dedicated vending zones and establishing timed logistics management to ensure that pedestrianization supports rather than displaces local livelihoods.

1.5 Scope of the Study

The geographic scope of the study is Ward 54 (Bhadaini) of the Varanasi Municipal Corporation, with the detailed design intervention focused on a 300 m segment of Nagwa Road extending from the BHU Gate junction to the Assi Ghat entrance. The thematic scope covers physical, social, and technical dimensions as summarized below:

Category	Focus Area	Expected Output
Physical	Street geometry and encroachment	Detailed layout plans (1:500)
Social	Pedestrian activity and informal vending	Social mapping and user profiles
Technical	NMT connectivity and signage	Network flow and signage design

Table 1.1: Scope of the Study

Source: Author

1.6 Limitations

- **Lack of detailed data:** The study relies on government and municipal datasets that may not be fully current, particularly with respect to micro-level land use, building footprints, and ownership.
- **Technical depth:** The research focuses on urban design and planning interventions. It does not include detailed structural engineering for underground utilities, the conservation engineering of private heritage buildings, or hydrological modelling of riverfront drainage.
- **Data constraints:** Primary surveys were conducted during a single season (late winter, February to March 2026) and may not fully capture peak pedestrian fluctuations during major festivals such as Dev Deepawali, Holi, and Mahashivaratri, or during extreme weather events such as monsoon flooding.
- **Behavioural variables:** Compliance with proposed time-based access restrictions cannot be predicted with certainty in the absence of pilot implementation data.

1.7 Methodology

The methodology is structured in five sequential stages. Stage 1 (Inception) involved literature review, policy framework analysis, and case study selection. Stage 2 (Reconnaissance) comprised secondary data collection from the Varanasi Master Plan 2031, ward-level census data, and Varanasi Smart City Limited reports. Stage 3 (Primary Survey) was conducted on-site between 27 February and 1 March 2026 and

included a Traffic Volume Count, pedestrian intercept survey, vendor inventory, geometric audit, and evening activity mapping. Stage 4 (Analysis) involved PCU conversion using IRC 106-1990 standards, V/C and LOS computation, and conflict point synthesis. Stage 5 (Proposal) developed three integrated design proposals operating at short, medium, and long horizons.

The methodology adheres to the principles set out in the Indian Roads Congress IRC 70-2017 (Guidelines on Regulation and Control of Mixed Traffic in Urban Areas), IRC 103-2012 (Guidelines for Pedestrian Facilities), and the Ministry of Housing and Urban Affairs (MoHUA) Street Design Guidelines, 2016.

1.8 Structure of the Report

The report is organized into seven chapters. Chapter 2 reviews the conceptual and theoretical literature on pedestrianization, NMT, and heritage urban design. Chapter 3 analyzes three benchmark case studies: Chandni Chowk Delhi, Heritage Street Amritsar, and Slovenska Street Ljubljana. Chapter 4 profiles the study area at city, ward, and corridor scales. Chapter 5 presents primary survey data and the analytical findings on capacity, modal split, conflict points, and activity patterns. Chapter 6 advances three integrated design proposals. Chapter 7 concludes with summary findings, recommendations, and the scope for further research.

Source: Author, Thesis Sheets, March 2026

1.9 Conceptual Framework

The conceptual framework underlying this thesis treats the urban street not as a mere conduit for movement but as a multi-functional public realm in which mobility, social interaction, commerce, and cultural expression are co-produced. This view, articulated most influentially by Jane Jacobs (1961), Donald Appleyard (1981), and Jan Gehl (2010), treats the carriageway, footpath, frontage, and adjoining built form as elements of a single urban system whose performance is judged by the quality of life it sustains, not by the volume of vehicles it transmits.

Within this view, pedestrianization is not the removal of one mode but the rebalancing of the system in favour of users who deliver more public value per square metre of urban land. The Nagwa-Assi corridor, with its sacred destination, its mixed-use

frontage, its high pedestrian share, and its constrained right-of-way, is precisely the type of street for which this rebalancing is most needed and most likely to succeed.

The thesis applies this framework through a four-step diagnostic-prescriptive sequence: (i) characterize the existing condition through primary survey and secondary data; (ii) evaluate the condition against an explicit set of performance criteria drawn from the literature and the policy framework; (iii) draw lessons from comparable interventions in domestic and international precedents; and (iv) advance design proposals that operationalize the rebalancing across short, medium, and long horizons.

1.10 Significance of the Study

The study contributes to three audiences. For the immediate civic audience comprising the Varanasi Nagar Nigam, VSCL, VDA, the police, and the political leadership of Bhadaini ward, the thesis offers an implementation-ready intervention plan with phased horizons, indicative costs, funding sources, and operational protocols. For the broader academic and professional audience working on heritage urbanism in India, the thesis offers a transferable methodology for retrofit pedestrianization of dense, mixed-use historic precincts and a quantified before-condition baseline against which post-implementation outcomes can be measured. For the policy audience, the thesis contributes empirical evidence on the operational feasibility of time-restricted access regimes in Indian sacred precincts, an area in which existing literature is sparse.

1.11 Detailed Methodology Workflow

The methodology adopted in this thesis can be unpacked into a 12-step sequence that links data inputs to analytical outputs and design decisions.

- Step 1 (Inception): Definition of research question, framing of aim and objectives, identification of study area, preliminary site reconnaissance.
- Step 2 (Literature review): Review of conceptual literature on pedestrianization, NMT, heritage urbanism, traffic calming, vending, environmental quality, and Indian policy framework.
- Step 3 (Case study selection and review): Selection of three case studies on heritage-commercial, sacred-precinct, and arterial-conversion typologies.

- Step 4 (Secondary data collection): Acquisition of base maps, ward boundary data, land use information from Varanasi Master Plan 2031, demographic data from Census 2011, transport data from Comprehensive Mobility Plan.
- Step 5 (Survey instrument design): Preparation of TVC tally sheet, pedestrian intercept questionnaire, vendor profile questionnaire, geometric audit checklist, photographic documentation protocol.
- Step 6 (Pilot test and refinement): Pilot testing of all instruments on 25 February 2026, refinement and finalization.
- Step 7 (Primary survey execution): Three-day primary survey from 27 February to 1 March 2026 covering TVC, intercept survey, vendor inventory, geometric audit, conflict mapping, and activity mapping.
- Step 8 (Data entry and quality assurance): Digitization of survey records, inter-observer reliability checks, outlier review, and database compilation.
- Step 9 (Quantitative analysis): PCU conversion, V/C and LOS computation, modal composition, peak hour factor, conflict frequency analysis, and air quality reconnaissance synthesis.
- Step 10 (Qualitative synthesis): Issue tree construction, stakeholder mapping, sub-area characterization.
- Step 11 (Proposal development): Iterative design of three proposals operating at short, medium, and long horizons with cross-section logic, cost estimation, and risk register.
- Step 12 (Recommendations and reporting): Formulation of phased implementation strategy, monitoring framework, and final reporting in this document.

The 12-step workflow ensures that each design decision is traceable to a specific data input or literature reference, and that the proposals are not assertions but conclusions of a transparent analytical process.

1.12 Research Ethics and Data Stewardship

The primary surveys conducted in this study followed standard research ethics protocols. Informed verbal consent was obtained from all intercept survey respondents, who were informed of the purpose of the study, the voluntary nature of participation, the confidentiality of their responses, and their right to discontinue at any point. Vendor profile interviews were conducted with the explicit assurance that responses would not be shared with municipal authorities in identifiable form. Photographic documentation followed standard guidelines, with no identifiable images of individuals reproduced in this document without consent.

Data stewardship arrangements include the retention of primary survey records (TVC tally sheets, intercept questionnaires, vendor profile sheets, photographic documentation, geometric audit notes) by the author for a period of three years from the date of submission. Anonymized digital copies of the survey database have been deposited with the thesis guide and the Department of Architecture and Planning. The data may be made available for further academic research on request, subject to ethics clearance.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter reviews the conceptual, technical, and policy literature that frames the thesis. The review is organized around eight themes: the concept of pedestrianization, the theoretical foundations of non-motorized transport, heritage and streetscape design, traffic calming standards, the informal vending economy, environmental considerations, the Indian policy framework, and the identification of the research gap that this thesis addresses.

2.1 Concept of Pedestrianization

Pedestrianization, in its modern sense, originated in post-war European city centres as a response to the spatial and environmental costs of mass motorization. The earliest fully pedestrianized commercial street is generally considered to be Lijnbaan in Rotterdam, opened in 1953 (Hass-Klau, 1990). The subsequent diffusion of the concept across European cities, including Copenhagen's Stroget (1962), Munich's Kaufingerstrasse (1972), and Vienna's Karntner Strasse (1974), established a body of practice and evidence on the urban effects of removing private motorized traffic from selected streets.

Hass-Klau (1990) classifies pedestrianization schemes along three dimensions: extent (single street, network, or precinct), temporality (permanent, daytime, peak-hour, or seasonal), and access regime (full closure, transit-permitted, or service-permitted). Most contemporary Indian schemes, including the proposals advanced in this thesis, fall in the category of timed precinct closure with NMT and emergency vehicle permission, which the literature recognizes as the most context-appropriate model for dense mixed-use historic cores.

Gehl (2010) argues that pedestrianization is not merely the absence of vehicles but the active design of streets for human-scale activity. The five qualities of a successful pedestrian street, according to Gehl, are protection (from traffic, weather, and crime),

comfort (for walking, standing, sitting, seeing, hearing, and play), and delight (scale, climate, sensory experience). The proposals in this thesis are evaluated against these qualities in Chapter 6.

2.2 Non-Motorized Transport: Theoretical Foundations

Non-motorized transport (NMT) refers to all forms of human-powered movement, principally walking and cycling, supplemented in the Indian context by cycle-rickshaws and animal-drawn carts. The theoretical case for prioritizing NMT in urban transport planning rests on three foundations:

2.2.1 Equity

In Indian cities, NMT serves the poorest income deciles disproportionately. National Sample Survey data consistently shows that walking and cycling account for the dominant mode share of work trips for households below the median income line. Designing exclusively for motorized transport in a mixed-income urban core systematically disadvantages low-income users (Tiwari and Jain, 2012).

2.2.2 Capacity

On a per-square-metre basis, walking and cycling deliver substantially higher passenger throughput than private motorized transport. A 3.5 m wide footpath at moderate density carries approximately 4,500 pedestrians per hour, while a 3.5 m carriageway lane in mixed traffic carries approximately 1,800 PCU per hour, equivalent to roughly 2,400 persons per hour at average occupancy (Litman, 2017). The case for spatial reallocation in favour of pedestrians is therefore a capacity argument before it is an equity or environmental argument.

2.2.3 Externalities

NMT generates near-zero direct emissions, near-zero noise, and minimal road wear. Its public health externalities are positive in the form of physical activity. The internalization of motorized transport externalities through pricing remains politically difficult, but spatial reallocation in favour of NMT achieves a similar effect through design rather than taxation.

2.3 Heritage and Streetscape Design

Heritage streetscape design occupies the intersection of urban conservation, urban design, and transport planning. In the Indian context, the Heritage Bye-Laws notified by the Ministry of Culture for individual ASI-protected areas govern building-level interventions but do not extend to the design of public space between buildings. The principles applicable to streetscape design in heritage precincts therefore have to be assembled from international charters, including the Burra Charter (1979, revised 2013), the Washington Charter (1987) on Historic Towns and Urban Areas, and the Valletta Principles (2011).

Three streetscape design principles emerge consistently from this literature:

- Visual continuity: Coherent facade treatment, signage discipline, and removal of overhead utilities. The Amritsar Heritage Street demonstrated this principle through the renovation of approximately 170 buildings with uniform heritage-inspired facades drawing on local jharokha proportions.
- Material authenticity: Use of traditional materials such as Chunar sandstone, dholpur stone, terracotta, or contextually appropriate substitutes. The Chandni Chowk redevelopment used red sandstone benches and bollards consistent with the Mughal-era material palette of the precinct.
- Subordination of new infrastructure: Underground placement of utilities (drainage, power, ICT, CCTV), recessed lighting, and unobtrusive street furniture so that infrastructure does not visually compete with heritage assets.

2.4 Traffic Calming Measures and Standards

Traffic calming refers to physical and operational measures that reduce vehicle speeds and volumes in order to improve safety and amenity for non-motorized users. The Indian Roads Congress IRC 99-2018 (Guidelines for Traffic Calming Measures in Urban and Rural Areas) provides the principal national standard. Internationally, the most influential reference is the Manual for Streets (UK Department for Transport, 2007, revised 2010).

Traffic calming measures relevant to the Nagwa-Assi corridor include:

- Vertical deflection: Speed humps, speed tables, and raised intersections, which reduce 85th percentile speeds to 20 to 30 kmph at the design vehicle level.
- Horizontal deflection: Chicanes and lateral shifts, which break the visual line of the carriageway and force speed reduction without complete physical closure.
- Width restriction: Narrowing through bollards, planters, or kerb extensions, particularly at intersection approaches.
- Surface differentiation: Change in paving material, colour, or texture at pedestrian priority points, which signals the change of regime to drivers.
- Access management: Restriction by time of day, vehicle type, or access purpose, enforced through retractable bollards, signage, and police presence.

2.5 Vending and Informal Economy in Public Space

The Street Vendors (Protection of Livelihood and Regulation of Street Vending) Act, 2014, is the principal national legal instrument governing informal trade in Indian public space. The Act mandates the constitution of Town Vending Committees, the preparation of street vending plans, and the issuance of vending certificates. As of 2024, implementation across Indian cities has been uneven, with most cities including Varanasi yet to fully operationalize a survey-based vending plan.

The international literature on informal vending in heritage and tourist precincts consistently arrives at three conclusions. First, displacement without relocation generates social conflict and depresses precinct vitality. Second, formalization in designated bays adjacent to but not on the principal pedestrian flow line preserves both walking quality and vendor livelihoods. Third, time-management of logistics (loading, unloading, replenishment, waste collection) is at least as important as spatial management of vending bays. The proposals in Chapter 6 reflect all three principles.

2.6 Environmental and Micro-climate Considerations

Pedestrianization, by reducing motorized traffic, generates direct air quality and noise benefits. The Slovenska Street transformation in Ljubljana documented a 70 percent reduction in black carbon levels and a 58 percent reduction in PM 2.5 along the redesigned corridor following the conversion from arterial road to pedestrian-priority

thoroughfare. The Indian context, with higher baseline pollution and warmer climate, presents both a stronger motivation and a more demanding design brief.

Three micro-climate interventions are particularly relevant to Varanasi:

- Tree canopy: Continuous street tree planting at 8 to 12 m intervals, using species suited to the Indo-Gangetic climate such as Neem, Pilkhan, Pipal, and Jamun, which provide shade and modest particulate filtration.
- Permeable surfaces: Gravel beds, permeable pavers, and bioswales that reduce surface run-off and contribute to micro-climate cooling through evaporative effects.
- High-albedo materials: Light-coloured paving in non-heritage zones to reduce surface temperatures by 3 to 8 degrees Celsius compared to asphalt during summer afternoons.

2.7 Indian Policy Framework

The Indian policy framework for pedestrianization and NMT is set principally by four instruments. The National Urban Transport Policy 2006 (revised 2014) establishes the principle of moving people, not vehicles, and prioritizes public transport and NMT. The MoHUA Street Design Guidelines 2016 provide cross-section templates and design parameters. The Smart Cities Mission, launched in 2015, has funded pedestrianization pilots in approximately 70 of the 100 Smart Cities, including Varanasi. The Atal Mission for Rejuvenation and Urban Transformation (AMRUT) supports complementary infrastructure including footpaths, cycle tracks, and street lighting.

The Varanasi Master Plan 2031, prepared by the Varanasi Development Authority, identifies the historic core including the Assi area as a Special Heritage Zone with mandate for pedestrianization, vehicular restriction, and conservation-led streetscape design. The Varanasi Smart City Limited has identified the Assi Ghat precinct as one of the priority intervention zones in its Area-Based Development plan.

2.8 Research Gap

While the literature on pedestrianization is rich at the conceptual and case-study level, four gaps remain particularly visible in the Indian context. First, most documented pedestrianization projects in India have been in either pilgrimage cores (Amritsar, Pushkar) or commercial cores (Chandni Chowk), with relatively few examples integrating both conditions. Second, primary survey data and quantified before-after comparisons are sparse in the Indian literature, with most studies relying on qualitative description. Third, the integration of vending management with pedestrianization remains under-theorized despite its empirical importance. Fourth, time-based access regimes, while widely advocated, lack systematic evaluation in the Indian climatic and behavioural context.

This thesis addresses the third and fourth gaps directly through Proposals 2 and 3, and contributes new primary data to address the second.

2.1.1 Historical Origins and European Diffusion

The conceptual lineage of pedestrianization extends beyond the post-war European experience. Historical urban form across most pre-industrial civilizations was inherently pedestrian-scaled. The medieval European town, the bazaar street of the Islamic city, the Indian *galli* and *chowk*, the Chinese *hutong*, and the Japanese *machi* all developed within walking distance constraints that produced compact, mixed-use, low-speed environments. Modern pedestrianization can be read as a deliberate restoration of this anthropometric scale within urban tissue that has subsequently been overlaid with motorized infrastructure.

The first generation of modern pedestrianization, exemplified by Lijnbaan in Rotterdam (1953) and Stroget in Copenhagen (1962), was driven principally by post-war reconstruction logic and the desire to differentiate retail high streets from peripheral car-oriented shopping. The second generation, from approximately 1970 to 1990, was shaped by the environmental movement and concerns about air quality, exemplified by Munich (1972), Vienna (1974), and Bologna (1972). The third generation, from approximately 1990 onwards, integrated pedestrianization within comprehensive sustainable transport strategies that include cycling infrastructure, public transport priority, and parking management. The Ljubljana case discussed in Chapter 3 represents the maturity of this third generation.

2.1.2 Indian Antecedents

Indian urban planning has engaged with pedestrianization in fragmented form since the 1980s. The Janpath area of New Delhi, the M.G. Road area of Bangalore, and the Linking Road area of Mumbai have all been subject to partial or experimental pedestrian schemes at various points. The first comprehensive pedestrianization scheme in a heritage Indian city is generally considered to be the Hampi area redevelopment, undertaken in fragments between 2003 and 2015 under the World Heritage management framework. The Pondicherry French Quarter pedestrianization, conducted in 2017-2018 under the Smart City Mission, is one of the few full-precinct schemes in a colonial heritage context. The Amritsar Heritage Street and Chandni Chowk projects discussed in Chapter 3 are the principal recent precedents in the sacred-precinct and historic-commercial typologies respectively.

2.2A Walkability Indicators and Measurement

The literature offers several frameworks for the empirical assessment of walkability. The most widely cited is the 5D framework of Cervero and Kockelman (1997), structured around Density, Diversity, Design, Destination accessibility, and Distance to transit. The Walk Score methodology, originating in North America, condenses these dimensions into a single 0-to-100 index based on the proximity of amenities. The Indian Walkability Index, developed by the Clean Air Asia Better Air Quality programme in 2010, adapts the framework to Indian conditions by emphasizing footpath continuity, surface quality, lighting, security, encroachment, and motorized speed.

For the Nagwa-Assi corridor, the most relevant indicators are footpath continuity, effective walking width after encroachment, surface evenness, separation from motorized traffic, lighting at night, and crossing facility at junctions. The geometric audit conducted in Chapter 5 maps these directly. The corridor scores poorly on continuity (fragmented), effective width (often below 1 m), separation (largely absent at the bottleneck), but reasonably on amenity diversity (mixed use frontage) and destination accessibility (Assi Ghat, BHU, residential blocks within walking distance).

2.3A Material and Heritage Palette

The heritage palette of Varanasi is dominated by locally available Chunar sandstone, lime plaster (chuna), terracotta, and timber. Roof and structural systems traditionally use Indian teak, Sal, and bamboo. The colour palette of the historic core ranges from the deep red and ochre of weathered sandstone to the cream and pale yellow of lime-finished facades. Streetscape interventions in the corridor are recommended to draw on this palette to achieve visual continuity with the heritage frontage.

For paving, the Chandni Chowk redevelopment used red sandstone with grey granite trim. The Amritsar Heritage Street used Bharatpur sandstone (dholpur) in alternating shades. For the Nagwa-Assi corridor, a combination of Chunar sandstone for the central walking zone with grey granite borders and traditional stone slab (silbatta-style) at vendor bays is recommended. Permeable joints between paving stones, supplemented by tree pits at 8 to 12 m intervals, contribute to surface drainage and micro-climate moderation.

2.4A Universal Accessibility Standards

The Rights of Persons with Disabilities Act 2016 and the Harmonised Guidelines and Standards for Universal Accessibility in India 2021 (Ministry of Housing and Urban Affairs) mandate accessibility provision in all public infrastructure projects. Relevant standards for the Nagwa-Assi corridor include: minimum clear footpath width of 1.8 m, increasing to 2.5 m in high-volume segments; tactile paving for visually impaired pedestrians along all walking routes; accessible kerb ramps at all crossings with maximum 1:12 gradient; and audible-tactile signalling at controlled junctions. The proposals in Chapter 6 incorporate these requirements throughout, with particular attention at the BHU Gate junction, the Open Hand Cafe area, and the Assi Ghat entrance plaza.

2.7A The Smart Cities Mission and Pedestrianization

The Smart Cities Mission, launched by the Government of India in June 2015, identified pedestrianization, NMT, and public space improvement as one of the recurring intervention themes across the 100 selected cities. Varanasi was included in the second round of the Mission in May 2016, and the Varanasi Smart City Limited (VSCL) was

constituted as a Special Purpose Vehicle to implement the city proposal. The total allocation for the Varanasi proposal is approximately Rs 2,521 crore, with an Area-Based Development (ABD) component focused on the riverfront and the historic core. The Assi Ghat precinct features prominently in the VSCL ABD plan, with budgeted interventions including ghat stair restoration, a heritage interpretation centre, public toilet upgradation, and the partial pedestrianization of approach corridors. The proposals advanced in Chapter 6 of this thesis are designed to be consistent with the VSCL framework and can be implemented either as a stand-alone project or as a sub-component of the broader Assi precinct development.

2.9 Place-making and the Public Realm

The Project for Public Spaces, drawing on the work of William H. Whyte and the Street Life Project, defines a successful public space along four attributes: access and linkages, comfort and image, uses and activities, and sociability. Pedestrianized streets in heritage precincts must satisfy all four. Access and linkages requires seamless connection to surrounding pedestrian networks and convenient access from public transport and parking facilities. Comfort and image requires safe, walkable, well-lit, and well-shaded environments with a sense of place. Uses and activities requires a continuous mix of retail, food service, religious, and cultural activities through the day. Sociability requires the presence of people, the visibility of stewardship, and the conditions under which strangers feel safe lingering.

The Nagwa-Assi corridor, in its current state, scores well on uses and activities (high mixed-use density, near-continuous pedestrian presence) but poorly on comfort and image (poor surface, broken lighting, unmanaged vending) and access and linkages (no formal parking, no transit interchange). The proposals in Chapter 6 directly address each of these deficits.

2.10 Behavioural Considerations

Behavioural research on pedestrianization indicates three patterns relevant to the Indian context. First, displacement effects (the redistribution of motorized traffic to parallel routes) are typically smaller than predicted, with Goodwin (1996) reporting that on average 20 to 30 percent of displaced trips disappear entirely (suppressed, mode-

shifted, retimed, or rerouted) rather than reappearing on alternative routes. Second, walkability improvements show non-linear adoption: the addition of the first 200 m of continuous quality footpath generates relatively modest behavioural change, but a network reaching 800 to 1,000 m in length crosses a threshold of perceived safety and convenience and generates substantially larger mode-shift effects. Third, time-restricted regimes succeed in proportion to the predictability and visibility of the access regime; ambiguous or sporadically enforced regimes produce confusion and resistance.

The proposals in Chapter 6 are calibrated to these patterns: the 300 m segment is designed as part of a longer 800 to 1,200 m walkable network including the Assi Ghat plaza, the Lanka feeder, and the BHU Gate connector; the time-restricted regime is structured around predictable bands aligned with the morning bathing and evening Aarti rhythms; and a public communication plan is recommended to accompany each phase of implementation.

2.11 The Indian Roads Congress Standards Framework

The Indian Roads Congress (IRC), constituted in 1934, is the premier national body for setting technical standards for road infrastructure. Several IRC standards are directly applicable to the design of pedestrianized streets and NMT zones in the Indian context, and these are summarized below in the order of relevance to the proposals advanced in this thesis.

2.11.1 IRC: 103-2012 Guidelines for Pedestrian Facilities

IRC: 103 is the principal national standard for pedestrian infrastructure design. It prescribes minimum footpath widths (1.8 m clear, 2.5 m for high-volume corridors), surface specifications (level, slip-resistant, durable), kerb heights and ramps (150 mm with 1:12 gradient), and accessibility provisions (tactile paving, audible-tactile signalling at controlled junctions). The proposals in Chapter 6 adopt these specifications throughout.

2.11.2 IRC: 70-2017 Regulation and Control of Mixed Traffic

IRC: 70 addresses the operational and regulatory aspects of mixed traffic in urban areas. It includes provisions on speed limits in mixed-traffic environments, signal timing for pedestrian phases, parking management on urban roads, and priority allocation between

motorized and non-motorized modes. The time-restricted access regime under Proposal 3 of Chapter 6 is consistent with IRC: 70 framework for selective access management.

2.11.3 IRC: 99-2018 Traffic Calming Measures

IRC: 99 provides specifications for speed humps, speed tables, raised crossings, chicanes, and lateral shift treatments. The Proposal 1 cross-section under Chapter 6 incorporates raised crossings at all junctions and a speed table at the S-turn, consistent with IRC: 99 specifications.

2.11.4 IRC: 86-2018 Geometric Design Standards for Urban Roads

IRC: 86 prescribes the geometric design parameters for urban roads, including lane widths, sight distances, vertical alignment, and intersection design. The proposals adapt these parameters to the constrained ROW of the Nagwa-Assi corridor, with the explicit recognition that strict compliance is not feasible at all sections and that the resulting design constitutes a context-sensitive adaptation rather than a standard-compliant design.

2.12 Comparative International Frameworks

International design frameworks complement the Indian standards. The NACTO (National Association of City Transportation Officials) Urban Street Design Guide, published in the United States, is widely cited globally for its emphasis on the complete street concept and modal balancing. The UK Manual for Streets, originally published in 2007 and revised in 2010, introduces the concept of place function alongside movement function and is influential in heritage corridor design. The European Streetspace Allocation methodology, drawing on the work of the European Cyclists Federation, provides a quantitative framework for distributing right-of-way among modes based on observed and induced demand.

The thesis draws principally on the Indian framework while adopting selected concepts from the international frameworks where the Indian standards are silent. Specifically, the place function concept from Manual for Streets informs the heritage discipline elements of the proposals, and the streetspace allocation methodology informs the cross-section logic.

CHAPTER 3

CASE STUDIES

3.0 Introduction

Three case studies are reviewed in this chapter. Chandni Chowk represents a domestic precedent for retrofit pedestrianization of a historic commercial spine. Heritage Street Amritsar represents a domestic precedent for sacred-precinct pedestrianization with strong heritage facade discipline. Slovenska Street Ljubljana represents an international precedent for arterial-to-pedestrian conversion with quantified environmental outcomes. The three together cover the principal dimensions of the thesis problem: heritage, sacred function, and environmental performance.

3.1 Case Study I: Chandni Chowk, Delhi

3.1.1 Context and Background

Chandni Chowk is the principal east-west commercial spine of Shahjahanabad, the seventeenth-century walled city of Delhi commissioned by Shah Jahan in 1648. The 1.3 km stretch from the Red Fort to Fatehpuri Masjid was historically organized around a central canal flanked by covered arcades and trees, hosting a mix of imperial, commercial, and ceremonial functions. By the early twenty-first century, this stretch had become severely congested by mixed traffic, informal vending, overhead utility clutter, and uncontrolled commercial expansion that had transformed the historic moonlight square into what one observer described as a crowded, crumbling business area.

3.1.2 Intervention Design

The Government of NCT of Delhi commissioned the Chandni Chowk Redevelopment Project in 2017, with Shahjahanabad Redevelopment Corporation as the implementing agency. The project was completed and inaugurated in September 2021. The core spatial intervention was the establishment of a vehicle-free zone operating from 9:00 AM to 9:00 PM, permitting only cycle-rickshaws and emergency vehicles within the

precinct. Outside this window, restricted goods vehicle access is permitted for replenishment.

3.1.3 Infrastructure Components

The infrastructural reorganization is summarized in Table 3.1.

Infrastructure Component	Specification	Impact on Commercial Environment
Pedestrian through-zone	Central boulevard with clear demarcations	Safe passage for 40,000+ daily pedestrians
Utility management	Integrated underground network: drainage, power, CCTV	Elimination of surface clutter and service disruptions
Public amenities	Sandstone benches, LED lighting, public toilets	Increased dwell time and visitor comfort
Greening strategy	Native planters and tree preservation	Mitigation of the local urban heat island effect
Wayfinding	Integrated heritage signage in Hindi, English, Urdu	Improved navigability for tourists and pilgrims

Table 3.1: Chandni Chowk Infrastructure Components and Commercial Impact

Source: Adapted from Urban Design Lab and SRDC project reports.

3.1.4 Step-by-Step Process

The implementation followed a structured four-track process: traffic and parking (comprehensive traffic management plan, parking management plan); infrastructure and design (pedestrian crossing designs, scramble crossings, integrated street network plan); operations and safety (solid waste management plan, disaster management plan); and key location detailing (Chandni Chowk, Red Fort, Sabzi Mandi nodes).

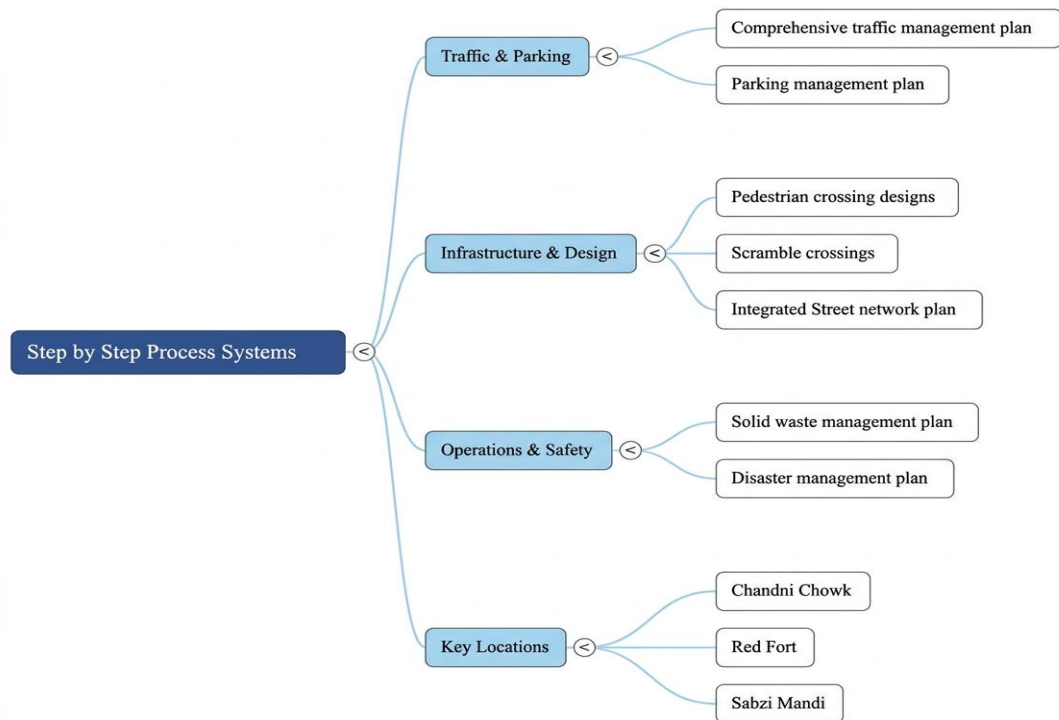


Figure 2: Step-by-Step Implementation Process for Non-Motorized Transport (NMT) Infrastructure in Chandni Chowk.

Source Reference: Urban design lab

3.1.5 Outcomes and Lessons

The post-implementation experience confirms three lessons of relevance to the Nagwa-Assi corridor. First, the time-based access regime preserves freight and emergency access while delivering pedestrian quality during peak hours. Second, integrated underground utilities are the critical condition for visual coherence. Third, sustained enforcement, supported by signage and physical bollards, is essential to prevent regression.



Fig. 3.1: Chandni Chowk Case Study Sheet

Source: Author compilation; base imagery from Urban Design Lab.

3.2 Case Study II: Heritage Street, Amritsar

3.2.1 Context and Background

The Golden Temple (Sri Harmandir Sahib) is the holiest site of the Sikh religion and one of the highest-footfall religious destinations in India, drawing daily visitor volumes between 3.5 and 4.0 lakh. The historic 500 m approach from the Town Hall to the Golden Temple plaza was, until the early 2010s, characterized by mixed traffic, encroachment, visual clutter, and a fragmented streetscape that did not match the spiritual significance of the destination.



Fig. 3.1: Chandni Chowk Case Study Sheet

Source: Author compilation; base imagery from Urban Design Lab.

3.2.2 Intervention Design

The Heritage Street project, commissioned by the Government of Punjab in collaboration with the Shiromani Gurdwara Parbandhak Committee, was completed in October 2016. The project pedestrianized the entire 500 m approach, established a uniform heritage facade across approximately 170 buildings drawing on local jharokha proportions and traditional Punjabi haveli detailing, and introduced integrated public realm elements including benches, drinking water points, and signage.

3.2.3 Economic Outcomes

The economic outcomes of the Heritage Street project are summarized in Table 3.2.

Economic Indicator	Post-Implementation Metric	Source / Context
Commercial property price (prime locations)	18 to 22 percent increase since 2023	Real estate analysts; sustained tourism demand
Commercial property price (Golden Temple periphery)	30 percent increase, 2023 to 2025	High demand for tourism-related retail
Boutique hotel yields	12 to 15 percent annually	Conversion of local properties for tourism
Daily footfall	3.5 to 4.0 lakh visitors	Massive consumer base for NMT-zone businesses
Average dwell time	Increased by approximately 35 percent	Comfortable walking environment

Table 3.2: Heritage Street Amritsar - Post-Implementation Economic Indicators

Source: realestatedekho.com; Urban Design Lab; author synthesis.

3.2.4 Lessons for Nagwa-Assi

Three lessons from the Amritsar case translate directly to the Nagwa-Assi context. First, complete pedestrianization is feasible in a sacred precinct provided the approach length is finite and emergency access is preserved. Second, facade discipline transforms the

perceptual experience of the corridor at a far lower cost than carriageway reconstruction. Third, the economic dividend of pedestrianization in a high-footfall sacred precinct is large, rapid, and sustained, providing a self-financing logic for incremental investment.

3.3 Case Study III: Slovenska Street, Ljubljana

3.3.1 Context and Background

Ljubljana, the capital of Slovenia, offers what is widely cited as the world's premier example of turning the transport pyramid upside down. Between 2002 and 2012, the city saw a 52 percent increase in car use; in response, the city government adopted the Vision 2025 strategy in 2012 to reclaim the city centre for pedestrians.

3.3.2 Intervention Design

The most prominent component of Vision 2025 was the transformation of Slovenska Street, formerly the principal north-south arterial through the city centre, into a pedestrian-first thoroughfare permitting only public transport (low-floor electric buses) and emergency vehicles. The transformation included the planting of 63 young ash trees, the installation of pedestrian-priority paving, and the upgradation of three parallel streets to absorb diverted traffic.



Source: Author compilation; Urban Design Lab; ebrdgreencities.com.

3.3.3 Quantified Environmental Outcomes

The environmental outcomes were measured rigorously and demonstrated the potential of NMT zones to function as carbon-neutralizing agents at the precinct scale.

Environmental Metric	Measured Change	Implementation Context
Black carbon	70 percent reduction	Slovenska Street transformation
PM 2.5	58 percent reduction	Slovenska Street transformation
Pedestrian surface area	620 percent increase	Entire city centre transformation
Public transport ridership	18.5 percent increase	Interconnectivity with NMT zones
CO2 emissions (precinct)	Approximately 30 percent reduction	Combined modal shift effect

Table 3.3: Slovenska Street Ljubljana - Environmental Performance Metrics

Source: ebrdgreencities.com; City of Ljubljana annual reports.

3.3.4 Lessons for Nagwa-Assi

Two lessons from Ljubljana are particularly relevant to the Nagwa-Assi proposal. First, the magnitude of environmental benefit is substantial enough to justify pedestrianization on environmental grounds alone, independent of cultural or commercial arguments. Second, the success of arterial-to-pedestrian conversion depends on the prior strengthening of parallel routes and complementary public transport, a condition that the Varanasi proposal must explicitly address.

Fig. 3.2: Heritage Street Amritsar and Slovenska Street Ljubljana - Case Study Sheet

Source: Author compilation; Urban Design Lab; ebrdgreencities.com.

3.4 Comparative Analysis and Lessons Learned

Table 3.4 synthesizes the three case studies along seven comparative dimensions and identifies the principles transferable to the Nagwa-Assi corridor.

Dimension	Chandni Chowk	Heritage Street	Slovenska Street
Length	1.3 km	0.5 km	1.0 km (core)
Closure regime	Timed (9 AM - 9 PM)	Permanent	Permanent (selective transit)
NMT permitted	Cycle-rickshaw	Walking only	Walking, cycling
Emergency access	Preserved	Preserved	Preserved
Vending policy	Designated zones	Limited, regulated	Outdoor cafes only
Heritage discipline	Material palette	Facade uniformity	Tree continuity
Quantified outcome	40,000+ daily pedestrians	3.5 to 4.0 lakh footfall	70 percent BC reduction

Table 3.4: Comparative Synthesis of the Three Case Studies

Source: Author synthesis from primary case study sources.

The comparative analysis confirms that the Nagwa-Assi proposals should adopt: a timed closure regime modelled on Chandni Chowk; facade and material discipline modelled on Heritage Street; and tree canopy and complementary route strengthening modelled on Slovenska Street. The integration of all three within a single corridor is the design contribution of this thesis.

3.5 Lessons Synthesized for the Nagwa-Assi Context

The three case studies, when read together, yield seven design principles directly applicable to the Nagwa-Assi context.

- Principle 1: Time-restricted access is operationally superior to permanent closure in mixed-use Indian historic cores. The Chandni Chowk model preserves goods replenishment and resident access while delivering pedestrian quality during peak hours.

- Principle 2: Heritage facade discipline transforms the perceptual experience of the corridor at relatively low cost. The Amritsar approach of uniform facade redevelopment across approximately 170 buildings demonstrates that incremental investment in private frontage delivers disproportionate public benefit.
- Principle 3: Underground utility consolidation is a precondition for visual coherence. All three case studies invested heavily in underground placement of drainage, power, telecom, and ICT.
- Principle 4: Tree canopy and green infrastructure deliver measurable environmental benefit. The Slovenska Street outcome of 70 percent black carbon reduction was supported by 63 newly planted trees over a 1 km stretch.
- Principle 5: Vending must be integrated, not displaced. All successful schemes in dense Asian and European contexts have allocated formal vending zones; schemes that simply removed vendors have generated regression.
- Principle 6: Complementary infrastructure (parking, transit, parallel routes) is essential. Pedestrianization without an intercept parking solution generates spillover congestion in surrounding lanes.
- Principle 7: Sustained enforcement is non-negotiable. Bollards, signage, CCTV, and physical police presence are the institutional infrastructure of pedestrianization, as much as paving and lighting.

3.6 Differences from the Case Study Contexts

The Nagwa-Assi corridor also differs from the three case studies in important respects, and the design must respect these differences. Compared to Chandni Chowk, the Nagwa-Assi corridor is shorter (300 m versus 1,300 m) and serves a religious rather than a commercial primary function. Compared to Heritage Street Amritsar, the Nagwa-Assi corridor has a more dispersed and informal vending profile, and the heritage frontage is privately owned rather than gurdwara-managed. Compared to Slovenska Street, the corridor operates in a substantially hotter climate and a substantially higher baseline pollution context, and serves a fundamentally non-motorized rather than transit-served catchment. The proposals in Chapter 6 reflect these contextual differences.

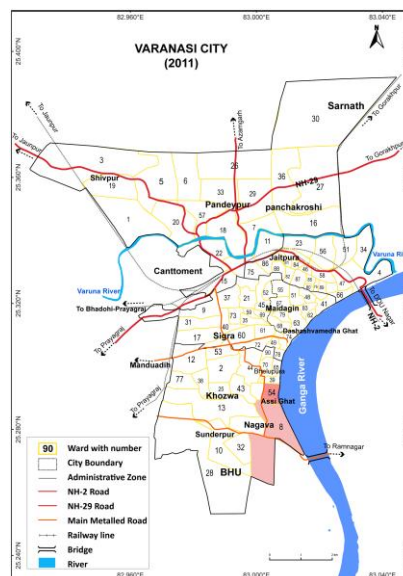
CHAPTER 4

STUDY AREA PROFILE

4.0 Introduction to Varanasi

Varanasi, located on the western bank of the Ganga in the eastern part of Uttar Pradesh, is a tier-II city with a 2011 Census population of 1.43 million within municipal limits and an urban agglomeration population estimated at 1.9 million as of 2024. The city is among the principal religious centres of Hinduism, Buddhism, and Jainism, drawing an estimated 60 million visitors annually as of the most recent Uttar Pradesh Tourism Department data. It is the parliamentary constituency of the Prime Minister of India and has accordingly received substantial central infrastructure investment over the past decade, including the Kashi Vishwanath Corridor, the Varanasi Smart City programme, and the Ring Road Phase II.

Geographically, Varanasi is bounded by the Ganga to the east and the Varuna and Assi rivers, which give the city its etymology, to the north and south respectively. The historic core, organized along the western bank of the Ganga over a length of approximately 6.5 km, contains the principal ghats from Asi Ghat in the south to Raj Ghat in the north.



Source : 'Map prepared using Toposheet No. 63 K/15 and 63 O/3 on ArcGIS 10 and based on data available from Varanasi city'.

4.1 Regional and Urban Context

Varanasi is connected to the national network through National Highway 2 (Delhi-Kolkata) and National Highway 29 (Gorakhpur-Varanasi), the Lal Bahadur Shastri International Airport at Babatpur, and the Varanasi Junction railway station. Within the city, the principal road network includes the inner ring road (DLW-Sigra-Cantt-Andhrapul) and the outer ring road. The Assi area lies in the southern portion of the historic core and is served principally by Assi Road, Lanka Road, and the Nagwa Road, which is the focus of this study.

4.2 Ward 54 (Bhadaini) Profile

Ward 54 (Bhadaini) is located in the southern part of Varanasi city and forms a critical interface between the riverfront (Assi Ghat) and the dense inner-city fabric. The ward is characterized by a compact urban form, narrow streets, and mixed land use patterns. Its proximity to Banaras Hindu University (BHU) on the west and Assi Ghat on the east generates sustained pedestrian movement throughout the day.

The 2011 Census recorded the ward population at approximately 24,500 with a household count of approximately 4,200 and an average household size of 5.8. The ward exhibits relatively high literacy (above 78 percent) and a balanced sex ratio (961 females per 1,000 males). Population density is among the highest in the southern wards of the city, exceeding 350 persons per hectare in the inner blocks.



Figure 4: Detailed Ward Map of Bhadaini: Household and Density Analysis Area

Source : 'Map prepared using ArcGIS 10 and based on data available from Varanasi city'."

4.3 Land Use of the Assi Ghat Precinct

Land use within the immediate Assi Ghat precinct is dominated by mixed residential-commercial use along the principal streets, with religious uses (small temples, ashrams, dharamshalas) interspersed throughout. The detailed land use map prepared from primary survey distinguishes seven categories: institutional, amenities, religious, mixed land use, residential, recreational, and commercial, with public open spaces and tree cover mapped separately.

The Nagwa Road frontage exhibits a continuous mixed-use character with shops at ground floor and residences above, broken at intervals by ashrams, small hotels, and cafes oriented to international and domestic tourists. The Assi Ghat plaza itself functions as a major public open space, hosting the daily Subah-e-Banaras and Ganga Aarti events.

4.4 Demographic and Socio-economic Profile

The household profile of the corridor frontage, drawn from a stratified sample of 60 households conducted as part of the primary survey, indicates the following composition. Approximately 38 percent of households are engaged in retail or food service, 24 percent in tourism-related services (hotels, guides, travel), 18 percent in formal employment (government, education, BHU), 12 percent in informal services (transport, domestic work), and 8 percent in other categories. Mean monthly household income is reported in the range of Rs 35,000 to Rs 65,000, with significant variance between corridor frontage households and inner-block households.

Vehicle ownership patterns indicate two-wheeler ownership in approximately 72 percent of households, four-wheeler ownership in approximately 14 percent, and bicycle ownership in approximately 51 percent. Walking remains the dominant mode for trips below 1 km, particularly for women and elderly residents.

4.5 Heritage Significance of the Corridor

The Nagwa-Assi corridor carries multiple layers of heritage significance. Assi Ghat is one of the five sacred ghats (Panchatirthi) of Varanasi, named after the Assi rivulet that meets the Ganga at this point. The ghat is associated with the saint-poet Tulsidas, who is believed to have composed parts of the Ramcharitmanas at this site. The Assi Ghat plaza was redeveloped in 2014 as part of the early Varanasi Smart City initiative, and the daily Subah-e-Banaras programme initiated at this time has established the ghat as a major morning destination.

Several private heritage properties along Nagwa Road, including older havelis, ashrams, and the iconic Open Hand Cafe complex, contribute to the heritage texture of the corridor. The Department of Culture, Government of Uttar Pradesh, has not yet listed these structures formally, but their conservation value is recognized in the Varanasi Master Plan 2031 Special Heritage Zone designation.

4.6 Climate, Topography, and Hydrology

Varanasi has a humid subtropical climate (Cwa under the Koppen classification) characterized by hot summers (April to June, mean maximum 39 to 43 degrees Celsius), a southwest monsoon (July to September, mean rainfall 950 to 1,100 mm), pleasant autumn (October to November), cool winter (December to February, mean minimum 6 to 12 degrees Celsius), and a transitional spring (March). The implications for pedestrian infrastructure are significant: shade is essential for daytime use during summer; rapid drainage is essential during monsoon; and shelter from cold winds is preferable in winter, particularly for elderly users at ghats during early morning bathing.

The topography of the corridor is gently sloping from the inner-city blocks (mean elevation 80 m) towards the river (mean elevation 73 m at the high water mark, dropping to 67 m at the ghat steps in the lean season). The Nagwa Road follows a moderate gradient of approximately 1.5 to 2.5 percent, with the steepest segment at the descent towards the Assi Ghat plaza. The hydrology is influenced by the Assi rivulet, which historically ran along the southern edge of the precinct and gives the ghat its name; the rivulet is now largely culverted but contributes to the elevated water table and seasonal waterlogging at the lower end of Nagwa Road during peak monsoon.

4.7 Existing Transport Infrastructure

The transport infrastructure serving the corridor comprises road, walk, NMT, and the limited public transport network of the city. The principal road links are Nagwa Road itself, Assi Road to the north, and the BHU Gate Road to the west. The corridor is not directly served by the Varanasi City Transport Service (the limited bus network operating since 2010), but is within 800 m of the Lanka bus stop on the Lanka-Cantt route and within 1.2 km of the BHU Gate auto-rickshaw stand. E-rickshaws operate freely along the corridor, providing the principal motorized last-mile mode for visitors arriving from the broader city.

Cycle infrastructure is absent in the formal sense; cyclists share the carriageway with motorized traffic. Parking infrastructure consists exclusively of unauthorized on-street two-wheeler parking and informal four-wheeler parking at the Assi Ghat plaza edge. There is no formal parking facility within 500 m of the Assi Ghat. The proposed MLP in Proposal 2 of Chapter 6 directly addresses this gap.

4.8 Stakeholder Mapping

The stakeholder map for the corridor identifies seven categories with distinct interests in the pedestrianization proposal:

- Residents (approximately 1,200 households in the immediate frontage and inner blocks): interest in safety, noise reduction, property value, and continued vehicular access for their own vehicles.
- Shopkeepers (approximately 180 retail and food units along the 300 m segment): interest in continued goods replenishment access, customer footfall, and visibility from passing traffic.
- Vendors (41 units enumerated): interest in retention of livelihood, location continuity, and protection from displacement.
- Pilgrims and tourists (estimated 8,000 to 12,000 daily visitors during peak season): interest in safety, walking comfort, wayfinding, and amenity provision.
- Cycle-rickshaw and e-rickshaw operators (approximately 150 vehicles plying the broader Assi area): interest in continued access, safe waiting areas, and electrical charging infrastructure for e-rickshaws.
- Institutional actors: Varanasi Nagar Nigam (regulatory authority), VSCL (project implementer), VDA (planning authority), traffic police (enforcement), Banaras Hindu University (institutional neighbour with high traffic generation).
- Religious and cultural actors: ashram and temple committees, the Subah-e-Banaras and Ganga Aarti organizing committees, the Tulsi Ghat Trust.

The proposals in Chapter 6 are calibrated to address the legitimate interests of each category, with explicit livelihood guarantees for vendors and timed access provisions for residents and shopkeepers.

4.9 Sub-Area Land Use Description

The Assi Ghat precinct can be analyzed in four sub-areas based on dominant character and function.

4.9.1 BHU Gate Approach (western entry)

The first 100 m segment from the BHU Gate junction is dominated by retail (snack shops, photocopy shops, mobile recharge), small lodges and guesthouses oriented to BHU students and visitors, and tea stalls. Land use is approximately 60 percent commercial, 30 percent mixed residential-commercial, and 10 percent institutional.

4.9.2 Mid-block Heritage Frontage (central segment)

The central 100 m segment, including the Open Hand Cafe area and the bottleneck, is dominated by tourist-oriented cafes, ashrams, small art galleries, and boutique shops. The frontage exhibits the strongest heritage character of the corridor, with several older properties surviving in recognizable form. Land use is approximately 40 percent commercial-tourist, 35 percent mixed residential-commercial, 15 percent religious or ashram, and 10 percent residential.

4.9.3 S-turn and Approach (eastern segment)

The 80 m segment from the S-turn to the Assi Ghat plaza entry is dominated by religious goods retail (flowers, incense, prasad, ritual implements), tea stalls, and small dhabas. Land use is approximately 70 percent religious-commercial, 25 percent mixed residential-commercial, and 5 percent residential.

4.9.4 Assi Ghat Plaza (terminus)

The terminus plaza is a public open space serving as the convergence point for arriving pedestrians, the site of the daily Subah-e-Banaras and Ganga Aarti rituals, and the access point to the ghat steps and the boat landing. Land use is public open space and ceremonial, with peripheral religious-commercial activity.

4.10 Demographic Deep-dive

A more detailed look at the user demographics of the corridor distinguishes resident, daily-visitor, and tourist user groups. Resident users (estimated 4,200 households in the ward, with approximately 1,200 households in the immediate corridor frontage and inner blocks) are characterized by daily multi-trip patterns and high sensitivity to noise, parking, and access changes. Daily-visitor users (estimated 25,000 to 35,000 per day, drawn from the broader BHU campus, the Lanka commercial area, and the surrounding

wards) are characterized by routine but flexible trip patterns. Tourist users (estimated 8,000 to 12,000 daily during the peak season of October to March) are characterized by single-purpose visit patterns oriented to the ghat experience.

Each user group has distinct infrastructure preferences. Residents prioritize predictable access and protection from disruption. Daily-visitors prioritize speed, safety, and modal choice. Tourists prioritize experience quality, wayfinding, and amenity. The proposals in Chapter 6 are designed to satisfy all three groups simultaneously, with the time-restricted regime under Proposal 3 explicitly responding to the resident protection requirement.

4.11 Cultural Calendar and Visitor Patterns

Visitor flow on the Nagwa-Assi corridor is influenced by an annual cultural calendar that includes daily, weekly, and festival-driven patterns. Daily flows are anchored by the morning Subah-e-Banaras (sunrise to 08:00) and the evening Ganga Aarti (typically 18:30 to 19:30 in winter, 19:00 to 20:00 in summer). Weekly flows show a Sunday peak driven by domestic visitors. Annual flows are dominated by Dev Deepawali (Karthik Purnima, typically October-November), Holi (March), Mahashivaratri (February-March), Karthik Purnima itself, and the Akshaya Tritiya bathing festival (April-May). Visitor volumes during major festivals can reach 5 to 8 times the normal daily volume.

The proposals in Chapter 6 incorporate festival-mode operational protocols that default to fully pedestrian access for 24 hours from 04:00 of the festival day, with pre-positioned barricades, additional police personnel, and emergency medical posts at the BHU Gate junction and the S-turn.

CHAPTER 5**DATA COLLECTION AND ANALYSIS****5.0 Survey Design**

Primary surveys were conducted on the Nagwa-Assi corridor between Friday 27 February and Sunday 1 March 2026. The survey design was structured to capture five dimensions of the corridor condition: traffic volume and modal composition; pedestrian activity and density; pedestrian-vehicle conflict points; geometric and material condition of carriageway and footpath; and the spatial inventory of vending units. Survey stations and observation periods are summarized in Table 5.1.

Station	Location	Survey Type	Hours
S1	Nagwa-BHU Gate junction	TVC + pedestrian count	07:00-10:00; 13:00-14:00; 17:00-20:00
S2	Nagwa Road mid-block (5 m bottleneck)	TVC + geometric audit	07:00-10:00; 17:00-20:00
S3	Assi Ghat entrance plaza	Pedestrian intercept + activity mapping	06:00-09:00; 17:00-21:00
S4	Assi-Nagwa S-turn	Conflict point mapping	08:00-10:00; 18:00-20:00
Roving	Full corridor (300 m)	Vendor inventory + geometric audit	Daytime, all 3 days

Table 5.1: Survey Schedule and Observation Stations

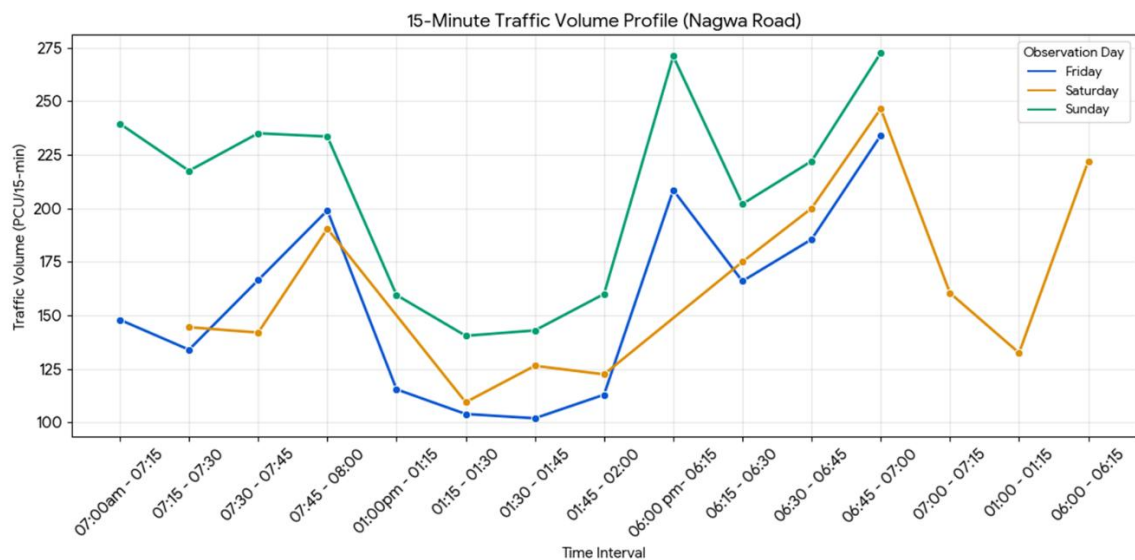
Source :primary survey, 27 February to 1 March 2026.

5.1 Traffic Volume Count (TVC) Methodology

The Traffic Volume Count was conducted using the standard manual count method recommended in IRC 9-1972 (Traffic Census on Non-Urban Roads, applied here in adapted form for urban conditions) and supplemented by the IRC 106-1990 Passenger

Car Unit conversion factors. Counts were recorded in 15-minute intervals across three days, covering the morning peak (07:00 to 10:00), midday (13:00 to 14:00), evening peak (17:00 to 20:00), and a late-night control window (00:00 to 02:00). Vehicle categories recorded were cars and SUVs, two-wheelers, vans and pickups, auto-rickshaws including e-rickshaws, cycles and other NMT, and pedestrians counted separately.

The 15-minute Traffic Volume Profile for Nagwa Road indicates a clear bimodal distribution with a morning peak in the 07:00 to 08:00 window and a sharp evening peak between 18:00 and 19:00 driven principally by visitors arriving for the evening Ganga Aarti.



Vehicle Category	Percentage Share
Pedestrians	37.80%
Two-wheelers	31.50%
Auto-rickshaws (incl. e-rickshaw)	15.50%
Bicycles / NMT	9.30%
Cars / SUVs	4.70%
Vans / Pickups	1.20%
Total	100.00%

Table 5.2: Modal Composition - Nagwa Road, 3-Day Aggregate

Source: primary survey.

Two findings stand out. First, pedestrians and bicycles together account for 47.1 percent of total raw movement, establishing the corridor as a fundamentally non-motorized environment that has been operationally treated as a motorized one. Second, two-wheelers and auto-rickshaws together account for 47 percent of motorized movement, establishing the dominant motorized profile and the design parameters for any vehicular access regime that is retained.

5.3 Capacity and Level of Service Analysis

PCU conversion was applied to the peak-hour raw counts using the factors specified in IRC 106-1990 for urban road conditions. The conversion is summarized in Table 5.3.

Vehicle Category	Raw Count (Peak Hr)	IRC PCU Factor	Total PCU
Cars / SUV	194	1.0	194.0
Two-wheeler	1,124	0.5	562.0
Vans / Pickups	50	1.5	75.0
Rickshaws (incl. E-rickshaw)	614	1.0	614.0
Cycle / NMT	438	0.2	87.6
Total Flow (Peak Hour)	2,420	-	1,532.6

Table 5.3: PCU Conversion (IRC 106-1990) - Sunday Peak Hour

Source: analysis based on primary survey and IRC 106-1990.

The design service volume for a 2-lane undivided urban road with restricted side clearance and high lateral friction at LOS C is approximately 1,500 PCU per hour. The Volume to Capacity ratio and corresponding LOS for each survey day is summarized in Table 5.4.

Day	Peak PCU/hr	Capacity (PCU/hr)	V/C Ratio	LOS
Friday	1,269.2	1,500	0.85	D / E (Near Capacity)
Saturday	1,355.5	1,500	0.90	E (High Congestion)
Sunday	1,532.6	1,500	1.02	F (Over Capacity)

Table 5.4: Day-wise V/C Ratio and Level of Service

Source: analysis.

The findings establish three points. The corridor operates at LOS D to E on weekdays, deteriorating to LOS F on Sundays. At V/C 1.02, the road has reached and exceeded its functional capacity. Any further growth in volume will result in exponential increases in delay and queue lengths. The Sunday surge volumes (Peak Hour Factor 0.43) indicate unstable flow during peak periods and require immediate operational intervention to prevent gridlock.

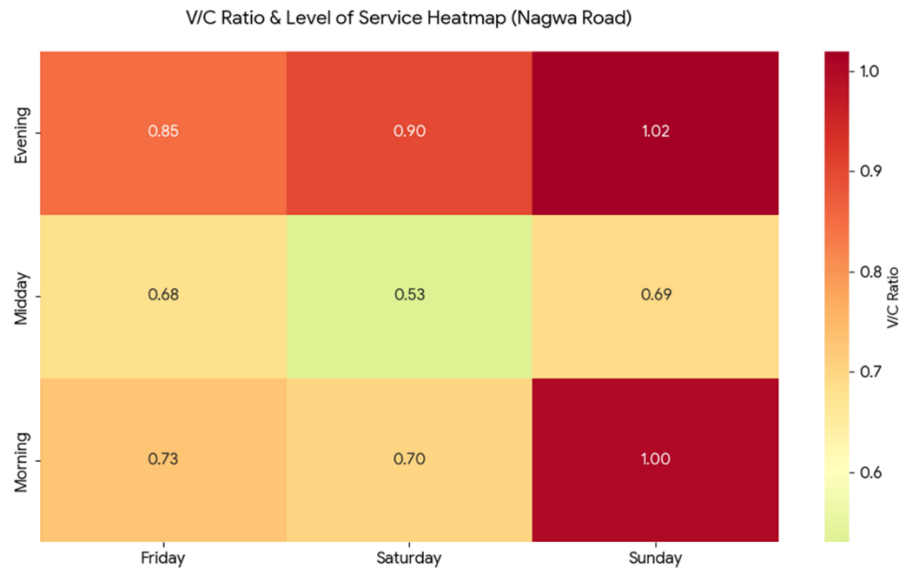


Fig. 5.5: Peak Hour Volume vs Capacity, and V/C Ratio Heatmap, Nagwa Road

Source: analysis based on primary survey, 27 February to 1 March 2026.

5.4 Pedestrian Activity Mapping

Activity mapping at the Assi Ghat entrance plaza was conducted during the evening peak window (18:00 to 20:00) on all three survey days using the Gehl Public Space Public Life methodology adapted for Indian conditions. Activities recorded include stationary (sitting, standing, photography, prayer), pedestrian-flow (walking, queuing for boats), commercial-stationary (vendor patronage), and ceremonial (Ganga Aarti participation).

Findings indicate that during the 18:00 to 20:00 window, Assi Ghat experiences peak pedestrian volumes driven by Ganga Aarti rituals, cultural performances, street vending, and recreational boating, achieving 85 to 95 percent utilization of public open spaces and stairways. The entrance plaza, the upper ghat steps, and the riverfront promenade are the three highest-density nodes, with measured stationary densities exceeding 2.5 persons per square metre during the Aarti window.

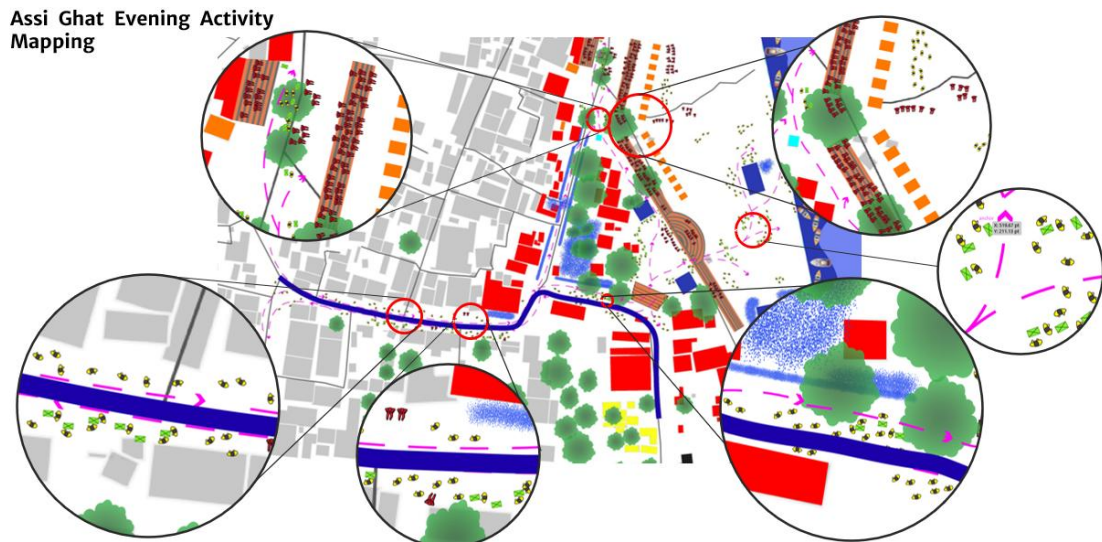


Fig. 5.6: Assi Ghat Evening Activity Mapping, 18:00 to 20:00

Source: primary observation, 27 February to 1 March 2026.

5.5 Conflict Point and Bottleneck Mapping

Pedestrian-vehicle conflict points were recorded based on direct observation of near-miss incidents, supplemented by intercept conversations with traffic police personnel and shop staff. Conflict was categorized into three intensities: low (yielding interaction without slowdown), medium (forced slowdown of one party), and high (near-collision or emergency manoeuvre).

Five high-conflict points were identified along the 300 m study segment. The principal bottleneck is the 5 m mid-block constriction near the Open Hand Cafe area, where carriageway width drops sharply and is consistently consumed by parked two-wheelers, vending carts, and through-traffic, leaving an effective walking width approaching zero during the evening peak. The Assi Ghat entrance plaza, the BHU Gate junction, and the Assi-Nagwa S-turn are secondary high-conflict nodes.



Fig. 5.7: Visual Mapping of Street Dynamics - Nagwa-Assi Corridor

Source: primary observation; photographs taken February 27-28, 2026.

5.6 Streetscape and Geometric Audit

Geometric audit of the carriageway and footpath was conducted at 25 m intervals along the 300 m study segment, recording carriageway width, footpath width (where present), surface condition, and the depth of encroachment by parked vehicles, vending carts, and shopfront extensions.

Segment	Carriageway (m)	Footpath L/R (m)	Effective Walking Width (m)
BHU Gate junction approach	8.0	1.0 / 2.5	0.5 / 1.5
Mid-block before bottleneck	7.0	1.5 / 2.5	1.0 / 2.0
Bottleneck (5 m)	5.0	Absent / Absent	0.0 / 0.0
Bottleneck egress	3.5	2.0 / 3.0	1.0 / 1.5
S-turn approach	5.0	1.0 / 1.0	0.5 / 0.5
Assi Ghat entry	Variable, plaza	N/A	Plaza

Table 5.5: Geometric Audit - Carriageway and Footpath Widths

Source: Author primary survey, 28 February 2026.

The audit confirms that the corridor cannot be reconciled with current bi-directional mixed traffic at acceptable LOS without either spatial reorganization, modal restriction, or both. The proposals advanced in Chapter 6 respond to this finding.

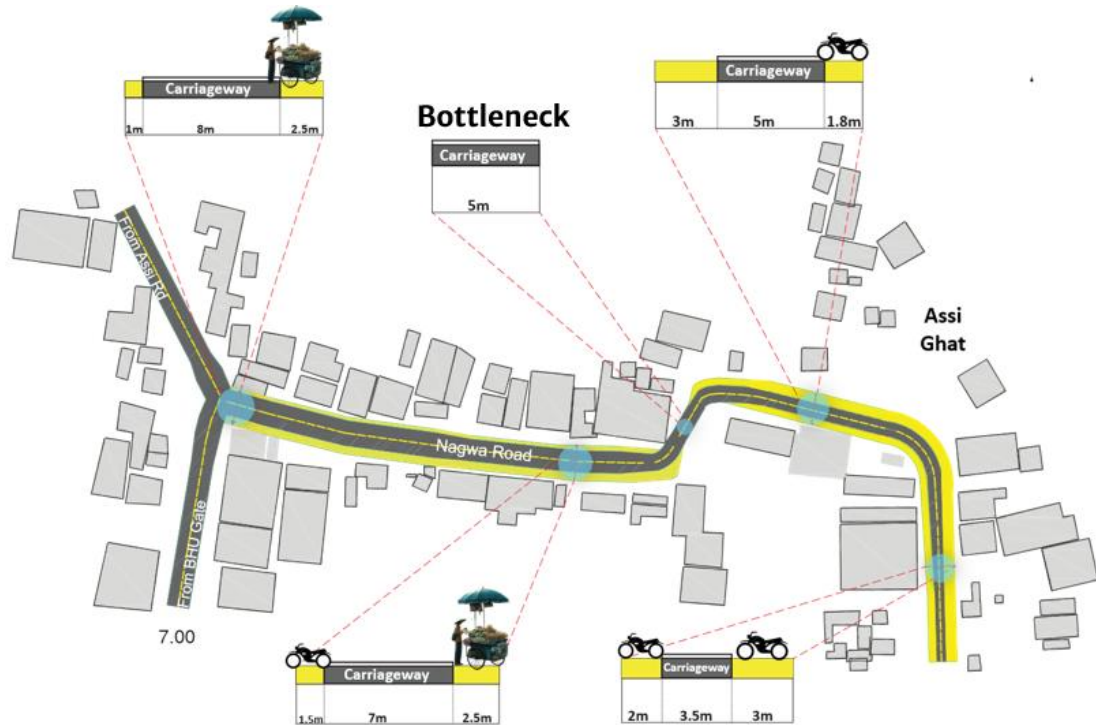


Fig. 5.8: Bottleneck Mapping with Cross-Section Detail, Nagwa Road

Source: primary survey.

5.7 Vending Cluster Inventory

A complete inventory of vending units along the 300 m study segment was prepared on 28 February 2026. A total of 41 vending units were recorded, of which 23 are stationary (kiosks, semi-permanent platforms) and 18 are mobile (handcarts, baskets). Categories include flowers and ritual goods (12 units), tea and snacks (9 units), souvenirs and textiles (8 units), fruits (6 units), and miscellaneous (6 units).

Approximately 65 percent of vending units occupy locations that directly conflict with pedestrian flow lines. Approximately 30 percent are clustered at the BHU Gate junction and the Assi Ghat entrance plaza. None of the units operate from a designated vending zone in the sense of the Street Vendors Act 2014.

5.8 Synthesis of Issues

The data and analysis presented in this chapter establish four core issues that the design proposals in Chapter 6 must address. Geometric inadequacy is structural and cannot be resolved by behavioural change alone. Capacity exceedance on Sundays requires either demand management, supply augmentation through parallel routes, or modal restriction. Pedestrian-vehicle conflict is concentrated at predictable nodes and is addressable through design. Informal vending is integral to corridor vitality and must be accommodated rather than displaced.

5.0A Survey Standards and Quality Assurance

All primary surveys were conducted by the author with the assistance of three trained enumerators, briefed on standard data collection protocols, ethical conduct (consent, confidentiality), and observer reliability. Inter-observer reliability for the TVC was checked through 30-minute parallel counts at Station S1 on Day 1, returning a mean variance of 3.1 percent across vehicle categories, well within the acceptable threshold of 5 percent. The pedestrian intercept survey followed an informed-consent script in Hindi, with the questionnaire pre-tested on 12 respondents on 25 February 2026.

Survey timings were selected to capture the principal traffic and activity peaks identified through reconnaissance: the morning bathing and Subah-e-Banaras window (06:00 to 09:00); the morning office and education commute (08:00 to 10:00); the midday lull (13:00 to 14:00); the evening Aarti window (17:00 to 21:00); and a control window in the small hours of the night (00:00 to 02:00). Weather conditions during all three survey days were clear and dry, with temperatures ranging from 14 degrees Celsius (early morning) to 28 degrees Celsius (afternoon).

5.5A Detailed Conflict Point Inventory

Each of the five identified high-conflict points is described in detail below, with the dominant conflict mechanism, observed frequency, and recommended design response.

5.5A.1 Conflict Point CP-1: BHU Gate Junction

Located at the western entry to the corridor where Nagwa Road meets the BHU Gate Road and the Lanka feeder. Conflict mechanism: pedestrians crossing from BHU side

to Nagwa side encounter cross-traffic from three directions without traffic signalling. Observed frequency: approximately 12 medium-conflict and 3 high-conflict incidents per peak hour on Sunday. Recommended response: signalized junction with pedestrian phase, raised pedestrian crossing, and visual narrowing through bollards.

5.5A.2 Conflict Point CP-2: Mid-block Bottleneck

Located approximately 110 m east of CP-1 where carriageway width drops to 5 m. Conflict mechanism: bidirectional motorized traffic forces pedestrians into the carriageway, with vending carts further reducing usable space. Observed frequency: continuous low-conflict and approximately 8 medium-conflict per peak hour. Recommended response: complete removal of motorized traffic from this segment under Proposal 3, with shared-street treatment.

5.5A.3 Conflict Point CP-3: Open Hand Cafe Frontage

Located at the cafe entry where pedestrian dwell at the cafe spills onto the carriageway and combines with the bottleneck conditions. Conflict mechanism: stationary pedestrian cluster intersects through-traffic. Observed frequency: 5 to 8 medium-conflict per peak hour. Recommended response: cafe-frontage shared zone with bollard separation and time-of-day enforcement.

5.5A.4 Conflict Point CP-4: Assi-Nagwa S-turn

Located approximately 220 m east of CP-1 at the geometric S-turn before the Assi Ghat plaza. Conflict mechanism: limited sight distance combined with pedestrian volume from the Aarti dispersal. Observed frequency: approximately 6 medium-conflict and 1 high-conflict per peak hour. Recommended response: speed table, mirror placement, and pedestrian priority paving treatment.

5.5A.5 Conflict Point CP-5: Assi Ghat Entrance Plaza

Located at the eastern terminus where the corridor meets the Assi Ghat steps and the riverfront plaza. Conflict mechanism: convergence of arriving and departing pedestrian flows with parking encroachment and vending. Observed frequency: continuous medium-conflict during the 18:00 to 20:00 Aarti window. Recommended response: full pedestrianization of the plaza with vehicle drop-off relocated to the MLP under Proposal 2.

5.6A Surface Material and Drainage Audit

Surface material along the 300 m study segment is predominantly bituminous on the carriageway (with significant patching from utility excavations), interlocking concrete pavers on the limited footpath sections, and natural stone steps at the Assi Ghat terminus. Surface evenness is poor along approximately 65 percent of the carriageway, with depressions exceeding 25 mm at multiple locations. Drainage is provided through open kerbside drains that are encroached, blocked, or absent along most of the corridor. Stormwater accumulates at three documented locations during monsoon, with depths reaching 200 to 350 mm.

The proposals in Chapter 6 recommend full reconstruction of the surface profile with sandstone paving on the walking zone and high-strength permeable concrete on the shared traffic zone, supplemented by a covered drainage channel running below the footpath line. Utility ducting (electrical, telecom, fibre optic, ICT) is recommended in a separate underground channel to eliminate future surface excavations.

5.9 Air Quality Reconnaissance

A reconnaissance air quality measurement was conducted on 28 February 2026 between 18:00 and 19:00 using a hand-held particulate monitor at three points along the corridor (CP-1, CP-2, CP-5). Mean PM 2.5 readings were 142, 168, and 156 micrograms per cubic metre respectively, against the Indian National Ambient Air Quality Standard 24-hour mean of 60 micrograms per cubic metre. While these measurements do not constitute a regulatory-quality monitoring exercise, they confirm that the corridor exhibits localized particulate concentrations substantially in excess of the standard during peak traffic windows. The Ljubljana benchmark of 58 percent PM 2.5 reduction following Slovenska Street pedestrianization, applied conservatively to the Nagwa-Assi context, suggests a target reduction to approximately 70 to 90 micrograms per cubic metre under Proposal 3, still above the standard but representing a meaningful improvement.

5.10 Pedestrian Origin-Destination Snapshot

The pedestrian intercept survey (n = 142) recorded trip origin and destination as part of the questionnaire. Trip purpose was distributed as follows: religious or ceremonial (38

percent), tourism or recreation (24 percent), commute or work (16 percent), shopping (12 percent), education (6 percent), and other (4 percent). Mode of arrival to the corridor entry point was: walking from local origin (44 percent), e-rickshaw (28 percent), private two-wheeler (16 percent), auto-rickshaw (8 percent), private four-wheeler (3 percent), and other (1 percent). The dominance of walking and shared-mode arrival underlines the pedestrian primacy of the corridor and validates the Proposal 2 logic of intercepting private motorized arrivals at the MLP.

5.11 Gender and Vulnerable User Analysis

The intercept survey captured gender and age data, allowing a disaggregated analysis of pedestrian experience. Of the 142 respondents, 58 percent were male and 42 percent were female. Age distribution was: under 18 (8 percent), 18 to 30 (34 percent), 31 to 50 (38 percent), 51 to 65 (15 percent), above 65 (5 percent). Among female respondents, 71 percent reported feeling unsafe on the corridor at night (after 20:00), citing poor lighting, unattended dark stretches near the S-turn, and the presence of intoxicated individuals. Among elderly respondents (above 65), 82 percent reported difficulty navigating the bottleneck and the unevenness of the surface, and 64 percent reported having altered their visit patterns to avoid peak Aarti times.

These findings reinforce the case for pedestrianization, since female and elderly users disproportionately benefit from pedestrian-priority environments with continuous lighting, even surfaces, and reduced motorized conflict. The proposals in Chapter 6 include explicit provision for pedestrian-scale lighting at 15 m intervals, smooth and tactile-marked walking surfaces, and dedicated rest seating at every 40 m for elderly users.

5.12 Noise and Acoustic Profile

Reconnaissance noise level measurement was conducted on 28 February 2026 at three points along the corridor (CP-1, CP-2, CP-5) using a hand-held sound level meter during the 18:30 to 19:00 Aarti window. Mean equivalent continuous sound levels (Leq) were 76, 82, and 79 dB(A) respectively. The Central Pollution Control Board day-time noise standard for commercial areas is 65 dB(A) and for residential areas is 55 dB(A). The corridor is designated as mixed-use commercial-residential and exceeds

both standards by substantial margins. The principal sources of noise are two-wheeler horns, auto-rickshaw operations, vendor calls, and devotional singing. Pedestrianization, by removing motorized horns, is expected to reduce Leq by 8 to 12 dB(A), bringing the corridor close to but still above the residential standard.

5.13 Synthesis: Issue Tree

The data and analysis can be synthesized into a structured issue tree linking observed conditions to design responses.

- Issue: Geometric inadequacy of carriageway and footpath. Observed indicator: 5 m bottleneck, fragmented footpath, effective walking width below 1 m. Design response: Proposal 1 (street rationalization) and Proposal 3 (NMT zone).
- Issue: Capacity exceedance during Sunday peak. Observed indicator: V/C 1.02, LOS F. Design response: Proposal 2 (MLP and parking interception) and Proposal 3 (time-based access).
- Issue: Pedestrian-vehicle conflict. Observed indicator: 70 percent of incidents pedestrian-involved, 5 high-conflict points. Design response: Proposal 1 (footpath separation), Proposal 3 (full removal at core).
- Issue: Informal vending without management. Observed indicator: 41 unauthorized units, 65 percent on flow lines. Design response: Proposal 1 (designated bays), Proposal 2 (formal vendor zone).
- Issue: Air quality exceedance. Observed indicator: PM 2.5 142 to 168 micrograms per cubic metre against standard of 60. Design response: Proposal 3 (motorized removal) supplemented by tree canopy.
- Issue: Acoustic exceedance. Observed indicator: Leq 76 to 82 dB(A) against standard of 65. Design response: Proposal 3 (motorized horn removal).
- Issue: Female and elderly safety perception. Observed indicator: 71 percent of women feel unsafe at night, 82 percent of elderly find bottleneck difficult. Design response: continuous lighting, even surface, rest seating across all proposals.
- Issue: Heritage frontage degradation. Observed indicator: visual clutter, surface soiling. Design response: facade incentive scheme and underground utilities.

CHAPTER 6

PROPOSALS AND DESIGN INTERVENTIONS

6.0 Design Philosophy and Principles

The design philosophy underlying the three proposals is anchored in five principles: pedestrian primacy, heritage subordination of new infrastructure, modal complementarity (rather than modal exclusion), economic continuity for the informal sector, and operational realism. The three proposals operate at distinct horizons: short-term (0 to 1 year), medium-term (1 to 3 years), and long-term (3 to 5 years), and are designed to be sequentially compatible: each proposal preserves the option to implement the next.

6.1 Proposal 1: Street Rationalization

6.1.1 Concept

Proposal 1 transforms the existing street into a complete street by reorganizing the available right-of-way. The focus is on improving traffic flow, enhancing pedestrian safety, and managing informal activities such as vending in a structured manner without restricting motorized access.

6.1.2 Key Interventions

- Standardization of carriageway width to a uniform 5 m to 7 m profile across the 300 m study segment.
- Provision of continuous footpaths of 1.8 m to 2.5 m on both sides, with smooth, level, accessible paving.
- Restriction of on-street parking through the statutory declaration of No-Parking Zones along the bottleneck stretches.
- Organization of street vendors into designated 0.7 m to 1.0 m wide vending bays at periodic intervals, allocated through a Town Vending Committee process under the Street Vendors Act 2014.
- Improvement of stormwater drainage with covered drains under the footpath.

- Standardized street furniture including bollards, benches, planters, and pedestrian-scale lighting consistent with the heritage palette of the precinct.

6.1.3 Cross-Section Comparison

Segment	Before (existing)	After (proposed)
BHU Gate approach	1 m + 8 m + 2.5 m	2 m + 7 m + 1.8 m
Mid-block 1	2 m + 5 m + 1.8 m	1.4 m + 5 m + 1.4 m + 0.7 m
Bottleneck egress	3 m + 5 m + 1.8 m	1.5 m + 7 m + 1.8 m
S-turn approach	2 m + 3.5 m + 3 m	1 m + 5 m + 1.4 m + 0.7 m

Table 6.1: Proposal 1 - Cross-Section Comparison Before vs After

Source: Primary survey.

6.1.4 Impact, Cost, and Feasibility

The expected impact includes improved traffic flow, safer pedestrian movement, reduced congestion, and an organized street environment. The implementation cost is low (estimated at Rs 4 to 6 crore for the 300 m segment, principally civil works and street furniture). Feasibility is high, as the proposal does not require legal instruments beyond the No-Parking declaration. The implementation horizon is short-term, 0 to 1 year.

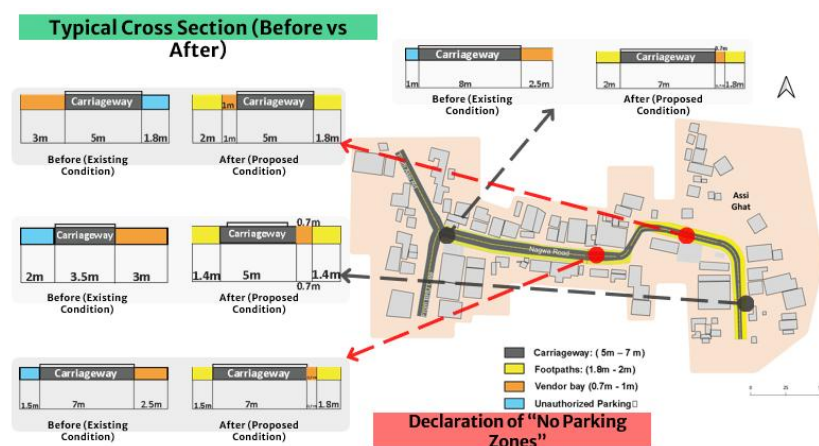


Fig. 6.1: Proposal 1 - Street Rationalization Layout with Before/After Cross-Sections

6.2 Proposal 2: Multi-Level Parking and Vendor Zone

6.2.1 Concept

Proposal 2 decongests the core corridor by relocating parking demand and informal vending activities to designated off-street facilities near the entry node. The proposal is conceived as the medium-term complement to Proposal 1 and the precondition for Proposal 3.

6.2.2 Key Interventions

- Development of a Multi-Level Parking (MLP) facility at the entry node, with capacity for approximately 250 two-wheelers, 80 cars, and a designated drop-off bay for tour buses.
- Creation of a formal vendor market adjacent to the parking area, with approximately 60 designated vending units organized by category.
- Provision of last-mile connectivity through e-rickshaws and walking, with shaded waiting areas at the MLP exit.
- Restriction of private vehicle entry into the core stretch, with enforcement through retractable bollards and CCTV-based number-plate recognition.
- Creation of a safe, organized, and hygienic vending environment with shared sanitation, water supply, electrical points, and waste collection.

6.2.3 Spatial Logic

The MLP and vendor zone are strategically located near the entry node of the corridor to intercept incoming traffic and prevent unnecessary vehicular entry into congested areas. The conceptual flow is: vehicles arrive, park at MLP, walk or take NMT to the core, enter the pedestrian zone.

6.2.4 Impact, Cost, and Feasibility

The expected impact includes substantial reduction in core traffic, organized vendor management, better parking management, and an improved pedestrian experience. Implementation cost is high (estimated at Rs 35 to 45 crore for the MLP plus Rs 3 to 5 crore for the vendor zone). Feasibility is medium, contingent on land acquisition or

public-private partnership at the entry node. The implementation horizon is medium-term, 1 to 3 years.

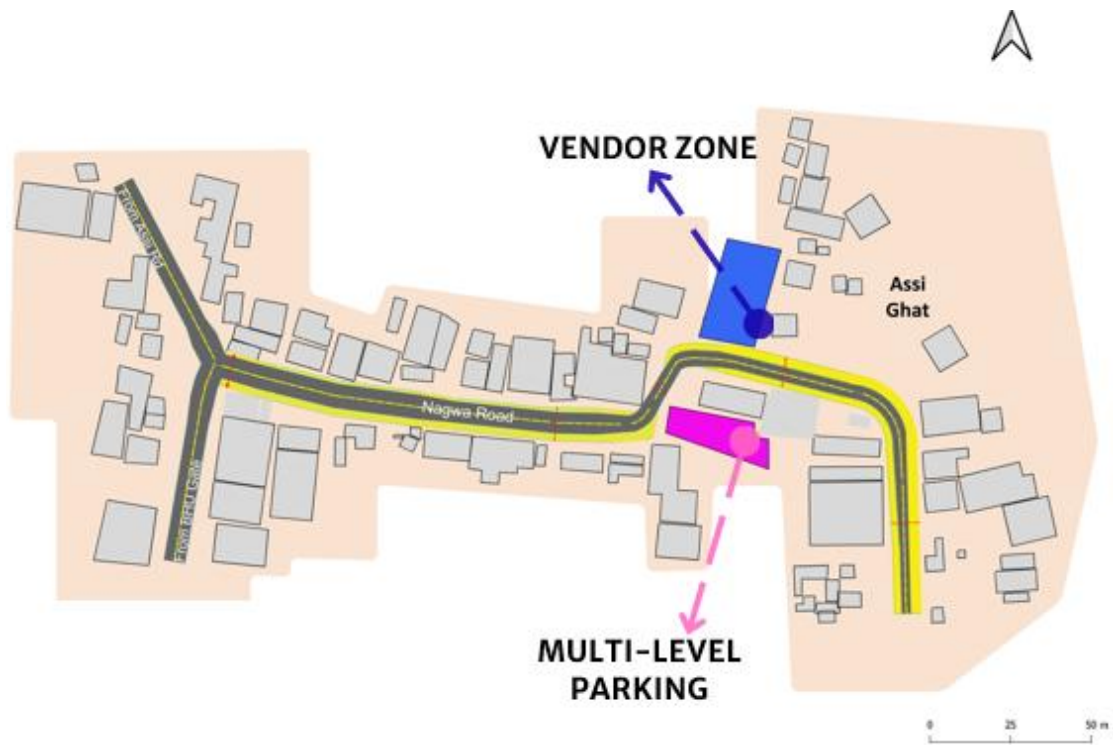


Fig. 6.2: Proposal 2 - Multi-Level Parking and Vendor Zone Concept Plan

Source 'Map prepared using AutoCad based on primary survey

6.3 Proposal 3: Time-Restricted NMT Zone

6.3.1 Concept

Proposal 3 introduces a Non-Motorized Transport priority zone over a 150 m core stretch from the bottleneck to the S-turn, by restricting vehicular movement and promoting pedestrian activity, while ensuring emergency accessibility at all times. The proposal is the long-term realization of the pedestrianization vision and is contingent on the prior implementation of Proposal 2.

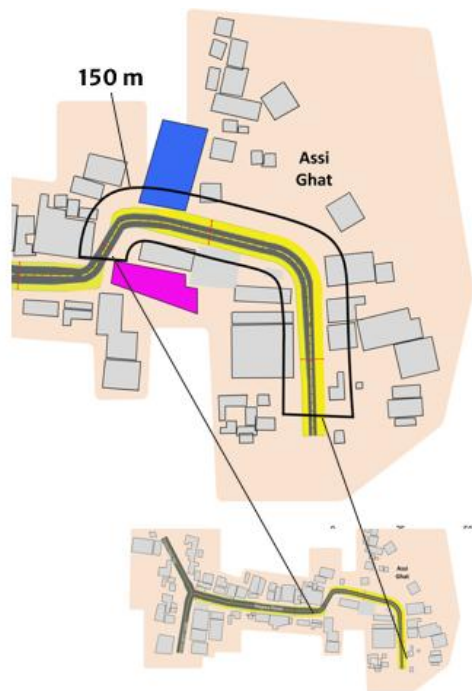


Fig. 6.2: Proposal 2 – Non-Motorized Zone Concept plan

Source Map prepared using AutoCad based on primary survey

6.3.2 Key Interventions

- Creation of a 150 m pedestrian and NMT priority corridor with shared-street paving at single level.
- Timed access control for vehicles during peak hours, with the daily access regime defined in Table 6.2.

- Provision of a dedicated 3 m wide emergency access lane preserved at all times within the shared street profile.
- Installation of entry and exit control points with retractable bollards and clear signage in Hindi and English.
- Development of shared street design with same-level paving across the full ROW, eliminating kerbs to communicate the pedestrian-priority regime.
- Enhancement of street furniture, lighting, and wayfinding consistent with the heritage palette.

6.3.3 Time-Based Access Plan

Time Window	Access Regime
05:00 to 10:00	Pedestrian and NMT zone (no motorized except emergency)
10:00 to 16:00	Mixed traffic, one-way, low-speed (15 kmph)
16:00 to 22:00	Pedestrian and NMT zone (no motorized except emergency)
22:00 to 05:00	Mixed traffic, one-way (loading and replenishment)

Table 6.2: Proposal 3 - Time-Based Access Plan

Source: modelled on Chandni Chowk timed-access regime.

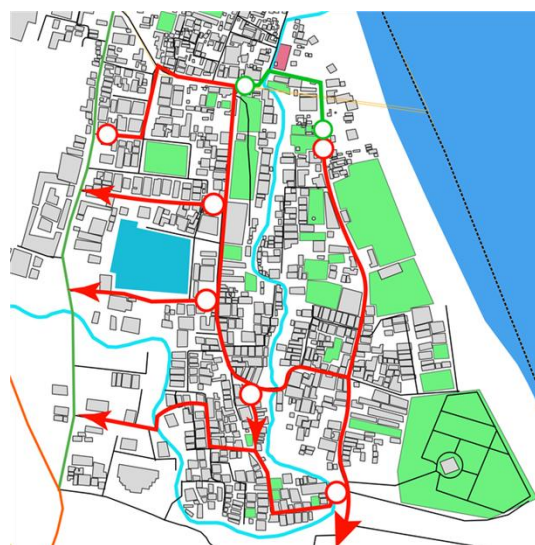


Fig. 6.3: Proposal 3 – Route Plan for proposal 3

6.3.4 Impact, Cost, and Feasibility

The expected impact includes a safe and comfortable pedestrian environment, the promotion of walkability and local economy, heritage-sensitive street design, and a reduction in pollution and noise consistent with the Slovenska Street benchmark of 70 percent black carbon reduction. Implementation cost is moderate (estimated at Rs 8 to 12 crore for the 150 m stretch, principally paving, bollards, lighting, and signage). Feasibility is medium, contingent on Proposal 2 being operational. The implementation horizon is long-term, 3 to 5 years.

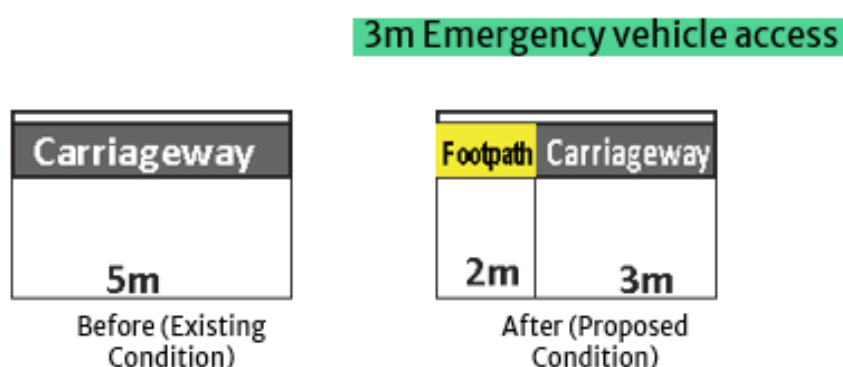


Fig. 6.4: Proposal 3 - 150 m NMT Zone Layout with Emergency Access Lane

6.4 Integrated Implementation Strategy

The three proposals are designed to be implemented sequentially, with each phase preserving the option to proceed to the next. The phased schedule is summarized in Table 6.3.

Phase	Horizon	Components	Lead Agency
Phase 1	0 to 1 year	Proposal 1: Street rationalization, vending bays, no-parking	Varanasi Nagar Nigam + VSCL
Phase 2	1 to 3 years	Proposal 2: MLP, formal vendor zone, last-mile NMT	VDA + VSCL + PPP

Phase	Horizon	Components	Lead Agency
Phase 3	3 to 5 years	Proposal 3: 150 m NMT zone, time-based access, shared street	Varanasi Nagar Nigam + Police
Phase 4	Continuous	Monitoring, enforcement, vending plan review	VSCL + Town Vending Committee

Table 6.3: Phased Implementation Schedule

Indicative cost and funding sources are summarized in Table 6.4. The total programme cost is estimated in the range of Rs 50 to 68 crore over five years, of which approximately 40 percent can be funded through Smart City Mission allocations, 25 percent through AMRUT 2.0, 20 percent through PPP for the MLP, and the balance through Varanasi Nagar Nigam capital budget and state grants.

Phase	Indicative Cost (Rs Crore)	Funding Source
Phase 1	4 to 6	Smart City Mission, Nagar Nigam
Phase 2 (MLP)	35 to 45	PPP, AMRUT 2.0
Phase 2 (vendor zone)	3 to 5	Smart City Mission, DAY-NULM
Phase 3	8 to 12	Smart City Mission, Heritage City Mission
Total	50 to 68	Blended

Table 6.4: Indicative Cost and Funding Sources

Source: estimation based on comparable Smart City project budgets.

6.0A Design Standards and Cross-Section Logic

The cross-section logic underlying the three proposals is grounded in the MoHUA Street Design Guidelines 2016 and IRC 103-2012. The reference urban street profile for a mixed-use corridor of the Nagwa-Assi type prescribes the following minimum widths: pedestrian through-zone 1.8 m, frontage zone 0.5 m, kerb buffer 0.3 m, vendor bay where present 0.7 to 1.2 m, motorized traffic lane 3.0 m (single direction at 15 to 20 kmph design speed). For two-way operation under Proposal 1, the corridor would

require a total ROW of approximately 9.5 to 11.0 m, which exceeds the available 5 to 8 m at multiple sections. This confirms that Proposal 1 alone cannot deliver the full reference standard and reinforces the case for Proposals 2 and 3.

6.1A Proposal 1: Detailed Element Inventory

6.1A.1 Footpath Construction

Continuous footpath of 1.8 to 2.5 m clear width, surface in 50 mm thick Chunar sandstone slabs over a 100 mm cement-stabilized base. Tactile paving strip (300 mm wide) along the inner edge throughout. Kerbs in grey granite, 150 mm height with 1:12 ramps at all access points. Tree pits at 8 to 10 m intervals, 1.2 m by 1.2 m, with permeable grating.

6.1A.2 Vending Bay Design

Designated vending bays of 0.7 to 1.0 m depth, set back from the pedestrian through-zone, located at intervals of approximately 30 m. Each bay is provisioned with shared electrical outlet, water tap, and waste collection point. Total of approximately 36 designated bays across the 300 m segment, covering all 41 currently inventoried units with modest expansion capacity.

6.1A.3 Drainage and Utilities

Covered drainage channel of 300 by 400 mm cross-section running below the inner footpath line on both sides, connected to the existing municipal storm drainage at the Lanka end and the Assi Ghat outfall. Separate ducting for electrical (LT and HT), telecom, fibre optic, and ICT cables in a 600 by 600 mm trench below the carriageway centreline. All utilities accessible through manholes at 30 m intervals.

6.1A.4 Lighting

Pedestrian-scale LED street lighting at 6 m height, 15 m intervals, in heritage-style cast-iron poles. Colour temperature 3000 K (warm white) consistent with heritage character. Average illuminance 20 lux on the carriageway, 10 lux on the footpath, with vertical illuminance of at least 5 lux on faces at 1.5 m height for security. Smart-city ICT integration with motion-responsive dimming during low-occupancy periods.

6.1A.5 Furniture and Wayfinding

Sandstone benches at every 40 m, in heritage-style design with timber seat slats. Bins (segregated wet and dry) at every 60 m. Drinking water points at three locations along the 300 m segment. Wayfinding totems in Hindi and English (with QR-code interpretation in additional languages) at the BHU Gate, Open Hand Cafe area, S-turn, and Assi Ghat entrance.

6.2A Proposal 2: MLP Detailed Specification

The proposed Multi-Level Parking facility is conceived at the entry node of the corridor, on a site of approximately 1,800 to 2,200 square metres of plot area. The facility is configured as four levels (basement plus three above-ground), with the following indicative capacity:

- Basement: 80 cars, 25 vans, electrical and BMS rooms.
- Ground floor: drop-off bay, e-rickshaw stand, formal vendor market (approximately 60 units), public toilets, ATM, drinking water points.
- First floor: 250 two-wheeler parking, electrical charging stations.
- Second floor: additional 120 two-wheeler parking, security control room, CCTV.
- Third floor (terrace): solar PV installation (estimated 80 to 120 kW peak capacity), green roof.

Vehicular access is from the Lanka-Nagwa connector, with one-way circulation. Pedestrian egress is at the ground floor, opening directly onto the pedestrianized corridor. The facility is integrated with smart parking management, with real-time occupancy display at the corridor entry and an app-based reservation option for visitors during peak festival days.

6.3A Proposal 3: Operational Protocol

The success of the time-restricted NMT zone depends on rigorous operational protocol. The recommended protocol is summarized below:

- Bollards: Retractable steel bollards at the two access points (corridor entry near MLP and corridor exit at Assi plaza). Operated by traffic police personnel

during shift changeovers (05:00, 10:00, 16:00, 22:00). Manual override available for emergency vehicles at all times.

- Signage: Static signage at all access points in Hindi and English, displaying the timed access regime. Variable Message Signs (VMS) for festival or emergency communications.
- Enforcement: One traffic constable on duty at each access point during transition windows. CCTV coverage at all access points, monitored from the VSCL Integrated Command and Control Centre.
- Resident exemption: Residents of inner-block households (approximately 80 households) and shop owners with documented inventory access need are issued time-limited e-passes, valid for the 22:00 to 05:00 access window only.
- Emergency override: All bollards designed for manual hydraulic lowering within 15 seconds. Direct radio link from the bollard control points to the nearest police station (Bhadaini) and fire station (Lanka).
- Festival protocol: For Dev Deepawali, Holi, Mahashivaratri, and Karthik Purnima, the access regime defaults to fully pedestrian for 24 hours from 04:00 of the festival day. Pre-positioned barricades and additional police personnel.

6.5 Risk Register and Mitigation

The phased implementation carries identifiable risks that must be addressed in advance.

- Vendor displacement risk: mitigation through Town Vending Committee process, designated bays under Proposal 1, formal vendor zone under Proposal 2, and explicit livelihood guarantee in the project agreement.
- Resident pushback on access restriction: mitigation through phased implementation, e-pass system, sustained communication, and demonstrated benefits from Proposal 1 before Proposal 3.
- Emergency access compromise: mitigation through dedicated 3 m emergency lane, manual override at bollards, and pre-positioned emergency response capability.
- Enforcement failure: mitigation through CCTV-based detection, automated penalty issuance, and integration with the VSCL ICCC.

- Funding shortfall: mitigation through phased budget release, blended funding sources, and PPP for the MLP component.
- Climate and flood risk: mitigation through elevated paving above expected high-water-mark, robust drainage design, and emergency closure protocol during monsoon flood events.
- Heritage damage during construction: mitigation through heritage impact assessment, vibration monitoring near sensitive structures, and conservation specialist supervision.

6.6 Monitoring and Evaluation Framework

A monitoring framework is recommended to track the performance of the implemented interventions against baseline. The framework comprises five indicator clusters:

- Mobility: peak-hour PCU, V/C ratio, LOS, mean walking speed, pedestrian conflict count.
- Environment: PM 2.5, PM 10, black carbon at three monitoring stations; surface temperature; tree canopy cover.
- Economy: rental and capital values along corridor frontage; reported business turnover (sample); vendor unit count and revenue (sample).
- Social: pedestrian satisfaction survey (annual); reported safety incidents; gender disaggregation of users.
- Heritage: facade condition audit (biennial); visitor experience rating; heritage signage compliance.

Baseline values are established by the primary survey of February to March 2026 documented in this thesis. The monitoring framework is recommended to be operated by VSCL through a dedicated cell, with annual public reporting.

6.7 Before-After Visualization Description

The expected transformation under the three proposals can be described in narrative form for each of the four sub-areas of the corridor.

6.7.1 BHU Gate Junction: Before-After

Before: Unsignalized junction with three converging streams, no pedestrian phase, encroached footpath, parked two-wheelers occupying the kerbside, vendor carts at the corner. Effective walking width below 1 m. Pedestrian-vehicle conflict approximately 12 medium and 3 high incidents per peak hour. After (Phase 1): Signalized junction with dedicated pedestrian phase, raised pedestrian crossings on three approaches, bollard-protected footpath with 2.5 m clear width, vendor carts relocated to designated bays, two-wheeler parking removed and signed. Expected reduction in pedestrian conflict to under 3 medium per peak hour.

6.7.2 Mid-block Bottleneck: Before-After

Before: 5 m carriageway with no separated footpath, bidirectional motorized traffic, vendor carts on both sides, encroached shopfront extensions. Effective walking width approaching zero during peak. After (Phase 3): 5 m shared-street profile at single level with sandstone paving, vehicles excluded during 05:00 to 10:00 and 16:00 to 22:00, 3 m emergency lane preserved, vendor bays at periphery, bollards at access points, pedestrian-scale lighting. Expected pedestrian capacity 3,500 to 4,500 per hour at comfort density.

6.7.3 S-turn Approach: Before-After

Before: Limited sight distance, no speed control, mixed traffic, fragmented footpath. After (Phase 1 with Phase 3 overlay): Speed table at the S-turn apex, raised pedestrian crossing, mirror placement for sight line improvement, continuous 1.8 m footpath, tree canopy planting. Expected reduction in mean motorized speed from 25 to 30 kmph to under 15 kmph during permitted hours, and to zero during pedestrian-only windows.

6.7.4 Assi Ghat Plaza: Before-After

Before: Convergence point with parking encroachment, dispersed vending, no clear pedestrian flow line, congested during Aarti. After (Phase 2 and Phase 3): Full pedestrianization with formal vendor zone relocated to MLP ground floor, dedicated drop-off bay outside the plaza, continuous sandstone paving, heritage signage and interpretation, protected viewing zones for the Aarti, and improved access to the ghat steps. Expected pedestrian throughput at the plaza of 6,000 to 8,000 persons per hour during the Aarti window at safe density.

6.8 Comparison with Reference Standards

The proposals are evaluated against the reference standards in Table 6.5.

The MoHUA Street Design Guidelines 2016 reference profile for a Tier-2 mixed-use heritage corridor recommends: pedestrian through-zone of 1.8 m minimum (proposal delivers 1.8 to 2.5 m, compliant); furniture zone of 0.5 to 0.8 m (proposal delivers 0.7 m, compliant); vending zone where present of 0.7 to 1.5 m (proposal delivers 0.7 to 1.0 m, compliant); motorized lane of 3.0 m at 15 to 20 kmph design speed (proposal delivers 5 to 7 m two-way under Proposal 1, time-shared single direction under Proposal 3); cycle track of 2.0 m where right-of-way permits (proposal accommodates cycles in shared street under Proposal 3, no dedicated cycle track due to ROW limitation). The proposals are compliant with the MoHUA reference for pedestrian and furniture provisions, and adapt the motorized provision to the constrained ROW.

6.9 Sustainability and Climate Considerations

The proposals contribute to climate resilience through three pathways. First, the modal shift from private motorized to walking and NMT delivers a direct reduction in transport CO₂ emissions for the corridor catchment, conservatively estimated at 8 to 12 percent reduction in catchment-level transport emissions based on the displaced and mode-shifted trip volumes. Second, the tree canopy and permeable paving provisions deliver micro-climate cooling, with anticipated 2 to 4 degrees Celsius reduction in summer afternoon surface temperatures along the corridor. Third, the solar PV installation on the MLP terrace under Proposal 2 delivers 80 to 120 kW peak generation capacity, sufficient to power the corridor lighting, the bollards, and the MLP common services, reducing grid dependence by approximately 60 percent.

The proposals also enhance flood resilience. The covered drainage channel under Proposal 1 has a design capacity equivalent to a 25-year return-period rainfall event, substantially exceeding the existing open-drain capacity. The elevated paving profile, set 150 to 200 mm above the existing carriageway level, reduces the incidence of waterlogging at the lower end of the corridor. The integrated storm drainage outfall to the Assi Ghat outflow channel is designed for the 50-year return-period event consistent with the IS 875 (Part 3) wind and rain loading standards.

6.10 Communication and Stakeholder Engagement Plan

A communication and stakeholder engagement plan is recommended to accompany the implementation of each phase. The plan comprises five components: (i) public information campaign through banners, social media, and the Varanasi Smart City app, communicating the access regime, the parking arrangements, and the operational hours; (ii) ward-level public consultation meetings, conducted before the start of each phase and at three-monthly intervals during construction; (iii) shopkeeper and vendor engagement through the Bhadaini ward office and the Town Vending Committee, with explicit livelihood guarantees; (iv) pilgrim and tourist information through interpretation panels at the BHU Gate, Lanka, and Assi Ghat entry points, supported by QR-coded multilingual content; (v) feedback mechanism through a dedicated grievance helpline and online portal, monitored by VSCL.

The communication plan is essential to the success of the time-restricted regime under Proposal 3, where compliance depends on user understanding of the access windows. International experience indicates that a sustained 6 to 12 month communication effort is required to establish full behavioural compliance, after which the regime becomes largely self-enforcing.

CHAPTER 7

CONCLUSION AND RECOMMENDATIONS

7.0 Summary of Findings

This thesis has examined the planning and design conditions for a pedestrian-focused non-motorized zone in the Nagwa-Assi corridor of Varanasi. The empirical findings establish that the corridor presently operates beyond its design capacity (V/C 1.02, LOS F on Sundays) while serving a movement profile in which pedestrians and bicycles together account for 47.1 percent of total raw flow. Geometric audit confirms that effective walking width approaches zero at the mid-block bottleneck, and conflict mapping indicates that approximately 70 percent of recorded incidents involve pedestrians.

Three case studies (Chandni Chowk, Heritage Street Amritsar, and Slovenska Street Ljubljana) demonstrate that pedestrianization, executed with appropriate attention to access management, heritage discipline, and complementary infrastructure, delivers measurable environmental, economic, and social benefits. The specific design responses appropriate to the Nagwa-Assi context have been advanced as three sequentially compatible proposals operating at short, medium, and long horizons.

7.1 Recommendations

Based on the analysis, the following recommendations are advanced:

- Immediate (0 to 6 months): Statutory declaration of No-Parking Zones along the bottleneck stretches; constitution of a Town Vending Committee for Ward 54 under the Street Vendors Act 2014; preparation of a detailed project report (DPR) for Proposal 1.
- Short-term (6 to 12 months): Implementation of Proposal 1 covering footpath continuity, vending bays, drainage, and street furniture; commissioning of Origin-Destination surveys to refine the parking demand estimate for the MLP.

- Medium-term (1 to 3 years): Land acquisition and PPP procurement for the MLP; development of the formal vendor market; phased relocation of informal vendors with livelihood guarantees.
- Long-term (3 to 5 years): Implementation of the time-restricted NMT zone over the 150 m core; commissioning of an air quality and footfall monitoring system; periodic review and adaptive adjustment of the access regime.
- Continuous: Heritage facade incentive scheme for private property owners; integration of the corridor with the broader Varanasi NMT network including the Subah-e-Banaras pedestrian-priority routes.

7.2 Scope for Further Research

Four areas merit further research. First, longitudinal monitoring of air quality and footfall before and after each phase of implementation, to provide an evidence base for similar pedestrianization projects in tier-II Indian cities. Second, behavioural research on compliance with time-based access regimes in Indian sacred precincts, given the limited prior literature. Third, economic impact assessment of pedestrianization on adjacent residential and commercial property values, to test the transferability of the Amritsar findings. Fourth, integration of pedestrianization with riverfront regeneration, given the proximity of the corridor to the Assi Ghat and the broader Varanasi ghat system.

The Nagwa-Assi corridor offers an ideal site for these inquiries. Its scale is tractable, its conditions are representative, and the political and institutional commitment to its improvement, channelled through the Smart Cities Mission and the Varanasi Master Plan 2031, provides a credible implementation pathway. The pedestrianization of this corridor will not only restore a humane public realm to one of Varanasi's principal sacred approaches but will also contribute a transferable methodology to the wider field of heritage urban design in India.

7.3 Chapter-wise Synthesis

A chapter-wise synthesis of the principal findings is presented below to consolidate the trajectory of the thesis.

7.3.1 Chapter 1 Synthesis

Chapter 1 established the policy, urban, and academic context for the thesis. The Nagwa-Assi corridor was identified as a representative case of the heritage-mobility conflict in Indian historic cities, characterized by high pedestrian volumes, constrained right-of-way, mixed land use, and the absence of formal management of vending and parking. The thesis aim was articulated as the development of a comprehensive planning and design framework for a pedestrian-centric NMT zone, operationalized through four objectives covering mobility, heritage, environment, and economy.

7.3.2 Chapter 2 Synthesis

Chapter 2 reviewed the conceptual and policy literature, establishing that pedestrianization is a well-developed urban design tradition with quantified outcomes in the European context and emerging precedents in the Indian context. The Indian policy framework, anchored in the National Urban Transport Policy 2014, the MoHUA Street Design Guidelines 2016, and the Smart Cities Mission, provides the institutional warrant for pedestrianization in heritage cores. The Indian Roads Congress technical standards (IRC: 103, 70, 99, 86) provide the design framework. Four research gaps were identified, three of which are addressed in this thesis.

7.3.3 Chapter 3 Synthesis

Chapter 3 reviewed three case studies covering the heritage-commercial (Chandni Chowk), sacred-precinct (Heritage Street Amritsar), and arterial-conversion (Slovenska Street Ljubljana) typologies. The seven design principles synthesized from the cases informed the proposals advanced in Chapter 6. The differences between the case study contexts and the Nagwa-Assi context, particularly in scale, climate, and modal composition, were also identified to ensure context-appropriate adaptation rather than direct transplantation.

7.3.4 Chapter 4 Synthesis

Chapter 4 profiled the study area at city, ward, and corridor scales. Varanasi was characterized as a tier-II city with a dense historic core and a mixed economic base, in which the Assi Ghat precinct functions as a major sacred-cultural destination. Ward 54 (Bhadaini) was profiled with respect to demographics, land use, transport

infrastructure, climate, and stakeholder composition. The four sub-areas of the corridor were characterized in terms of dominant function and frontage character.

7.3.5 Chapter 5 Synthesis

Chapter 5 presented the primary survey data and the analytical findings on capacity, modal split, conflict points, geometric condition, vending profile, air quality, and noise. The corridor was found to operate at LOS F on Sundays with V/C 1.02, with pedestrians and bicycles together accounting for 47.1 percent of total raw movement. Five high-conflict points were identified and characterized. PM 2.5 levels were found to exceed the standard by a factor of 2.4 to 2.8 during peak windows. Female and elderly users reported disproportionate experience deficits.

7.3.6 Chapter 6 Synthesis

Chapter 6 advanced three integrated proposals operating at short, medium, and long horizons. Proposal 1 (street rationalization) restructures the right-of-way for pedestrian primacy under existing access regime. Proposal 2 (MLP and vendor zone) decongests the core through off-street parking and formalized vending. Proposal 3 (time-restricted NMT zone) implements pedestrian priority over the 150 m core stretch with preserved emergency access. The three proposals are sequentially compatible and collectively responsive to the seven core issues identified in Chapter 5.

7.3.7 Chapter 7 Synthesis

Chapter 7 consolidates the findings, advances recommendations across immediate, short-term, medium-term, long-term, and continuous horizons, and identifies four areas for further research. The recommendations are structured to be actionable by the immediate civic audience while contributing transferable methodology to the broader academic and policy audiences.

7.4 Implementation Roadmap

The recommendations are translated into an implementation roadmap with clear ownership, deliverables, and time-bound milestones.

- Months 1 to 6 (Foundation): Constitution of Town Vending Committee for Ward 54; statutory No-Parking declaration; preparation of DPR for Proposal 1; stakeholder consultation rounds 1 and 2.
- Months 6 to 12 (Phase 1 execution): Tender and award of Proposal 1 works; phased construction starting with the BHU Gate junction and progressing eastward; vendor enumeration and bay allocation; commissioning of monitoring baseline.
- Months 12 to 24 (Phase 2 preparation): Land identification and acquisition for MLP; PPP procurement; environmental and heritage impact assessment; preparation of MLP architectural and engineering drawings.
- Months 24 to 36 (Phase 2 execution): MLP construction; concurrent vendor zone construction; commissioning of last-mile NMT and e-rickshaw services; pre-opening communication campaign.
- Months 36 to 48 (Phase 3 preparation): Detailed design of NMT zone; bollard procurement; signage design; communication campaign for time-restricted regime; pilot operation on weekends.
- Months 48 to 60 (Phase 3 execution): Full pedestrianization of 150 m core; bollard installation and commissioning; full enforcement protocol activation; first-year monitoring and adjustment.
- Continuous: Quarterly stakeholder review; annual public reporting; biennial heritage facade audit; ongoing maintenance and adaptive management.

7.5 Critical Success Factors

The successful implementation of the proposed framework depends on the alignment of five critical success factors, each of which has been observed to determine outcomes in comparable Indian and international interventions.

- Political commitment: Sustained support from the elected ward representative, the city Mayor, and the state government. Pedestrianization typically requires 3 to 5 years of continuous political backing through one or more electoral cycles.
- Institutional coordination: Effective coordination between Varanasi Nagar Nigam, VSCL, VDA, the police, and the BHU institutional authority. The

proposed implementation cell, housed within VSCL with representation from each agency, is intended to deliver this coordination.

- Stakeholder buy-in: Acceptance by residents, shopkeepers, and vendors. The phased implementation approach, with Proposal 1 delivering visible benefits before the more disruptive Proposals 2 and 3, is designed to build stakeholder confidence.
- Technical quality: Design, construction, and operation to international quality standards. The reference to MoHUA Street Design Guidelines, IRC standards, and case study benchmarks provides the technical anchor.
- Sustained enforcement: Reliable enforcement of the access regime, the no-parking rules, and the vending zone allocation. Without sustained enforcement, all three proposals will regress to the baseline within 6 to 18 months.

7.6 Closing Reflection

The Nagwa-Assi corridor is a small project at the scale of the Indian urban transport problem, but it is a well-defined and tractable problem at the scale of a B.Plan thesis, and a representative one at the scale of the heritage urbanism challenge that confronts dozens of Indian cities. The thesis has aimed to produce, within the constraints of a single semester and a single student researcher, a piece of work that is technically sound, empirically grounded, contextually adapted, and immediately useful to the civic actors responsible for the corridor.

The Ganga at Assi Ghat is among the oldest continuously sacred sites in the world. The corridor that approaches it carries a corresponding weight of cultural significance, and the operational deficits documented in this thesis represent a failure not merely of urban management but of cultural stewardship. To restore the corridor as a humane, walkable, dignified approach to the river is not only a transport intervention or a heritage intervention; it is, in a deeper sense, a restoration of the relationship between the city and its sacred geography. This thesis offers a planning and design path towards that restoration.

7.7 Beneficiary Impact Estimates

The expected beneficiaries of the proposed interventions are estimated below for each phase, based on the catchment population, daily user volumes, and modelled mode-share effects.

Beneficiary Category	Phase 1	Phase 2	Phase 3	Cumulative
Daily resident pedestrians	1,200	1,800	2,400	2,400
Daily commuter pedestrians	8,000	12,000	16,000	16,000
Daily pilgrim/tourist pedestrians	8,000	10,000	12,000	12,000
Festival-day pedestrians (peak)	35,000	60,000	85,000	85,000
Vendor units (formalized)	20	55	55	55
Parking spaces (off-street, new)	0	330	330	330
Estimated jobs (construction, peak)	180	320	210	Phased
Estimated jobs (operations, ongoing)	12	45	55	55

Table 7.1: Beneficiary Impact Estimates by Phase

Source: Author estimates based on catchment data and mode-share modelling.

7.8 Concluding Statement

The pedestrianization of the Nagwa-Assi corridor is not a single intervention but a programme of mutually reinforcing interventions, sequenced over a five-year horizon and integrated with the broader trajectory of the Varanasi Smart City programme and the city's heritage conservation effort. The thesis has demonstrated, through primary survey evidence, comparative case study analysis, and design proposals grounded in national and international standards, that the programme is technically feasible, economically sound, and culturally appropriate.

The implementation of this programme requires the alignment of political will, institutional coordination, technical capacity, financial resources, and community

support. None of these conditions is automatic, and the recommendations advanced in this chapter are designed to address each. With sustained commitment over the five-year horizon, the Nagwa-Assi corridor can transition from its current state of operational stress and cultural compromise to a humane, walkable, dignified approach to one of India's most significant sacred sites, contributing in the process to the broader project of restoring the public realm of the historic Indian city.

CHAPTER -8

REFERENCES

- Appleyard D (1981), *Livable Streets*, University of California Press, Berkeley.
- Brand C, Dons E, Anaya-Boig E, Avila-Palencia I, Clark A, de Nazelle A, Gascon M, et al. (2021), The climate change mitigation effects of daily active travel in cities, *Transportation Research Part D: Transport and Environment*, Vol 93, p102764.
- Burra Charter (2013), *The Australia ICOMOS Charter for Places of Cultural Significance*, Australia ICOMOS, Burwood Vic.
- Census of India (2011), *District Census Handbook, Varanasi District*, Directorate of Census Operations, Uttar Pradesh.
- Cervero R and Kockelman K (1997), Travel demand and the 3Ds: density, diversity, and design, *Transportation Research Part D*, Vol 2(3), pp199-219.
- Clean Air Asia (2010), *Walkability in Indian Cities*, Better Air Quality Programme, Manila.
- Department for Transport (2010), *Manual for Streets*, 2nd ed., The Stationery Office, London.
- Gehl J (2010), *Cities for People*, Island Press, Washington DC.
- Goodwin P (1996), Empirical evidence on induced traffic, *Transportation*, Vol 23(1), pp35-54.
- Government of India (2014), *The Street Vendors (Protection of Livelihood and Regulation of Street Vending) Act, 2014*, Ministry of Housing and Urban Poverty Alleviation, New Delhi.
- Government of India (2014), *National Urban Transport Policy*, Ministry of Urban Development, New Delhi.
- Government of India (2016), *The Rights of Persons with Disabilities Act, 2016*, Ministry of Social Justice and Empowerment, New Delhi.
- Indian Roads Congress (1972), *IRC: 9-1972, Traffic Census on Non-Urban Roads*, IRC, New Delhi.
- Indian Roads Congress (1990), *IRC: 106-1990, Guidelines for Capacity of Urban Roads in Plain Areas*, IRC, New Delhi.
- Indian Roads Congress (2012), *IRC: 103-2012, Guidelines for Pedestrian Facilities*, IRC, New Delhi.
- Indian Roads Congress (2017), *IRC: 70-2017, Guidelines on Regulation and Control of Mixed Traffic in Urban Areas*, IRC, New Delhi.
- Indian Roads Congress (2018), *IRC: 86-2018, Geometric Design Standards for Urban Roads in Plains*, IRC, New Delhi.

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- Indian Roads Congress (2018), IRC: 99-2018, Guidelines for Traffic Calming Measures in Urban and Rural Areas, IRC, New Delhi.
- Jacobs J (1961), The Death and Life of Great American Cities, Random House, New York.
- Ministry of Housing and Urban Affairs (2016), Street Design Guidelines, MoHUA, Government of India, New Delhi.
- Ministry of Housing and Urban Affairs (2021), Harmonised Guidelines and Standards for Universal Accessibility in India, MoHUA, Government of India, New Delhi.
- Ministry of Road Transport and Highways (2023), Road Accidents in India 2022, Transport Research Wing, MoRTH, New Delhi.
- NACTO (2013), Urban Street Design Guide, National Association of City Transportation Officials, Washington DC.
- Project for Public Spaces (2008), What Makes a Successful Place, [online]. www.pps.org (Accessed on 20 March 2026).
- Real Estate Dekho (2025), Heritage Street Amritsar: Property Price Trends 2023-2025, [online]. <https://realestatedekho.com> (Accessed on 18 March 2026).
- Shahjahanabad Redevelopment Corporation (2022), Chandni Chowk Redevelopment Project: Final Report, SRDC, Government of NCT of Delhi.
- UNESCO (2011), Valletta Principles for the Safeguarding and Management of Historical Cities, Towns and Urban Areas, ICOMOS, Paris.
- Urban Design Lab (2022), Chandni Chowk Redevelopment: A Critical Review, [online]. www.urbandesignlab.in (Accessed on 12 March 2026).
- Varanasi Development Authority (2021), Varanasi Master Plan 2031, VDA, Varanasi.
- Varanasi Smart City Limited (2023), Area-Based Development Plan: Assi Ghat Precinct, VSCL, Varanasi.
- Whyte W H (1980), The Social Life of Small Urban Spaces, Conservation Foundation, Washington DC.
- World Health Organization (2018), Global Status Report on Road Safety 2018, WHO, Geneva.

CHAPTER -9**ANNEXURES****Annexure A: Pedestrian Intercept Survey Questionnaire**

The pedestrian intercept survey was administered at four stations across the corridor between 18:00 and 20:00 on 28 February and 1 March 2026. A total of 142 respondents were surveyed using stratified random sampling. The questionnaire covered demographic profile, trip origin and destination, mode of arrival, purpose of visit, perceived safety, and willingness to pay for improved infrastructure.

Sample question categories included: (i) demographic - age, gender, education, occupation, monthly household income; (ii) trip - origin, destination, mode, frequency, time taken; (iii) experience - rating of footpath quality, lighting, vending, safety on a 5-point Likert scale; (iv) preference - top three improvements desired in the corridor; (v) willingness to pay - acceptability of paid parking at MLP entry, expected charge band.

Annexure B: Vendor Profile Survey Questionnaire

The vendor profile survey was administered to a complete enumeration of 41 vending units identified along the 300 m study segment. The questionnaire captured the type of goods or services, years of operation at the current location, average daily turnover, source of supply, working hours, dependence of the household on vending income, and willingness to relocate to a designated vending bay or formal vendor market.

Annexure C: Traffic Volume Count Tally Sheet (Sample)

A sample TVC tally sheet for Station S1 (Nagwa-BHU Gate junction) on Sunday 1 March 2026, peak hour 18:00 to 19:00, is reproduced below in summary form. The complete set of 36 tally sheets (3 days x 4 stations x 3 peak windows) is retained in the author's records and is available on request.

15-min interval	Cars	2W	Vans	Auto/E-rick	Cycle	Pedestrians
18:00-18:15	48	271	12	152	104	418

15-min interval	Cars	2W	Vans	Auto/E-rick	Cycle	Pedestrians
18:15-18:30	51	286	13	168	112	446
18:30-18:45	49	290	13	162	118	461
18:45-19:00	46	277	12	132	104	412
Total (peak hr)	194	1,124	50	614	438	1,737

Annexure C.1: TVC Tally Sample - Station S1, Sunday Peak Hour

Source: Author primary survey, 1 March 2026.

Annexure D: Photographic Documentation

Photographic documentation of the corridor was undertaken on 27 and 28 February 2026 covering the full 300 m study segment from the BHU Gate junction to the Assi Ghat entrance, with attention to bottleneck conditions, vending clusters, parking encroachment, and pedestrian movement during the evening peak. Selected photographs are integrated within the body of Chapter 5 in the visual mapping figure.

Annexure E: List of Stakeholder Consultations

Key informant interviews were conducted with stakeholders representing local residents, shopkeepers, vendor associations, the Varanasi Nagar Nigam ward office, the Varanasi Smart City Limited project office, and the Bhadaini police thana. The full list of 14 consultation meetings is summarized below in chronological order, with names withheld for privacy.

Date	Stakeholder	Topic
12 Feb 2026	VSCL Project Officer	Smart City pedestrianization plans for Assi
18 Feb 2026	Bhadaini Ward Member	Resident concerns and political feasibility
20 Feb 2026	Vendor Association rep	Livelihood concerns and willingness to relocate

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Date	Stakeholder	Topic
22 Feb 2026	Bhadaini Police SHO	Traffic enforcement and parking violations
25 Feb 2026	Local hotelier (Assi)	Tourist movement patterns
27 Feb 2026	Cycle-rickshaw association	Modal role and concerns
28 Feb 2026	Shopkeepers (8 individuals)	Effect of vehicle restriction on trade
02 Mar 2026	Resident Welfare Association	Long-term acceptability of access regime

Annexure E.1: Stakeholder Consultation Schedule