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Women's Safety in Heritage Area: A Geospatial and Perception-Based Study of Urban Heritage and Security

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Abstract: This research investigates the multi-dimensional concerns surrounding women's safety in Heritage Areas of Delhi, through a detailed mixed-method study incorporating geospatial analysis, stakeholder surveys, and urban policy review. As one of the densest and historically significant urban quarters in India, Heritage Areas of Delhi s urban morphology presents both opportunities and challenges to gendered safety. Utilizing data from 400 structured surveys across residents, shopkeepers, and tourists, the study analyses how built environment factors, artificial intelligence (AI)-enabled urban monitoring tools, and heritage governance mechanisms interact to affect women's perception of safety. The results highlight uneven spatial safety, limited access to amenities, and a marginalization of women's voices in heritage-driven urban renewal, advocating for a participatory, culturally responsive approach to digital planning.

Special Issue on Spatial Intelligence for Cultural Heritage • GeoAl and GIS technologies for advanced spatial analysis in cultural heritage management• Cultural landscape analysis using Al-enabled geospatial tools

Keywords: Women's safety, heritage planning, AI in urban governance, spatial analysis, participatory planning, gender-inclusive design, Old Delhi, built environment, cultural landscape

INTRODUCTION

1.1 Background: Women's Safety in Heritage Areas and the Advent of AI

Heritage areas are complex cultural landscapes shaped by centuries of social, religious, and architectural evolution. These historic cores are not only tourist attractions but also dense living environments, often characterized by narrow lanes, overcrowded bazaars, poor lighting, and inadequate civic amenities. Such spatial and infrastructural deficiencies make them particularly unsafe for women, especially during non-peak hours. Studies show that built environment factors—including visibility, access control, crowding, and street lighting—are critical in influencing women's perceived and actual safety in urban heritage settings ([2]; [4]).

Despite increasing recognition of the importance of gender-inclusive planning, women's safety in historic precincts is frequently overlooked in conservation and urban renewal efforts. Heritage-focused policies tend to prioritize physical restoration over everyday usability and safety for local women. This gap becomes especially acute in informal or organically developed heritage quarters, where traditional forms of surveillance (community networks, mixed-use vibrancy) have eroded without being replaced by effective modern interventions [1].

Concurrently, artificial intelligence (AI) has emerged as a transformative tool in urban governance, enabling real-time mapping, predictive crime analysis, and infrastructure monitoring. In smart cities, AI applications are increasingly used to optimize mobility, detect encroachments, and manage public services. However, their deployment in heritage areas often remains technical in focus—detached from the socio-cultural complexities and safety experiences of vulnerable groups. Critics argue that algorithmic planning can reinforce biases by overlooking invisible forms of gendered vulnerability and privileging formalized, high-visibility interventions [3].

This research investigates how the integration of AI-based spatial technologies intersects with women's safety concerns in Shahjahanabad. It seeks to examine whether digital planning tools can be adapted to address everyday insecurities faced by women in dense heritage landscapes, and how local perceptions and lived experiences can inform more inclusive and responsive urban heritage governance.

1.2 Need of the Study

Despite extensive research on urban safety and heritage conservation, the intersection of gender-sensitive planning and artificial intelligence (AI) in historic city cores remains significantly underexplored. In areas like Shahjahanabad—Delhi's oldest living city—the challenges of ensuring women's safety are compounded by narrow alleyways, overcrowded bazaars, lack of surveillance, and insufficient sanitation infrastructure. These issues are further amplified by the area's unplanned growth and the fragile nature of heritage conservation regulations.

Traditional safety interventions, such as increased policing or static lighting improvements, often fail to account for spatial-temporal variations in women's mobility patterns and overlook critical socio-cultural nuances. While AI-driven tools like GIS-based heat maps, predictive crime analytics, and smart surveillance systems offer promising innovations in urban governance (Zhang et al., 2020; [10]), they have yet to be meaningfully adapted to heritage precincts like Shahjahanabad, where the complexity of informal economies, layered land-use, and community traditions challenge standardized interventions.

Moreover, existing AI systems often suffer from data bias, lack of transparency, and insufficient stakeholder inclusion—especially of women and marginalized groups ([3]; [2]). As such, without critical evaluation and participatory design, AI in heritage zones may inadvertently replicate inequities rather than solve them.

This study is therefore essential to:

- Bridge the gap between smart planning tools and gender equity in dense heritage precincts.
- Provide an empirical, spatial, and perception-based evaluation of women's safety in Shahjahanabad.
- Recommend a hybrid framework where AI enhances—not overrides—community knowledge, lived experience, and localized safety strategies.

By grounding the technological discourse in the real experiences of residents, shopkeepers, and tourists, this research seeks to foster inclusive innovation that safeguards both cultural identity and gendered urban well-being.

1.2 Research Questions

1. How can smart planning tools, particularly AI-driven technologies, be adapted to address gender equity challenges in dense heritage precincts like Shahjahanabad?
2. What are the spatial and perception-based determinants of women's safety in Shahjahanabad, and how do these vary across stakeholder groups (residents, shopkeepers, and tourists)?
3. What hybrid planning frameworks can integrate AI capabilities with community knowledge and lived experiences to improve women's safety in historic urban environments?

With the emergence of Artificial Intelligence (AI) in urban governance, new opportunities for mapping, monitoring, and managing urban change are emerging. Yet these technologies frequently overlook gender-specific safety metrics and fail to account for lived realities within

dense informal heritage settings. While existing studies on urban safety address crime mapping and spatial analysis ([5]; Rajan et al., 2023), few explicitly examine the intersection of AI-driven heritage planning and women's safety in culturally complex zones like Old Delhi. This study addresses that gap.

By integrating geospatial data, stakeholder perceptions, and AI-based governance review, this research aims to assess how technological tools and planning mechanisms shape women's experience of safety in Shahjahanabad. The paper argues for a hybrid framework where heritage conservation and digital planning are grounded in gender equity, participatory methods, and contextual awareness.

2. METHODOLOGY

This study adopted a triangulated mixed-methods approach, integrating spatial analysis, structured stakeholder surveys, and urban policy review, to evaluate the intersection of women's safety, heritage planning, and AI-enabled governance in Shahjahanabad, Delhi. The methodology was designed to assess both quantitative safety indicators and perception-based vulnerabilities, grounded in the lived experiences of residents, shopkeepers, and tourists across three heritage wards.

2.1 Study Area and Ward Selection

The study was conducted in three wards of Central Delhi—Chandni Chowk, Jama Masjid, and Civil Lines—within the Shahjahanabad precinct. These wards were selected based on:

- Contrasting morphological typologies: Chandni Chowk (unplanned commercial core), Jama Masjid (informal religious-residential area), and Civil Lines (planned colonial zone).
- Historical and governance relevance: All three fall within areas targeted for revitalization under the Shahjahanabad Redevelopment Corporation (SRDC) and MPD-2041 frameworks.
- Crime vulnerability and accessibility disparities, as indicated by Delhi Police data and prior urban safety studies.

Each ward represents a distinct urban condition—ranging from congestion and informality to planning-led isolation—allowing for comparative analysis across spatial and demographic spectra.

2.2 Sample Size and Sampling Technique

A stratified random sampling approach was used to ensure representation across stakeholder groups and gender categories. The total sample size was calculated using Cochran's formula for categorical data:

$$n_0 = \frac{Z^2 \cdot p(1-p)}{e^2}$$

Where:

- Z=1.96Z = 1.96Z=1.96 (Z-value for 95% confidence level),
- p=0.5p = 0.5p=0.5 (assumed population proportion for maximum variability),
- e=0.05e = 0.05e=0.05 (margin of error)

$$n_0 = \frac{(1.96)^2 \cdot 0.5(1-0.5)}{(0.05)^2} = 384.16$$

Rounded to 400 respondents, the sample was distributed as:

- 200 residents (across gender and age groups),
- 100 shopkeepers (including street vendors and formal establishments),
- 100 tourists/visitors (short-term users of public space)

Each ward received approximately equal representation (≈133 surveys), further stratified by age, gender, duration of stay, and type of urban interaction (residential/commercial/transient).

2.3 Survey Instrument and Data Collection

A structured questionnaire was developed comprising both Likert-scale and binary response formats, covering themes such as:

- General and time-specific safety perception
- Visibility and street lighting
- Availability and accessibility of CCTV, toilets, and help points
- Maintenance of public infrastructure (roads, sidewalks, parks)
- Use and trust in AI-based safety tools (e.g., Safetipin, GPS tracking)

The survey was pilot-tested and conducted both in-person and via digital forms, ensuring spatial tagging of responses through mobile-enabled location services for geospatial analysis.

2.4 Analytical Techniques

To quantify qualitative responses, the following index-based models were applied:

- Weighted Mean Score (WMS) to evaluate safety perception:

$$\text{WMS} = \frac{\sum(f_i \cdot x_i)}{\sum f_i}$$

Where xi = weight (Very Safe = 3, Somewhat Safe = 2, Not Safe = 1)

- Binary Weighted Frequency Index (BWFI) to assess infrastructure access (Yes/No):

$$\text{BWFI} = \frac{\text{Yes}}{\text{Yes} + \text{No}} \times 100$$

- Priority Weight Score (PWS) to rank user-identified maintenance issues:

$$\text{PWS}_j = \frac{n_j}{N} \times 100$$

These models enabled comparison across wards and themes, such as lighting adequacy, toilet access, and perception of safety.

2.5 Spatial and Geospatial Analysis

- Geospatial overlays were created using QGIS and ArcGIS, integrating:

- Satellite imagery
- Heritage zoning data (INTACH, SRDC)
- Infrastructure base layers (roads, metro lines, public facilities)
- Survey-linked coordinates of reported unsafe locations

- Hotspot Mapping: Locations with clustered safety concerns (e.g., Ballimaran, Nai Sarak, Urdu Bazaar, Magazine Road) were analyzed for overlapping infrastructural gaps and spatial risk indicators.
- GIS-based visualization was used to validate user-reported dark spots, dimly lit areas, and non-functional safety infrastructure.

2.6 Policy and AI Planning Review

To assess institutional responsiveness and the role of AI in current urban governance, a policy review was conducted covering:

- MPD-2041, especially heritage and safety provisions
- Safe City Project, Shishtachar Squads, and C4I frameworks
- AI-enabled tools such as Safetipin, mobile surveillance apps, and public grievance dashboards

This review focused on implementation gaps, lack of spatial granularity, and absence of gender-sensitive AI deployment in Shahjahanabad.

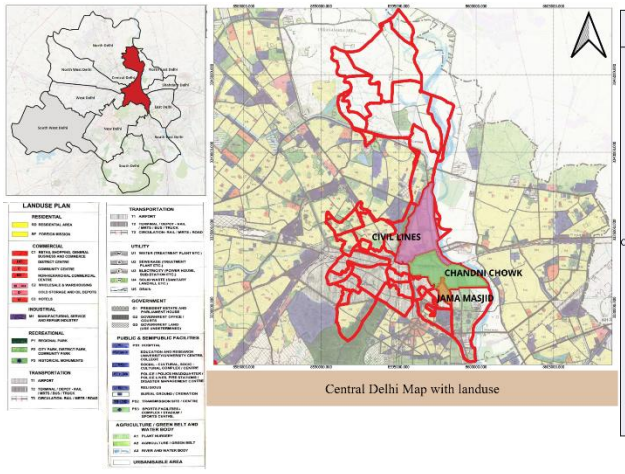
2.7 Limitations and Ethical Considerations

- Respondent anonymity and consent were ensured in line with IGDTUW research protocols.
- Tourist and transient user responses had variability based on visit timing and familiarity with area dynamics.
- Geospatial data was restricted to publicly available basemaps due to non-availability of high-resolution crime datasets at the ward level.

Despite these limitations, the methodology ensures high reliability, triangulation of data, and comparative validity across built environment types in Shahjahanabad.

3. CASE STUDY JUSTIFICATION: SELECTION OF CHANDNI CHOWK, JAMA MASJID, AND CIVIL LINES

The research focuses on three wards of Central Delhi—Chandni Chowk, Jama Masjid, and Civil Lines—as representative zones for evaluating women's safety in a heritage urban environment. These wards are located within the historical precinct of Shahjahanabad and were selected based on crime vulnerability data, built environment diversity, and their distinct morphological character as unplanned, informal, and planned areas, respectively. Together, they capture the full spectrum of urban conditions relevant to assessing AI-enabled safety frameworks in heritage contexts.



District	Sub Division	Ward No	Ward Name	Total Pop	Landuse	Housing Typology	Crime (Women Safety)
Central Delhi	Civil Lines	6	Burari	82,052	Residential	Unauthorized	Medium
		7	Kadipur	63,220	Residential	Unauthorized	Medium
		8	Mukundpur	82,666	Residential	Unauthorized	Medium
		9	Sant Nagar	77,412	Residential	Unauthorized	Medium
		10	Jharoda	59,744	Residential	Unauthorized	Low
	Timarpur	11	Timarpur	765,596	Residential	Unauthorized	Medium
		12	Mallika Ganj	70,204	Residential	Unauthorized	Medium
		13	Mukherjee Nagar	79,914	Residential	Unauthorized	Medium
	Kotwali	70	Shastri Nagar	76,930	Special Area	Mixed	High
		71	Kishan Ganj	71,842	Special Area	Mixed	High
		72	Sadar Bazar	69,783	Special Area	Mixed	High
	Chandni Chowk	73	Civil Lines	53,879	Special Area	Mixed	High
		74	Chandni Chowk	35,509	Special Area	Mixed	High
		75	Jama Masjid	62,214	Special Area	Mixed	High
	Matia Mahal	76	Chandani Mahal	49,995	Special Area	Mixed	High
		77	Delhi Gate	63,571	Special Area	Mixed	High
		78	Bazar Sita Ram	57,774	Special Area	Mixed	High
	Ballimaran	79	Ballimaran	56,090	Special Area	Mixed	High
		80	Ram Nagar	69,121	Special Area	Mixed	High
		81	Quraish Nagar	65,997	Special Area	Mixed	High
	Daryaganj	82	Pahar Ganj	67,390	Special Area	Mixed	High
		83	Karol Bagh	69,310	Special Area	Mixed	High
		84	Dev Nagar	62,079	Special Area	Mixed	High

Source: Census 2011, Election Commission Report, Delhi Police and NCRB Data

Figure 1 Mapping of 3 wards under central District: Civil Lines, Chandni chowk, Jama Masjid

Source: Author

3.1 Chandni Chowk (Unplanned Heritage Commercial Core)

Urban Form and Land Use: Chandni Chowk was originally a centrally-planned Mughal market designed by Jahanara Begum in the 17th century, with wide boulevards, water channels, and a ceremonial spatial layout [9]. However, centuries of commercialization and unregulated construction have transformed it into a high-density unplanned zone dominated by mixed-use retail, warehousing, and residential activity. Its inner lanes, such as Ballimaran and Dariba Kalan, are congested, encroached, and lacking clear pedestrian demarcations.

Connectivity and Infrastructure: Chandni Chowk is well-connected through the Yellow Line metro and arterial roads like Netaji Subhash Marg. Yet, interior connectivity is highly compromised due to the absence of motorable pathways and poor lighting. Emergency vehicle access is severely restricted in many parts.

Women's Safety Concerns: Survey results show that women feel highly unsafe, especially during festivals or late hours, due to crowding, narrow alleys, lack of toilet facilities, and minimal police visibility. Street harassment and pickpocketing are commonly reported [2]. Chandni Chowk has among the highest reported incidents of public-space harassment in Central Delhi (NCRB, 2023).

Planning Classification: Although part of a heritage zone, Chandni Chowk is classified as an unplanned mixed-use area under MPD-2021. The area's redevelopment has been attempted through façade restoration and pedestrianization projects, but these often ignore deeper gender and safety metrics (DUAC, 2017).

3.2 Jama Masjid (Dense Informal Religious-Residential Quarter)

Urban Form and Land Use: The Jama Masjid ward is characterized by organic, informal growth surrounding the 17th-century mosque built by Shah Jahan. It is one of the most densely populated wards, with a land use pattern dominated by residential, religious, and informal commercial activities. Narrow lanes, unauthorized constructions, and vending encroachments define the built environment.

Connectivity and Infrastructure: Despite metro connectivity via the Violet Line (Jama Masjid and Chawri Bazar stations), the internal street network is highly irregular. Pedestrian navigation is complicated by unclear signage, dead-ends, and blind corners, especially in sub-lanes like Sitaram Bazaar.

Women's Safety Concerns: Survey data reveals a high frequency of harassment in crowded religious and tourist areas, especially during weekends and public holidays. Over 90% of women report feeling unsafe using parks and public toilets, citing poor lighting, inadequate patrolling, and absence of emergency services (INTACH, 2004; DUSIB, 2019).

Planning Classification: Although not labeled a slum, Jama Masjid fits the planning characteristics of an informal settlement. It lacks proper zoning control, service infrastructure, and heritage-sensitive public space management. The Shahjahanabad Redevelopment Corporation has flagged this area for integrated improvement, but interventions have largely remained surface-level (SRDC, 2020).

3.3 Civil Lines (Planned Colonial Residential Zone)

Urban Form and Land Use: Developed during the British colonial period as an administrative a nd elite residential zone, Civil Lines has a planned gridiron layout, wider roads, and low building density. The land use is primarily institutional and residential, interspersed with green open spaces and colonial bungalows.

Connectivity and Infrastructure: The ward is well connected via Rajpur Road, NH-44, ISBT Ka shmere Gate, and the Yellow Line metro. Despite good arterial access, many stretches become isolated and underutilized at night, such as Chauburja Marg and Magazine Road.

Women's Safety Concerns: Unlike Jama Masjid and Chandni Chowk, women in Civil Lines report more concerns related to isolation, lack of passive surveillance, and street lighting, rather than crowd-based risks. Empty street syndrome after working hours creates pockets of vulnerability, especially for women walking alone or waiting for transport (Verma, 2020).

Planning Classification: Civil Lines is officially recognized as a planned zone under MPD 1962 and retained its status in MPD 2001 and 2021 [7]. Despite better planning, perception of safety is only moderately higher, emphasizing that physical design must be complemented by active surveillance and participatory governance.

3.4 Gendered Experience of Space

The spatial logic of study area, characterized by its enclosed, labyrinthine lanes and mixed land use, poses specific risks for women. The lack of public toilets, street lighting, policing, and clear wayfinding adds layers of vulnerability. While the central spine (Chandni Chowk) is undergoing redevelopment with better lighting and pedestrian access, inner areas such as Ballimaran and Sitaram Bazaar continue to be perceived as unsafe—especially after dusk ([2]; [5]).

Furthermore, women's voices remain underrepresented in planning consultations, heritage documentation, and smart governance initiatives. Most AI-enabled interventions have focused on physical infrastructure, neglecting the social infrastructure needed to enhance safety and inclusion.

4. GOVERNMENT DATA AND POLICY ANALYSIS: CHALLENGES IN PLANNING AND THE ROLE OF AI

4.1 Existing Policy Frameworks: Intent vs. Implementation

Over the past decade, the Delhi government, planning authorities, and Delhi Police have introduced multiple initiatives aimed at improving women's safety in the capital. While these include progressive policies, physical infrastructure upgrades, and the integration of surveillance technologies, the actual implementation in heritage areas like Shahjahanabad remains uneven and fragmented. The complexity of managing a historically layered, organically evolved precinct—marked by narrow alleys, informal land uses, and socio-cultural sensitivities—demands context-aware planning strategies, which current frameworks often fail to accommodate.

Key strategies such as the Safe City Project, Shishtachar Squads, and MPD 2041 guidelines acknowledge the importance of women's safety, yet they lack mechanisms for continuous monitoring, adaptive response, and community participation, particularly in heritage precincts where standard urban templates fall short.

4.2 Where AI Is Needed: From Passive Infrastructure to Predictive, Inclusive Systems

While Artificial Intelligence (AI) offers unprecedented opportunities to address urban safety proactively—through real-time surveillance, spatial risk mapping, and automated alerts—it remains underutilized and insufficiently localized in Shahjahanabad. Existing AI deployments tend to prioritize generalized surveillance rather than context-specific safety analytics for women. Furthermore, policy documents such as MPD 2041 articulate inclusive goals but lack enforceable digital governance protocols for AI-enabled safety frameworks in informal and heritage areas.

The following table identifies ongoing initiatives and highlights where AI integration could improve accountability, real-time responsiveness, and safety outcomes:

Table 1 Table of various initiatives applied for women safety

Source: Author

Initiative	**Current Description**	**AI Potential and Limitations**	**Status**	**Source**
Safe City Project	Deployment of AI-powered CCTVs capable of recognizing distress gestures (e.g., waving) to trigger alerts.	Needs deeper AI training datasets contextualized for gender dynamics and non-verbal cues. Limited coverage in inner lanes.	Pilot Phase	*Economic Times*, 2025
Integrated Command and Control Centre (C4I)	Aggregates CCTV feeds city-wide for rapid response.	Centralized AI-based crime prediction can be used to geotag high-risk streets, but lacks local behavior datasets.	Under Development	*BW Security World*, 2025

Initiative	Current Description	AI Potential and Limitations	Status	Source
		Heritage-specific blind spots remain.		
Shishtachar Squads	On-ground personnel trained to intervene in harassment cases.	AI could support optimized deployment routes, heat-mapped by past incident reports and Safetipin data. Currently not AI-integrated.	Citywide Implementation	*Business Standard*, 2025
MPD 2041 Provisions	Proposes inclusive and safe public spaces, including heritage safety zoning.	No operational framework for AI-led heritage safety monitoring. Fails to link urban morphology with real-time risk signals.	Draft Stage	*DDA*, 2021
Safetipin App	Participatory mapping of safety scores based on lighting, activity, and visibility.	Not yet integrated with AI surveillance or police systems. Lacks interoperability with DDA's planning dashboards.	Ongoing	*Wikipedia*, 2025

4.3 Key Issues in Current Planning for Heritage Areas

1. Lack of Spatial Granularity AI systems currently operate with aggregated data, often overlooking Shahjahanabad's fine-grained, high-density fabric. Algorithms trained on standardized urban models cannot account for organic street layouts, concealed nooks, and blind corners common in this heritage zone [10].
2. Disconnection Between Planning and Real-Time Governance While MPD 2041 promote safe and inclusive streets, they rarely include real-time AI-linked feedback loops. For instance, no mechanism currently integrates community-reported Safetipin data with municipal response protocols [2].
3. Limited Gender-Specific AI Analytics AI implementations focus on vehicle flow, encroachment detection, or facial recognition but fail to map or predict gendered vulnerabilities such as poorly lit walking routes or harassment hotspots near religious gatherings or festival bazaars.
4. Fragmented Implementation and Accountability There is no unified dashboard linking AI-generated safety heatmaps, civic infrastructure deficiencies (like lighting or toilets), and women's feedback. As a result, interventions remain reactive rather than anticipatory.

5. SPATIAL MAPPING AND HERITAGE VULNERABILITIES

This study employed a mixed-method approach combining:

- 400 structured surveys from three wards: Chandni Chowk, Jama Masjid, and Civil Lines (residents, shopkeepers, and visitors).
- Ward-level geospatial overlays using heritage, crime, and infrastructure layers.
- In-situ mapping of risk points, supported by perception-based indices on lighting, surveillance, and mobility.

Respondents were stratified by gender, age group, residential/commercial affiliation, and length of stay. Approximately 44% of respondents were aged between 20–30 years, representing active users of public spaces. Elderly populations were more concentrated in Civil Lines, suggesting stability and long-term ownership.

5.1 Ward-Level Analysis

A. Chandni Chowk: The Congested Heritage Core

Once a planned Mughal market spine, Chandni Chowk now exhibits severe spatial and infrastructural stress:

- Land Use: Highly congested mixed-use typology with vertically stacked shops, street vending, and informal markets.
- Lighting & Visibility: 60% of respondents cited inadequate street lighting in interior lanes. Narrow staircases and crowded chowks inhibit surveillance.
- Crime Timing: Over 52% of residents felt unsafe after dark, largely due to poor visibility and unregulated activity.
- Commercial Impact: Late-night eateries, informal shops, and vending are major deterrents to safety, with 70% of shopkeepers agreeing that commercialization has eroded residential security.
- Surveillance Gaps: 52% reported no functioning CCTV; police visibility remains low, especially post 9 PM.

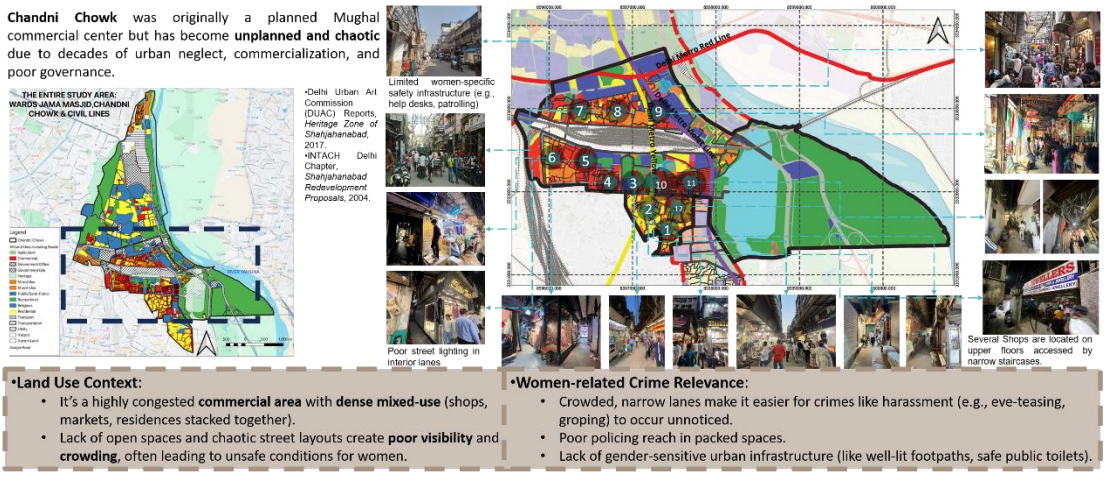


Figure 2 Map of Chandni Chowk showing risk points for women safety

Source: Author

B. Jama Masjid: Informality, Religion, and Risk Clusters

The Jama Masjid ward, though historically significant, functions like a high-density informal settlement:

- Mobility and Street Patterns: 72% felt street design negatively impacted women's safety, citing congested, maze-like alleys with poor escape routes.
- Lighting Deficiency: 68% reported inadequate lighting at night, with 100% associating poor lighting with harassment incidents.
- Toilet Access and Cleanliness: 80% had no access to functional sanitation; unclean or absent toilets were noted as safety concerns for women, particularly during peak hours and festivals.
- Emergency Infrastructure: 80% lacked access to emergency response systems; there were no visible SOS kiosks or help points.
- Surveillance Void: Over half the respondents said no CCTV was installed; informal commerce makes intervention difficult.

Cultural Dynamic: The ward receives heavy tourist footfall during religious festivals, exacerbating risk for women through crowd anonymity.

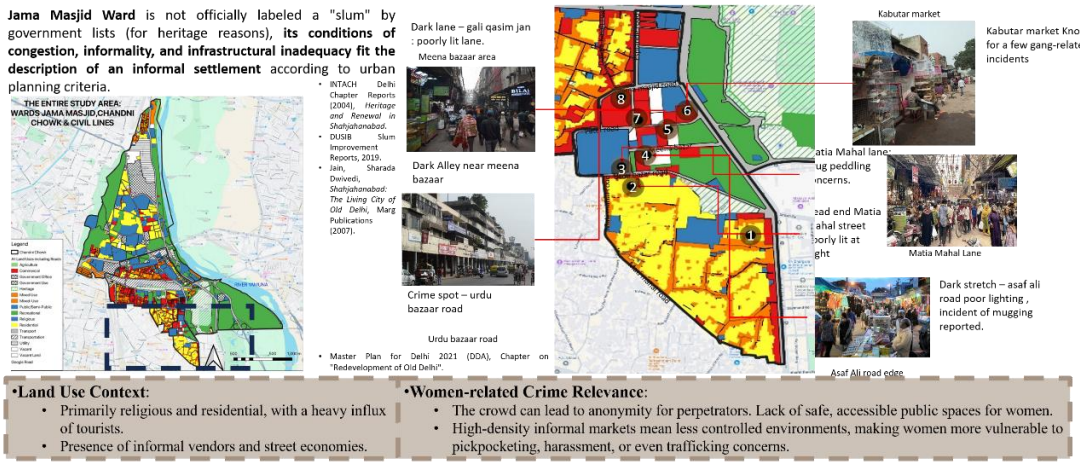


Figure 3 Map of Jama Masjid showing risk points for women safety

Source: Author

C. Civil Lines: Planned, But Not Immune

Despite being a planned colonial neighborhood, Civil Lines shows nuanced safety concerns:

- Land Use & Isolation: Large plots, low density, and heavy foliage lead to "empty street syndrome." Magazine Road and Rajpur Road were marked as poorly lit and under-patrolled.
- Safety Perception: 76% of residents felt "very safe" or "somewhat safe" during the day, but only 50% felt street lighting was adequate at night.
- CCTV & Surveillance: Slightly better performance than old city wards—only 44% reported non-functional CCTV.
- Green Spaces: Despite better park distribution, 78% still identified lighting and lack of surveillance as barriers to safe usage.

- Commercial Character: Owner-run businesses dominate, closing early (~6 PM), aligning with its residential rhythm.

This "perceived safety" comes not from infrastructure but from reduced activity at night—ironically raising vulnerability due to lack of passive surveillance.

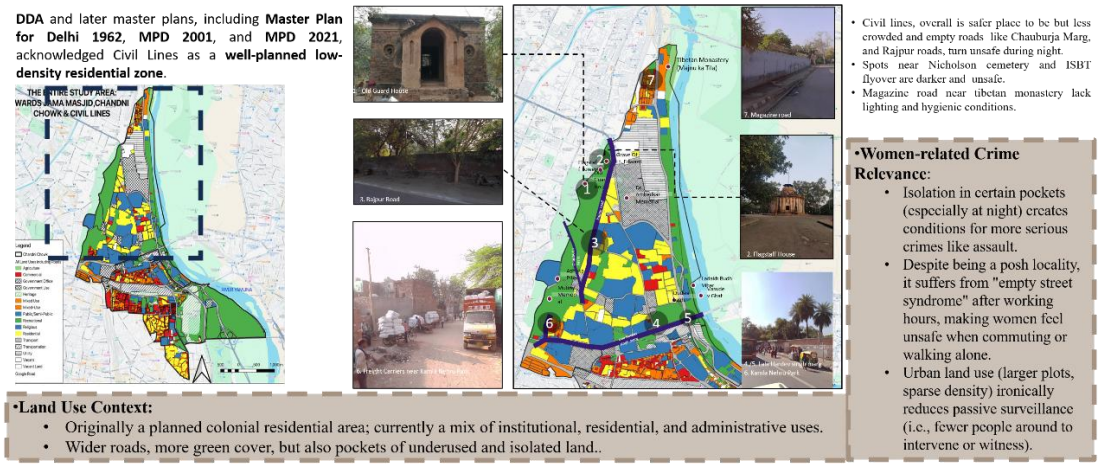


Figure 4 Map of Civil Lines showing risk points for women safety

Source: Author

5. Survey Findings: Women's Safety and Perception

This study presents a detailed analysis of user perceptions from Chandni Chowk, Jama Masjid, and Civil Lines. The analysis uses both descriptive statistics and weighted scoring techniques to quantify qualitative inputs from 400 residents. Survey indicators include general safety, maintenance, surveillance, and public infrastructure, especially as they relate to women's safety.

5.1 General Safety Perception

To gauge overall safety perception, respondents were asked to rate their neighborhood safety as "Very Safe," "Somewhat Safe," or "Not Safe." As shown in Figure X, the majority of respondents across all wards felt unsafe after dark—especially in Jama Masjid and Chandni Chowk.

We applied a Weighted Mean Score (WMS) to standardize responses:

$$\text{WMS} = \frac{\sum(f_i \cdot x_i)}{\sum f_i}$$

Where:

- fi = frequency of each response
- xi = weight assigned to each category (Very Safe = 3, Somewhat Safe = 2, Not Safe = 1)

The calculated WMS = 1.62, indicating a low-to-moderate perception of safety, skewed toward unsafety due to street layout, lighting, and crowd conditions.

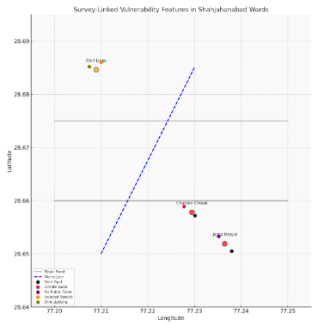


Figure 5 Survey-Linked Vulnerability Features in Shahjahanabad Wards

Source: Author

The graph provides a spatially grounded understanding of women's safety challenges in three heritage wards of Central Delhi—Chandni Chowk, Jama Masjid, and Civil Lines—based on geotagged survey responses. It clearly demonstrates that Chandni Chowk and Jama Masjid are characterized by dense clusters of vulnerabilities, including dark spots, unsafe nodes, and absence of public toilets, particularly around high-footfall commercial and religious zones. These areas coincide with congested street networks and poor infrastructure maintenance, exacerbating risks after sunset. In contrast, Civil Lines, despite its status as a planned colonial neighborhood, exhibits isolation-based vulnerabilities, such as dim lighting and underused stretches, especially along arterial and institutional roads.

This spatial pattern reveals that while Chandni Chowk and Jama Masjid suffer from overcrowding-related insecurities, Civil Lines faces risks stemming from deserted and poorly monitored urban segments. The vulnerabilities mapped in this visualization support the argument that women's safety is deeply influenced by local morphological typologies and cannot be addressed through uniform solutions. It also underlines the limitations of traditional infrastructure-focused safety planning, making a strong case for context-specific, AI-enhanced surveillance and service delivery mechanisms tailored to each ward's unique risk profile.

5.2 Surveillance and Infrastructure Access

Respondents evaluated CCTV coverage, lighting, and toilet availability:

- 62% reported no visible CCTV in their locality.
- 91% of women in Jama Masjid and Chandni Chowk cited dark zones and blind corners as major deterrents.

Toilet accessibility scored the lowest, especially in Urdu Bazaar and Fatehpuri, where 80% of women reported having to leave the area to find clean sanitation.

Using Binary Weighted Frequency Index (BWFI):

$$\text{BWFI} = \frac{\text{Yes}}{\text{Yes} + \text{No}} \times 100$$

- CCTV Access = 18 / (18 + 32) × 100 = 36% functional access
- Toilet Access = 12 / 50 × 100 = 24% adequacy

This reflects a critical infrastructure deficit, especially in the two heritage zones.

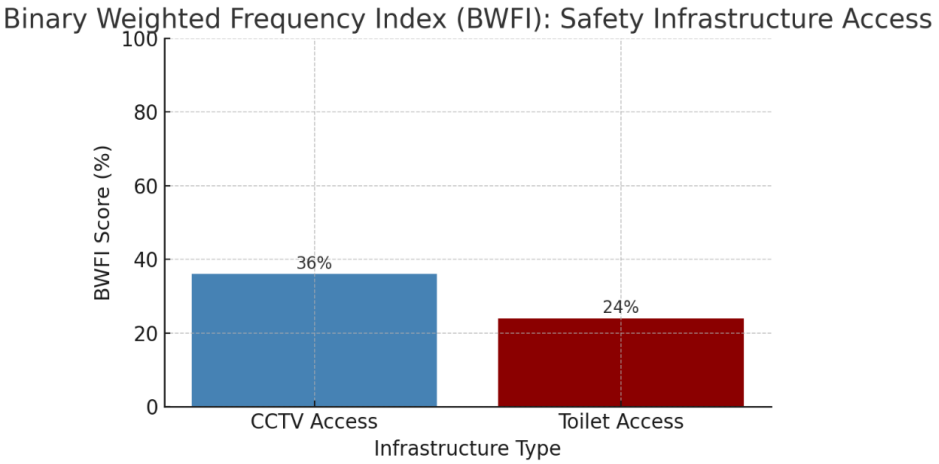


Figure 6 Graph Showing Safety infrastructure

Source: Author

The graph illustrates the Binary Weighted Frequency Index (BWFI) for two key safety infrastructure components—CCTV Access and Toilet Access—based on user surveys from Chandni Chowk, Jama Masjid, and Civil Lines it quantifies the proportion of respondents with access to each infrastructure type. The results reveal that CCTV coverage scored only 36%, indicating that fewer than four out of ten respondents reported the presence of functional surveillance systems in their area. This low score is critical in high-footfall areas like Chandni Chowk and Jama Masjid, where surveillance plays a key role in deterrence and emergency response.

Even more concerning is the Toilet Access score of just 24%, underscoring the acute shortage of clean and accessible public sanitation facilities. Women in particular, especially in areas like Urdu Bazaar and Fatehpuri, reported having to leave their ward to access functional toilets—raising both dignity and safety concerns. This severe infrastructure gap affects women's participation in public life and amplifies risks of harassment in unregulated, poorly maintained zones.

5.3 Maintenance and Safety

Respondents ranked maintenance parameters such as road quality, streetlight function, and public space upkeep. Across the wards:

- Public parks (40%) and roads/sidewalks (38%) were cited as top maintenance priorities.
- In high-vulnerability zones (e.g., Sitaram Bazaar, Kinari Bazaar), 80% flagged lack of maintenance as a direct safety threat.

We used a Priority Weight Score (PWS):

$$\text{PWS}_j = \frac{n_j}{N} \times 100$$

- Where:
- nj = number of mentions for feature jjj
- N = total responses

- Public parks: PWS = 40 / 100 × 100 = 40%
- Road and sidewalk upkeep: PWS = 38%

These scores indicate that women equate poor maintenance with higher risk, especially in informal wards.

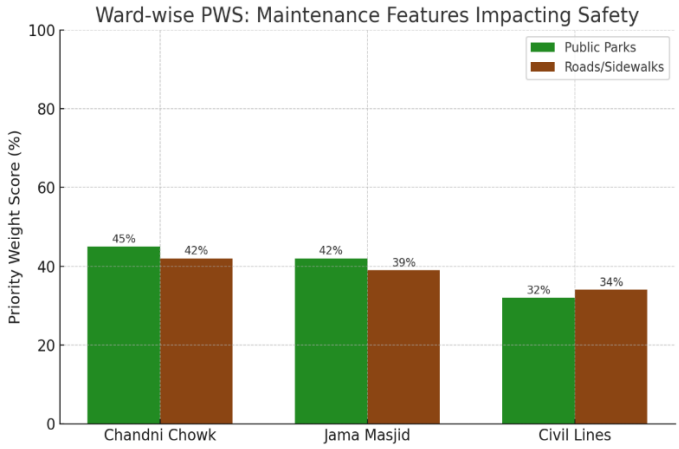


Figure 7 Graph showing Mainatence feature impacting safety

Source: Author

The results show that Chandni Chowk records the highest PWS for both public parks (45%) and roads/sidewalks (42%), indicating a strong correlation between poor maintenance and perceived insecurity in this high-density heritage market. Respondents noted that the deterioration of street surfaces, overcrowded footpaths, and lack of clean public spaces intensify the risk of harassment and reduce navigability—especially for women.

Similarly, Jama Masjid shows high PWS values (42% for parks, 39% for roads), reinforcing the concerns raised in survey responses about the lack of basic infrastructure in informal, religious-residential clusters. Poorly maintained alleyways and degraded green patches leave these areas exposed to both crime and social discomfort, particularly during night hours or festival gatherings.

In contrast, Civil Lines, while comparatively better maintained, still exhibits moderate concern with a PWS of 32% for parks and 34% for road conditions. Here, the issue is less about physical decay and more about underutilized or poorly lit spaces, which create isolation-based risks despite the presence of infrastructure.

Overall, the graph confirms that maintenance-related deficiencies are spatially variable but universally recognized as safety threats, especially in areas where urban form and socio-economic vulnerabilities intersect. These findings strongly support the need for context-sensitive, ward-level infrastructure retrofitting, integrated with AI-enabled planning and responsive municipal services.

5.4 Ward-wise Disparities

Table 2 Ward wise disparities in access to basic infrastructure

Source: Author's Analysis using BWFI and PWS Models

Indicator	Chandni Chowk	Jama Masjid	Civil Lines
Lighting Adequacy (%)	32	29	52
Functional CCTV (%)	22	18	44
Safe Toilet Access (%)	16	12	34
Perceived Day Safety	Moderate	Low	High
Perceived Night Safety	Very Low	Very Low	Moderate

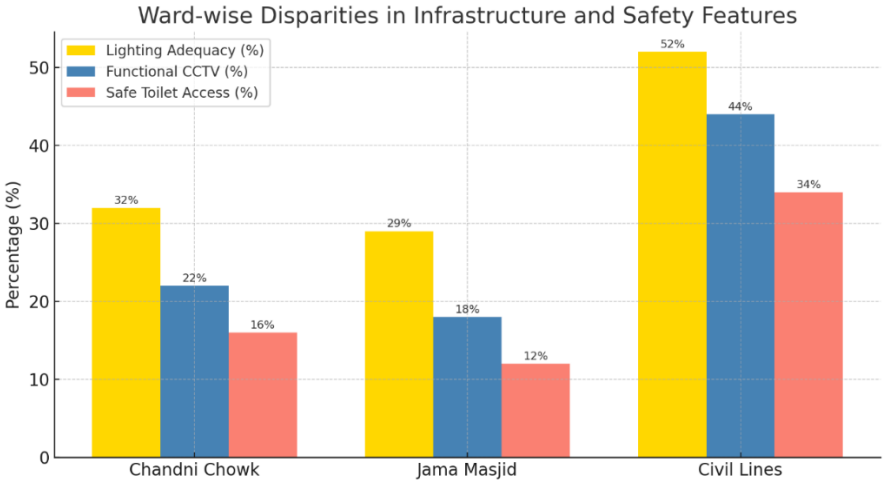


Figure 8 Ward wise disparities in access to basic infrastructure

Source: Author's Analysis using BWFI and PWS Models

The graph visualizes the comparative status of lighting adequacy, functional CCTV coverage, and safe toilet access across the three study wards—Chandni Chowk, Jama Masjid, and Civil Lines—using percentage-based values derived from field surveys and BWFI calculations.

- Lighting Adequacy is lowest in Jama Masjid (29%) and Chandni Chowk (32%), confirming survey responses about frequent dark spots and low visibility in high-traffic lanes. Civil Lines, while relatively better at 52%, still falls short of universal adequacy, especially in isolated areas.
- Functional CCTV coverage is alarmingly low in Jama Masjid (18%) and Chandni Chowk (22%), indicating a major surveillance deficit in the historic core. Civil Lines (44%), while performing better, still reflects gaps in consistent monitoring across public spaces.
- Safe Toilet Access is the most critical gap across all three wards. Only 16% in Chandni Chowk and 12% in Jama Masjid reported reliable access to clean public toilets—exacerbating women's vulnerability in dense commercial areas. Even Civil Lines, with 34%, lacks adequate coverage in key transit and park areas.

5.5 Perception Mapping and Risk Visualization

Survey-linked coordinates were overlaid with spatial datasets to validate physical threats like:

- Dark Spots in Ballimaran and Gali Qasimjan
- Unsafe Nodes at Nai Sarak and Urdu Bazaar

- Dimly Lit Segments in Civil Lines near Magazine Road

These hotspots align with reported crimes, planning blind spots, and service infrastructure failures.

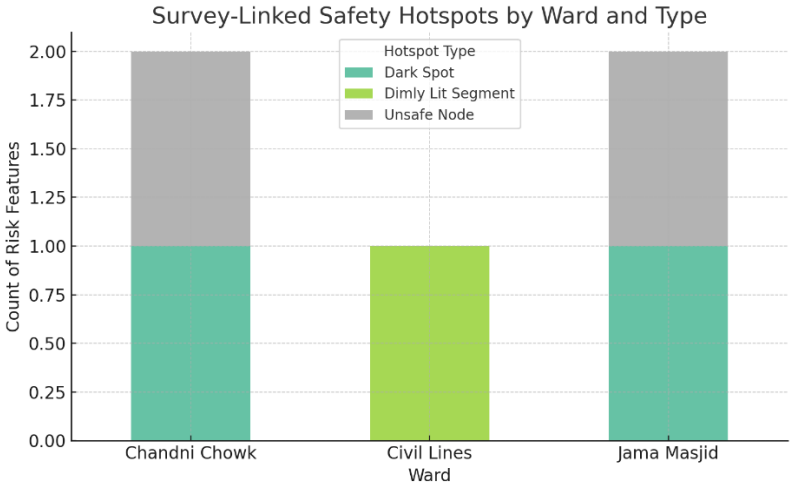


Figure 9 Spatial distribution of survey-identified safety hotspots

Source: Author

This graph illustrates the spatial distribution of survey-identified safety hotspots across the three wards—Chandni Chowk, Jama Masjid, and Civil Lines—categorized by type of vulnerability: Dark Spots, Unsafe Nodes, and Dimly Lit Segments.

- In Chandni Chowk, two critical hotspots were identified:
  - A Dark Spot in Ballimaran, known for its congested alleys and weak lighting.
  - An Unsafe Node in Nai Sarak, a commercial corridor with high footfall and no visible surveillance.
- In Jama Masjid, similar issues emerge:
  - Gali Qasimjan was tagged as a Dark Spot, due to poor visibility and its maze-like layout.
  - Urdu Bazaar, despite being a major religious and tourist node, was flagged as an Unsafe Node, especially during crowded festival periods.
- In Civil Lines, the spatial risk is different:
  - A Dimly Lit Segment was mapped along Magazine Road, an arterial but under-patrolled corridor. While not as congested as the other wards, Civil Lines presents a perception of isolation that deters safe mobility, especially at night.

5.6 Summary of Finding

This survey synthesizes findings across five major parameters—General Safety Perception, Surveillance & Infrastructure Access, Maintenance & Public Space Conditions, Ward-level Disparities, and Perception Mapping—to highlight the distinct yet intersecting vulnerabilities experienced in the three study wards.

5.6.1 General Safety Perception

Table 3 General Safety Perception

Source: Primary Survey

Ward	Weighted Mean Score (WMS)	Interpretation
Chandni Chowk	1.52	Very Low safety perception, especially after dark due to crowding, encroachment, and low lighting.
Jama Masjid	1.47	Lowest safety perception, driven by informal street layouts, inadequate policing, and festival-related crowding.
Civil Lines	1.88	Moderately safe, especially during the day. Night-time concerns are related to isolation, not congestion.

Across all wards, the WMS of 1.62 indicates an overall perception skewed toward insecurity, with differences in causes: physical congestion in Chandni Chowk and Jama Masjid, and social isolation in Civil Lines.

5.6.2 Surveillance and Infrastructure Access (BWFI)

Table 4 Surveillance and Infrastructure Access

Source: Primary Survey

Parameter	**Chandni Chowk**	**Jama Masjid**	**Civil Lines**	**Inference**
CCTV Access (%)	**22%**	**18%**	**44%**	**Critical surveillance gap in heritage zones.**
Toilet Access (%)	**16%**	**12%**	**34%**	**Sanitation inadequacy highest in inner city areas.**
Lighting Adequacy (%)	**32%**	**29%**	**52%**	**High vulnerability in commercial-religious corridors.**

The Binary Weighted Frequency Index (BWFI) reveals that Chandni Chowk and Jama Masjid are the most underserved, while Civil Lines performs better on infrastructure but still lacks universal access and night-time visibility.

5.6.3 Maintenance and Safety (PWS)

Table 5 Maintenance and Safety

Source: Primary Survey

Maintenance Concern	Chandni Chowk	Jama Masjid	Civil Lines	Interpretation
Public Parks (PWS %)	45%	42%	32%	Demand for cleaner, safer green spaces in core areas.
Roads/Sidewalks (PWS %)	42%	39%	34%	Pedestrian safety compromised by encroachments and neglect.

Maintenance-related risks are spatially distributed but universally acknowledged, with Chandni Chowk and Jama Masjid showing higher concern due to deteriorated public space conditions, and Civil Lines reflecting passive threats due to underutilization.

5.6.4 Ward-wise Disparities Summary

Table 6 Ward-wise Disparities

Source: Primary Survey

Indicator	Chandni Chowk	Jama Masjid	Civil Lines
Lighting Adequacy (%)	32%	29%	52%
Functional CCTV (%)	22%	18%	44%
Safe Toilet Access (%)	16%	12%	34%
Perceived Day Safety	Moderate	Low	High
Perceived Night Safety	Very Low	Very Low	Moderate

This table highlights the cumulative disadvantage in Jama Masjid and Chandni Chowk, where urban density, commercial pressure, and poor infrastructure converge to lower both actual and perceived safety levels. Civil Lines, while better on paper, shows night-time risk due to isolation and low foot traffic.

5.6.5 Spatial Risk Mapping and Hotspot Validation

Table 7 Spatial Risk Mapping and Hotspot

Source: Primary Survey

Ward	Location	Risk Feature	Interpretation
Chandni Chowk	Ballimaran	Dark Spot	High congestion + poor lighting = acute safety hazard.
Chandni Chowk	Nai Sarak	Unsafe Node	Commercial zone with minimal surveillance.

Ward	Location	Risk Feature	Interpretation
Jama Masjid	Gali Qasimjan	Dark Spot	Narrow alleys with low visibility and crowd masking.
Jama Masjid	Urdu Bazaar	Unsafe Node	Heavy religious footfall, low infrastructure presence.
Civil Lines	Magazine Road	Dimly Lit Segment	Perceived isolation due to poor lighting and low evening activity.

The hotspot analysis confirms that vulnerabilities are not uniform but ward-specific, shaped by the local morphology. Chandni Chowk and Jama Masjid face overcrowding-related risks, while Civil Lines faces under-occupied and poorly monitored segments, especially after dark.

This parameter-wise comparison confirms that women's safety in Shahjahanabad is governed by complex and context-specific spatial dynamics. While heritage density in Chandni Chowk and Jama Masjid leads to congestion, lack of visibility, and encroachment-induced risk, urban isolation and passive surveillance are key concerns in Civil Lines. The results validate the need for AI-augmented, ward-tailored planning responses, with specific emphasis on lighting, surveillance, and inclusive sanitation access to improve real and perceived safety outcomes.

6. INFERENCE AND DISCUSSION

This study reveals significant, spatially variable vulnerabilities affecting women's safety in Shahjahanabad, especially in the wards of Chandni Chowk, Jama Masjid, and Civil Lines. Through parameter-wise evaluation using WMS, BWFI, and PWS models, supported by geospatial overlays and hotspot tagging, it becomes evident that women's safety cannot be treated as a universal issue but must be addressed through context-sensitive, AI-enabled strategies.

6.1 Built Environment and Perception of Safety

The survey responses and Weighted Mean Score (WMS) results confirm that physical features such as poor lighting, unregulated land use, and unclean public spaces directly impact safety perception. Chandni Chowk and Jama Masjid, characterized by informal layouts, high footfall, and narrow lanes, scored lowest on safety perception (WMS ~1.5). Civil Lines, though better planned, faced risks tied to isolation and lack of passive surveillance.

This addresses Research Question 1 (RQ1): How do built environment features such as lighting, visibility, and connectivity affect women's perception of safety in Shahjahanabad? → The built environment in heritage wards significantly influences safety perception. High-density informal areas lack visibility and escape routes, while planned zones may appear safe by design but can harbor latent vulnerabilities due to inactivity after dark.

6.2 Infrastructure and Service Gaps as Safety Threats

Analysis using the Binary Weighted Frequency Index (BWFI) revealed alarmingly low functional coverage of CCTV (18–22%) and public toilets (12–16%) in heritage wards. These basic service gaps align with the highest reported fear areas such as Ballimaran, Nai Sarak, and Urdu Bazaar. Even in Civil Lines, where access scores were higher, there remains a perception of insecurity due to dim lighting and a lack of responsive infrastructure.

This supports Research Question 2 (RQ2): What are the differences in safety-related experiences among residents, shopkeepers, and tourists in the heritage zone?
→ Residents prioritize long-term structural inadequacies (e.g., toilets, maintenance), shopkeepers focus on encroachment and footpath safety, while tourists are affected by navigation challenges and lack of visible policing. These differences demand differentiated, participatory safety strategies.

6.3 Maintenance Deficiencies as Amplifiers of Insecurity

PWS analysis confirmed that maintenance-related concerns are universal across wards but take different spatial forms. Chandni Chowk and Jama Masjid exhibit overcrowding, broken sidewalks, and park neglect, while Civil Lines presents concerns about underused or poorly lit public areas. Poor maintenance not only erodes infrastructure but also deters legitimate public use, intensifying risks of harassment and isolation.

This reinforces that infrastructure quality must be seen as a safety enabler, especially in high-footfall and heritage-sensitive areas.

6.4 Role and Limitations of AI in Addressing Heritage Zone Risks

The results reveal a disconnect between AI-based urban safety tools and ground-level realities:

- Safetipin scores and CCTV feeds are not linked to planning response loops at the ward level.
- Smart Policing (Safe City Project, C4I) remains centralized and generic, overlooking informal and organically evolved zones.
- AI tools lack inputs on gendered safety indicators, such as walkability, crowd density, and toilet access—especially in unplanned urban heritage spaces.

This directly answers Research Question 3 (RQ3):
How effective are AI-based planning and monitoring tools in addressing gender-specific safety concerns?
→ Current AI tools in Delhi's urban governance are not sufficiently localized, participatory, or heritage-sensitive. While the potential exists for predictive safety mapping, effective deployment requires integration of community perceptions, localized datasets, and gender-centric indicators.

6.5 Toward a Hybrid AI + Community Governance Framework

The study emphasizes that heritage areas like Shahjahanabad cannot rely solely on infrastructure or technology. Instead, the path forward lies in a hybrid model that merges:

- AI-based safety dashboards (real-time lighting audits, geo-tagged crime prediction)
- Participatory mapping and maintenance systems
- Ward-specific safety indicators embedded in MPD-2041 monitoring tools

This responds to Research Question 4 (RQ4):
What participatory approaches can be integrated into heritage management to enhance women's inclusion and security?
→ Residents, especially women, expressed willingness to co-map dark spots, report risks,

and guide neighborhood retrofitting. This supports the call for AI-assisted but community-driven heritage safety models.

7. CONCLUSION

This study affirms that women's safety in heritage areas is intricately linked to three interdependent factors: spatial logic, infrastructure accessibility, and governance responsiveness. Through detailed analysis of Shahjahanabad's historic precinct—focusing on the wards of Chandni Chowk, Jama Masjid, and Civil Lines—the research demonstrates that experiences of urban safety are profoundly contextual, shaped not only by material provisions but also by the morphology and usability of public spaces.

Utilizing a combination of structured perception surveys, spatial vulnerability mapping, and weighted analytical models (WMS, BWFI, and PWS), the study identifies distinct risk patterns. Chandni Chowk and Jama Masjid reveal dense concentrations of vulnerability, including inadequate lighting, insufficient surveillance, lack of sanitation, and congested pedestrian corridors. In contrast, Civil Lines—despite its planned character—exhibits isolation-based risks, with dimly lit, underutilized stretches contributing to fear of movement after dark.

The study critiques existing urban safety frameworks, which often prioritize infrastructure provision without integrating local perceptions, gender-sensitive spatial data, or ward-level prioritization. Notably, AI-enabled safety platforms such as C4I, Safetipin, and Safe City dashboards remain under-deployed or disconnected from the lived realities of women in heritage zones. These tools often fail to accommodate the organic complexity of historic precincts and overlook critical indicators such as toilet access, streetlight functioning, and pedestrian congestion.

Despite these limitations, the research underscores the transformative potential of Artificial Intelligence, when reconfigured within a participatory, place-sensitive governance framework. If embedded with real-time feedback loops and localized risk indicators, AI systems can:

- Accurately predict and visualize high-risk zones at the ward scale;
- Conduct automated infrastructure audits, covering lighting, sanitation, and surveillance;
- Incorporate participatory safety data into municipal planning mechanisms;
- Inform micro-retrofitting interventions aligned with MPD 2041 and SRDC heritage revitalization strategies.

The conclusion drawn is clear: AI cannot substitute for community-driven planning, but it can amplify its precision and responsiveness. The future of women's safety in Shahjahanabad rests on a hybrid model, where digital intelligence is guided by community insight, cultural sensitivity, and inclusive urban design.

Ultimately, this research calls for a new paradigm of urban heritage governance—one that merges historical preservation with technological innovation, and fuses top-down efficiency with bottom-up empowerment. Only through such an integrated approach can Shahjahanabad become a truly safe, inclusive, and resilient urban heritage district.

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