Developing a Composite Street Livability Index for Commercial Streets in Indian Cities: A Case Study of T. Nagar (Thyagaraya Nagar), Chennai

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Article

Developing a Composite Street Livability Index for Commercial Streets in Indian Cities: A Case Study of T. Nagar (Thyagaraya Nagar), Chennai

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Abstract

Commercial streets are the most vibrant public spaces in rapidly urbanizing cities, and their livability has studied limited in the context of Indian urban environments. Existing national and international street assessment frameworks largely emphasize technical design compliance and walkability indicators while giving limited attention to the sociability and vibrancy that characterize commercial streets. This study develops a Composite Street Livability Index (SLI) to evaluate commercial street environments by integrating physical, functional, and experiential dimensions. The methodology adopts a mixed-methods approach combining physical street audits, perception surveys, and behavioural observations. Five key dimensions of livability are identified from national and international frameworks: safety and security; accessibility and connectivity; comfort and amenities; sociability and vibrancy; management and aesthetics. The framework is applied to the commercial street of Thyagaraya Road, T.Nagar, located in Chennai, one of the most active retail districts in India. The results reveal an overall Street Livability Index score of 80.2 out of 100, indicating relatively high livability despite notable spatial variations across the six street nodes. Safety and security (27.8%) and accessibility and connectivity (24.2%) contribute the largest shares to the overall index, reflecting the dominance of pedestrian infrastructure and mobility conditions in shaping street performance. Safety and security recorded the highest qualitative rating (4.07/5), highlighting the corridor's strong commercial activity and social interaction. However, lower scores in comfort, amenities, and management dimensions indicate the need for improved environmental quality and street maintenance. The proposed index demonstrates the value of integrating infrastructure and social activity indicators to assess commercial streets comprehensively and provides a context-sensitive evaluation tool for planners and policymakers to support people-oriented street transformation in Indian cities.

Keywords: street livability; urban planning; walkability; sustainability; public space; Street Livability Index

1. Introduction

1.1. Background

Urban streets are among the most fundamental components of the public realm and play a vital role in shaping the social, economic, and environmental quality of cities. Traditionally conceived as transportation corridors, contemporary urban design perspectives increasingly recognize streets as multifunctional public spaces that accommodate mobility, commerce, and social interaction. In dense urban environments, particularly within commercial districts, streets become vibrant urban settings where pedestrian movement, retail activity, and informal social encounters converge. The quality of these environments strongly influences pedestrian comfort, accessibility, safety, and the overall

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livability of urban neighborhoods. In response to growing concerns about pedestrian safety and sustainable mobility, several international frameworks have been developed to evaluate street environments. Tools such as the Healthy Streets Framework, the Global Walkability Index, and the Pedestrian Environment Review System provide systematic approaches to measuring walkability and pedestrian conditions. These frameworks typically assess factors such as connectivity, safety, accessibility, and infrastructure quality. While they offer valuable metrics for evaluating pedestrian environments, they are primarily designed for general urban streets and often emphasize physical infrastructure and mobility efficiency.

Table 1. Shows various international organizations assessment approach (by author).

Tool / Index (Year)	Developing Organization	Key Indicators and Assessment Approach
Healthy Streets Approach (2017)	Transport for London (TfL)	Integrates public health and equity into street assessment using ten indicators, including perceived safety, shade and shelter, things to see and do, ease of crossing, clean air, and noise levels; combines objective measurements with user perceptions and has been widely adopted by local governments.
Pedestrian Environment Review System – PERS (2010)	Transport Research Laboratory (TRL), UK	A structured audit tool employing systematic observation and scoring to evaluate footways, crossings, links, public spaces, lighting, and personal security within the pedestrian environment.
Global Walkability Index – GWI (2006)	World Bank	Using nine factors such as safety, security, amenities, traffic conditions, and disability infrastructure; combines physical audits with perception-based surveys of pedestrians.
Pedestrian Level of Service – PLOS (2010)	Transportation Research Board (TRB), Highway Capacity Manual (HCM)	Evaluates pedestrian comfort and service quality based on sidewalk width, pedestrian flow, traffic volume and speed, delays at crossings, and interactions with motorized traffic.
Placemaking Evaluation Frameworks (2009)	Project for Public Spaces (PPS)	Evaluates using sociability, comfort, imageability, participatory mapping, behavioural observation, and qualitative audits to assess the social performance and experiential quality.
Global Street Design Guide (2016)	National Association of City Transportation Officials (NACTO)	Provides design-based assessment guidance prioritizing pedestrians, cyclists, and public transport users through flexible street typologies, intersection design, traffic calming, and public realm improvements.

In the Indian context, national guidelines and policy initiatives have also begun to address pedestrian-friendly street design. Programs such as the Smart Cities Mission and street design guidelines issued by the Ministry of Housing and Urban Affairs promote complete streets, improved pedestrian infrastructure, and inclusive mobility. However, many of these frameworks focus largely on compliance with design standards and infrastructure provision, such as footpath width, crossing facilities, and traffic management. As a result, the experiential and social dimensions of streets such as sociability, vibrancy, and place-based interactions are often underrepresented in existing assessment tools.

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Table 2. Shows various national organizations assessment approach (by author).

Framework (Year)	Issuing Authority / Organization	Key Provisions for Pedestrian & Street Design
IRC:103–2012 and IRC:SP:119–2018	Indian Roads Congress (IRC)	provides technical standards for pedestrian infrastructure, including footpath widths, safe pedestrian crossings, kerb heights, signage, tactile paving, and universal accessibility
Guidelines for Designing Streets (2010)	UTTIPEC, Delhi Development Authority (DDA)	Introduces complete street principles with an emphasis on pedestrian safety and non-motorized transport priority, integrating street design with land use, multimodal mobility, and public realm quality.
Tender S.U.R.E. – Specifications for Urban Road Execution (2016)	Jana Urban Space Foundation, Bengaluru	Defines standardized street sections ensuring pedestrian continuity, and performance-based evaluation of street functionality and user experience.
Chennai Non-Motorised Transport (NMT) Policy (2014)	Greater Chennai Corporation with ITDP India	Prioritization of walking and cycling through continuous footpaths, safe pedestrian crossings, dedicated cycle infrastructure, and equitable allocation of street space.
ITDP Complete Streets Framework (2018)	Institute for Transportation and Development Policy (ITDP) India	Provides assessment tools for people- centered streets, focusing on high-quality footpaths, safe crossings, street furniture, active frontages, landscaping, and inclusive design.
Streets for People Challenge & Cycles4Change (2020–2021)	Ministry of Housing and Urban Affairs (MoHUA), Government of India	Encourages tactical urbanism through pilot-based street interventions, participatory design processes, and rapid, low-cost reallocation of street space to support pedestrians and cyclists.

This limitation is particularly evident in commercial streets, which function as movement corridors but also as dynamic social and economic spaces. In Indian cities, commercial corridors are characterized by high pedestrian density, diverse retail activities, informal vendors, and active street life. These characteristics create unique spatial and social dynamics that cannot be fully captured through conventional walkability or infrastructure-based indices. Consequently, existing assessment frameworks may overlook important aspects of commercial street environments, including social interaction, street vibrancy, and the integration of formal and informal activities. Despite the increasing importance of pedestrian-oriented urban design in Indian cities, there remains a limited number of context-specific frameworks that comprehensively evaluate the livability of commercial streets. Most existing studies either focus on general walkability assessments or examine isolated physical attributes of streets, without integrating the broader experiential qualities that contribute to urban livability. Therefore, there is a need for a context-sensitive evaluation framework that captures both the physical infrastructure and the social vitality of commercial street environments in rapidly urbanizing cities.

To address this gap, this study proposes a Composite Street Livability Index (SLI) that integrates multiple dimensions of street performance, including safety, accessibility, comfort, sociability, and management. The index is applied to the commercial corridor of Thyagaraya Road in Chennai. By combining physical street audits, perception surveys, and behavioural observations, the study aims to develop a comprehensive framework for evaluating commercial street livability and to demonstrate its applicability for informing people-oriented street design and urban policy.

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Figure 1. Identified parameters from literature review (by author).

2. Literature Review

2.1. Street Livability

Livability varies across contexts and groups. Livability has been associated with social and physical determinants of safety, health, environment friendly and sustainability [1]. Livability is a significant guiding principle for urban planning and policy decisions [2]. The idea of urban livability has gained prominence as a guiding principle within the context of the language of sustainability in urban policy and planning both in the majority of developed countries and to a lesser extent in the developing ones [3]. Liveable and shared street makes great places [4]. They are the contributors to street vibrancy. Mehta [5] argues that streets should bring people together, facilitate social interaction, and foster a sense of community. He emphasizes that streets as social public spaces contribute to the livability and vibrancy of cities. Streets are the social spaces in the cities connecting people and space [6]. Every street has three major activities, such as necessary activities, social activities and optional activities [7]. Street design should be carried out in a way considering people and spaces, rather than being constrained by rigid engineering standards. This will enable the creation of novel solutions that meet the overarching goals of a livable street [8]. Streets that are well designed are full of movement, nature, and recreation [9][10]. Streets are transformed into mini public spaces with wider footpaths, trees, and seating [11]. Streets improve walkability by providing both generous footpaths and convenient destinations [12]. Accessible places are those that are active at all times. Streets that are more than a transportation access and that which includes pedestrian oriented walkways ensure walkability in the neighbourhood and enrich social life [13][14]. Creating a walkable network of streets also entails making it easier for people to get to places they are likely to visit [15].

In order to create livable streets, more sidewalks for pedestrian activities needs to be designed, for people to walk, sit, chit chat with their friends, watch their neighbourhood, and in doing so contributing street liveliness and vibrancy [16]. Gehl [7] focused on creating human-cantered urban environments, he emphasizes the need for a human scale in urban design. The compact, mixed-use development patterns tend to be more conducive to livability and street vibrancy than sprawling and single-use development patterns [17]. By creating vibrant, livable neighbourhoods, streets can improve the quality life and create more sustainable, resilient communities [18]. As socio-economic development accelerates, the microscale living conditions demand greater attention [19]. Place making involves creating places that are meaningful to people, and that reflect the social, cultural, and historical contexts of their communities [20]. Carmona [19] defines, Place quality and place value are inter-linked in a virtuous loop in which quality dictates value and value defines quality of the place. Micro climate in streets can be achieved through street trees, which adds different kind of under the tree social and economic activities enriching environmental benefits [5]. Street trees adds aesthetic values and promotes economic opportunities in commercial streets [2]. The importance of incorporating green infrastructure into public spaces as a way of promoting ecological sustainability and resilience in urban environments is highlighted in many works [21,22]. The green streets approach to street design, which incorporates features such as street trees, green infrastructure, and green roofs to improve the ecological performance of urban streets [2]. The criteria for active commercial streets depend on acceptable speeds, volumes, noise levels, decrease of accidents, sidewalks and right-of-way for pedestrians [23]. The success of urban economy and creative economy are always carried by a unique commercial street [19]. A neighbourhood's potential can be activated through the commercial street, and it can serve as a significant public gathering place for locals and

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visitors to engage in activities and exchanges [24]. Commercial streets have played important roles in shaping people's sense of place, as evidenced by users' dependence on them for shopping and getting around [25]. Active ground floor use, row of shops, human scaled building, slow movement of vehicles, active sidewalks are the visual aesthetics for passer-by to enjoy the space [26]. A successful commercial street shares street spaces with different modes of transportation and is well connected with its surrounding street network and neighbourhood [27,28].

Design of streets and the level of traffic affects the livability in urban areas, high levels of traffic were less livable than those with lower traffic volumes and were found to be more vibrant and livable [29]. One key finding of McAndrews & Marshall [30] is the significance of encouraging environmentally friendly forms of transportation, such biking, walking, and public transportation, are creating more livable communities. Montgomery [24] argues that streets should be designed to human scale, with features such as wide sidewalks, street trees, and public seating, with a range of amenities that are easily accessible to residents. The well-designed public spaces can act as "social magnets," attracting people and encouraging social interactions [31][32]. Hillier [33] argues that streets can be designed to promote social activity, and that the spatial layout of streets and buildings can have a significant impact on the livability and vibrancy of urban neighbourhoods. According to William Whyte, the social life in public places has a significant impact on both the individual and societal quality of life. He held the opinion that we can learn a lot about what people desire in public areas by seeing and conversing with them, to shape livable communities [34]. Safety of the streets can be achieved through different types of activities in streets [35]. The universal accessibility for the vulnerable groups, or marginalized groups should be considered while designing the streets [11]. Jacob argues that streets should be designed with a sense of place and history, incorporating elements such as public art, historic architecture, and local culture [35]. Factors such as history, culture, and social dynamics of the neighbourhood has to be carefully integrated to the physical layout of the existing infrastructure [36]. In addition to fostering social contact and community involvement, well-designed public spaces can serve to create a sense of place and identity in urban environments [22]. Madanipour [37] states that cultural expression, social interaction and democratic participation are well seen in public spaces.

Recent studies emphasize that street livability is shaped by both physical design elements and experiential qualities. Elements such as street width, pedestrian infrastructure, street furniture, vegetation, and lighting influence pedestrian comfort and environmental quality. At the same time, social factors such as activity diversity, street vitality, and opportunities for interaction also contribute significantly to the perception of livable streets. A growing body of literature therefore argues for human-centered streetscape design, where streets are designed for movement but also for comfort, inclusivity, and place identity. In this context, street livability is often assessed through multiple dimensions, including safety, accessibility, comfort, aesthetics, and social interaction. Researchers have increasingly recognized that the integration of these dimensions contributes to more sustainable and people-oriented urban environments. As cities seek to promote active mobility and improve public spaces, evaluating the livability of streets has become a key component of urban sustainability strategies.

2.2. Walkability Indices

Walkability has emerged as one of the most widely studied indicators of urban livability and sustainable mobility. Walkability indices are commonly used to evaluate how well urban environments support pedestrian movement by measuring characteristics such as connectivity, land-use diversity, pedestrian infrastructure, and accessibility to destinations. These indices provide quantitative tools that enable planners and researchers to assess pedestrian conditions and identify areas requiring improvement. Recent research has highlighted the importance of developing comprehensive walkability assessment frameworks that integrate multiple spatial and environmental indicators. For example, studies have proposed walkability indices incorporating variables such as intersection density, land-use mix, public transport accessibility, and proximity to

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services to evaluate pedestrian-friendly urban environments. However, despite their usefulness, several studies point out limitations in existing walkability assessment tools. Many frameworks rely heavily on objective physical indicators, such as network connectivity and infrastructure provision, while giving less attention to subjective experiences such as perceived safety, comfort, and attractiveness. Some recent approaches attempt to address this limitation by combining objective spatial indicators with perception-based or behavioral data to provide a more comprehensive evaluation of pedestrian environments. A systematic review of walkability indices also indicates that most existing models focus primarily on mobility efficiency and health-related outcomes, often overlooking the social and experiential aspects of street environments. As a result, walkability indices may not fully capture the broader qualities that contribute to the livability of urban streets.

2.3. Commercial Streets

Commercial streets represent some of the most dynamic and socially active spaces in cities. Unlike purely residential or transportation-oriented streets, commercial corridors accommodate a diverse range of activities, including shopping, dining, social interaction, and informal economic exchanges. These streets therefore function as movement corridors but also as important public spaces that contribute to urban vitality. Recent studies have explored the spatial and social characteristics that influence the vitality of commercial streets. Research indicates that factors such as street width, retail density, ground-floor activity, and pedestrian flow significantly influence the vibrancy and attractiveness of commercial corridors. For instance, studies analyzing commercial pedestrian streets have found strong relationships between spatial configuration, pedestrian activity, and commercial vitality. Similarly, research on placemaking and commercial street environments highlights the importance of integrating social and experiential dimensions into street design. Placemaking approaches emphasize aspects such as sociability, activity diversity, accessibility, and environmental quality as essential components for creating lively and attractive commercial streets. Despite the growing body of research on commercial streets, many existing studies focus on individual design elements or pedestrian behavior rather than developing comprehensive frameworks that integrate multiple dimensions of street livability. Moreover, most existing indices are developed in Western contexts and may not fully capture the spatial complexity and socio-economic dynamics of commercial streets in rapidly urbanizing cities. This limitation highlights the need for context-specific evaluation frameworks capable of assessing both the physical infrastructure and the experiential qualities of commercial street environments.

Although previous studies have contributed significantly to understanding street livability, walkability, and commercial street vitality, there remains a limited number of frameworks that integrate physical infrastructure, pedestrian perception, and social vibrancy within a single evaluation model. Existing walkability indices primarily focus on mobility-related indicators, while studies on commercial streets often examine individual design factors rather than providing a comprehensive assessment tool. Therefore, there is a need for a composite and context-sensitive framework capable of evaluating the multidimensional livability of commercial streets, particularly in rapidly urbanizing urban environments.

3. Methodology

3.1. Research Design

This study adopts a mixed-methods research approach to develop and apply a composite Street Livability Index (SLI) for evaluating commercial street environments. The methodology integrates physical street audits, perception surveys, and behavioural observations to capture both the objective characteristics and experiential qualities of street environments. By combining multiple data sources, the framework aims to provide a comprehensive assessment of street livability that reflects infrastructure conditions as well as user perceptions and social activity patterns.

The research process was conducted in four stages:

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1. Identification of street livability indicators through literature review and policy guidelines.
2. Development of a composite index structure and parameter framework.
3. Field data collection through street audits, surveys, and behavioural observations.
4. Calculation of the Street Livability Index and spatial evaluation of the selected street segments.

3.2. study Area

The commercial strip at Thyagaraya Road (also known as Pondy Bazzar), located in T. Nagar, Chennai, selected as a case study, making it perfect site to investigate on complex socio-economic dynamics, extensive cultural connections, and notable urban foot traffics. Six main nodes along commercial street are the centre of the study. These nodes act as centres of analysis for the efficiency of urban space in fostering social cohesion and inclusion, selected as a case study for applying the Street Livability Index (SLI). This study area has busiest retail corridors, thousands of daily visitors, particularly during festival seasons, high pedestrian volumes, mixed traffic (private vehicles, buses, autos), significant presence of informal vendors, sidewalks and strong cultural and economic identity. This context made this site to test the applicability of the SLI framework.

Figure 2. Study area map of Thyagaraya Road, T.Nagar, Chennai (by author).

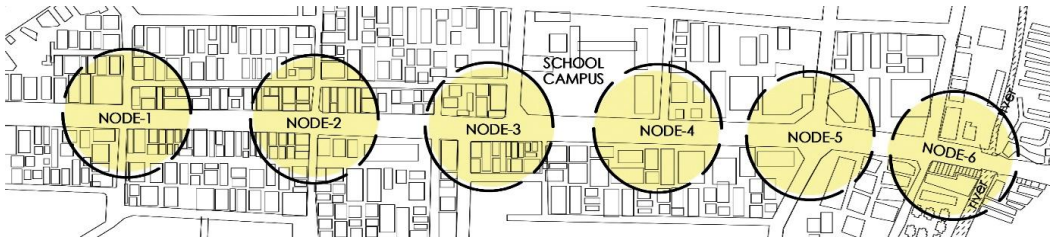

Figure 3. Study area Nodes of Thyagaraya Road, T.Nagar, Chennai (by author).

Figure 4. Shows nodes (1 to 6) (from top left to bottom right) of Thyagaraya Road, T.Nagar, Chennai. (by author).

3.3. Identification of Street Livability Indicators

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Street livability indicators were identified through a review of international assessment frameworks and national street design guidelines. Key references included frameworks such as the Healthy Streets Framework and commonly used walkability and pedestrian assessment tools. Based on the literature review and contextual relevance to Indian commercial streets, five major dimensions of street livability were identified:

Table 4. Street Livability Index (SLI) Framework: Dimensions and Indicators (by author).

Dimension	Indicators (examples)
Safety & Security	Lighting, crossings, traffic conflict
Accessibility & Connectivity	Sidewalk continuity, ramps, transit
Comfort & Amenities	Shading, seating, cleanliness
Sociability & Vibrancy	Street activity, vendor presence, linger
Management & Aesthetics	Utility placement, greenery, signage

3.4. Data Collection

- Physical Audit: Field assessments were conducted using structured audit sheets, synthesized from the Indian Roads Congress (IRC) and the Institute for Transportation and Development Policy (ITDP) guidelines to ensure compliance with national and international street design standards.
- Perception-Based User Surveys: To capture diverse perspectives, structured surveys were administered to a sample size of N = 360 stakeholders, including pedestrians, vendors, and local business owners. Data was collected using a 5-point Likert scale to quantify subjective perceptions of safety, comfort, and street vibrancy.
- Behavioral Mapping: Pedestrian dynamics and stationary activities were documented through systematic observation. This mapping analyzed movement patterns and socio-economic interactions between vendors and users during both peak and off-peak periods to capture temporal variations in street usage.

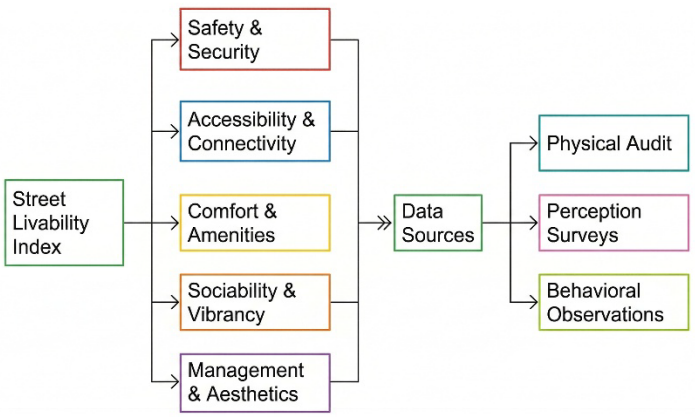

Figure 5. Conceptual Framework Diagram (by author).

3.5. Weight Calculation for the Composite Index

To develop the Composite Street Livability Index, relative weights were assigned to each parameter to reflect their importance in shaping street livability. The weighting process incorporated insights from literature, expert consultation, and user perceptions obtained from the survey. First, indicators under each parameter were normalized to ensure comparability across different measurement scales. The normalized indicator values were then aggregated within each parameter

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category. The final index score was calculated using a weighted aggregation method, where each parameter contributes to the overall Street Livability Index according to its assigned weight.

Conceptually, the composite index can be represented as:

$SLI = \Sigma (Wi \times Pi)$

Where:

SLI = Street Livability Index

Wi = weight assigned to parameter i

Pi = performance score of parameter i

The weights reflect the relative significance of different dimensions of street livability, ensuring that parameters such as safety, accessibility, and sociability are proportionally represented in the overall evaluation. The hybrid weighting approach is used to balance expert knowledge with user perspectives. The expert consultation, which comprised urban planners, engineers and architects suggested that safety and accessibility have more importance and the user survey indicates importance to comfort and amenities. The final weight distribution (Table 5) reflects a compromise between expert-derived priorities and user preferences.

Table 5. Dimension Weights for Street Livability Index (by author).

Dimension	Weight (%)
Safety & Security	34.2
Accessibility & Connectivity	31.8
Comfort & Amenities	10.2
Sociability & Vibrancy	15.7
Management & Aesthetics	8.1
Total	100

3.6. Calculation of the Street Livability Index

The final Street Livability Index was computed by aggregating the weighted scores of all parameters across the selected street segments. The index value ranges from 0 to 100, where higher scores represent better street livability conditions. The calculated scores were then compared across the six observation nodes to identify spatial variations in street livability along the corridor. This approach allows the framework to highlight areas with strong performance as well as segments requiring improvement in infrastructure, management, or public space quality.

4. Case Study Application and Results.

4.1. Physical Street Audits

A physical street audit was conducted across six nodes along the selected commercial corridor to capture on-ground conditions and complement the Street Livability Index (SLI) assessment. The audit focused on observable attributes influencing pedestrian experience, including walkway quality, spatial conflicts, and street-edge activity. By translating these characteristics into measurable indicators, the audit provides an objective evaluation of street performance and helps identify spatial deficiencies affecting overall livability.

4.1.1. Audit Design and Node Selection

The study corridor was divided into six nodes to examine variations in pedestrian experience across different segments of the street. Each node represents distinct spatial conditions such as intersections, high-activity retail stretches, and relatively quieter sections of the corridor. This node-based approach enables the identification of localized patterns that may not be visible when evaluating the corridor as a single homogeneous unit. An audit framework consisting of nine parameters was developed to assess pedestrian movement, safety, comfort, and street management conditions. The parameters included pedestrian volume, footpath continuity, usable footpath width,

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crossing provision, conflict intensity, on-street parking, vendor encroachment, built edge activity, and safety and lighting. Each parameter was evaluated using a five-point ordinal scale (1 = very poor, 5 = very good), adapted from established walkability audit practices and national street design guidelines. The use of standardized scoring allowed for consistent comparison across nodes and facilitated integration with the composite Street Livability Index.

4.1.2. Parameter-wise Performance

The summary matrix of the physical street audit across the six nodes is presented in Table 6. The results indicate that parameters related to formal pedestrian infrastructure provision demonstrate relatively strong performance. In particular, the provision of pedestrian crossings across all nodes received the highest possible score, indicating consistent availability of crossing facilities throughout the corridor. Similarly, sidewalk continuity and usable footpath width recorded relatively high scores, suggesting that basic pedestrian infrastructure has been implemented along the study area. These findings indicate that the corridor meets several physical design requirements typically emphasized in street design guidelines. However, parameters related to street management and conflict mitigation displayed comparatively weaker performance. Conflict intensity recorded the lowest overall score, highlighting persistent interactions and conflicts between pedestrians and vehicular traffic. Vendor encroachment and built-edge activity also showed uneven performance across nodes, indicating that while commercial activity contributes to street vibrancy, its spatial organization often compromises pedestrian comfort and effective sidewalk use.

Table 6. Physical street audit summary matrix (by author).

Physical Street Audit – Summary Matrix (6 Nodes)							
Parameter	Node 1	Node 2	Node 3	Node 4	Node 5	Node 6	Overall Performance
Pedestrian Volume	5	5	3	1	3	3	20
Footpath Continuity	5	5	5	5	3	3	26
Usable Footpath Width	5	5	5	5	5	3	28
Crossing Provision	5	5	5	5	5	5	30
Conflict Intensity	1	1	3	1	3	1	10
On-street Parking	3	3	1	5	5	3	20
Vendor Encroachment	3	3	3	1	3	5	18
Built Edge Activity	5	5	3	1	1	5	20
Safety & Lighting	5	5	5	3	5	5	28
Overall Node Performance	37	37	33	27	33	33	200

4.1.3. Node-Level Spatial Variation

A comparison of audit scores across the six nodes reveals significant spatial variation along the corridor. Nodes 1 and 2 emerged as the highest-performing segments, characterized by continuous footpaths, adequate lighting, and active built edges that support pedestrian movement and encourage street-level engagement. In contrast, Node 4 recorded the lowest overall score due to higher conflict intensity, reduced pedestrian comfort, and weaker street-edge activation. These findings highlight that street livability is not uniformly distributed across the corridor but is influenced by localized factors such as intersection design, parking behavior, and the regulation of

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informal commercial activities. The node-based analysis therefore provides important insights into spatial inequalities in pedestrian experience that may remain obscured in broader corridor-level assessments.

4.1.4. Integration with Street Livability Index Results

The physical street audit findings correspond closely with the results of the Street Livability Index. Both assessments indicate a dominance of safety and accessibility dimensions, reflecting the relatively strong performance of basic pedestrian infrastructure. However, the audit also reveals limitations in infrastructure-led street design approaches when they are not supported by effective operational management and enforcement. This gap is particularly evident on commercial streets where informal vending, parking behavior, and pedestrian crowding dynamically interact with formal infrastructure. The findings highlight that livability assessments must extend beyond physical design standards to incorporate indicators related to operational management and regulatory effectiveness. Current street design frameworks in India primarily emphasize infrastructure parameters such as footpath width, crossings, and universal accessibility, but often underemphasize the management of spatial conflicts, informal activities, and street-edge interfaces that shape everyday pedestrian experience. The audit results therefore suggest that improving street livability requires physical redesign but also sustained management strategies addressing parking regulation, vendor integration, and conflict mitigation.

4.2. Survey Results

The results of the structured perception survey are summarized in Table 7. The analysis indicates that Safety & Security (27.8%) and Accessibility & Connectivity (24.2%) together contribute more than half of the overall Street Livability Index score. This finding highlights the dominant influence of pedestrian infrastructure and perceived safety on street livability. The survey also reveals the significance of street activity and informal social interactions, reflected in the Sociability & Vibrancy dimension, which contributes 12.6% to the overall index. This dimension captures aspects such as pedestrian interaction, informal vending, and opportunities for social engagement, which are characteristic features of commercial streets. In contrast, Comfort & Amenities and Management & Aesthetics recorded comparatively lower contributions. These results indicate that factors such as shading, seating, cleanliness, greenery, and visual organization remain relatively weak components of the street environment. Addressing these aspects through targeted design and maintenance interventions could significantly improve the overall livability of the corridor.

Table 7. Dimension-Wise Scores for Thyagaraya Road (by author).

Dimension	Indicators (sample)	average score	n	normalized score	weight	weighted contribution
Safety & Security	Lighting, crossings, traffic conflict	4.07	5	81.4	0.342	27.8388
Accessibility & Connectivity	Sidewalk continuity, ramps, transit	3.81	5	76.2	0.318	24.2316
Comfort & Amenities	Shading, seating, cleanliness	3.52	5	70.4	0.102	7.1808
Sociability & Vibrancy	Street activity, vendor presence, linger	4.03	5	80.6	0.157	12.6542
Management & Aesthetics	Utility placement, greenery, signage	3.25	5	65	0.081	5.265
Overall SLI					1	80.208

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4.2.1. Visualization of Results

(a) Dimension Comparison – Bar Chart

Figure 6 presents a bar chart illustrating the dimension-wise contribution to the overall Street Livability Index. The chart highlights the dominance of Safety & Security and Accessibility & Connectivity while clearly indicating the relatively weaker performance of Comfort & Amenities and Management & Aesthetics. Such visualization enables rapid comparison across dimensions and helps identify priority areas for policy and design intervention. Dimensions with relatively high weights but moderate performance scores represent critical leverage points where targeted improvements can significantly enhance overall street livability.

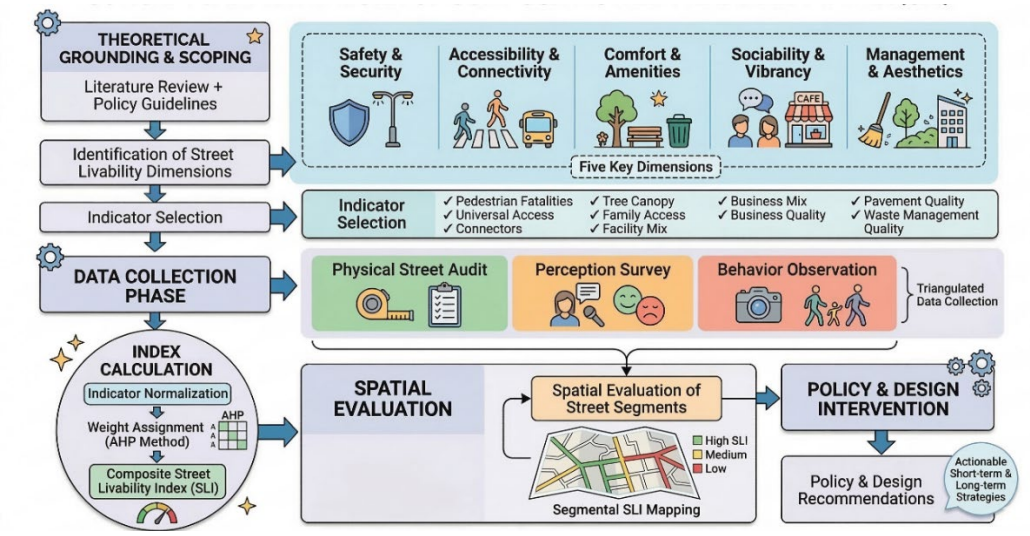

Figure 6. Conceptual Framework of composite street livability index (by author).

(b) Radar (Spider) Chart Interpretation

The radar chart shown in Figure 7 provides a visual representation of the relative contribution of each livability dimension to the overall Street Livability Index after applying the AHP-derived weights. The chart indicates that Safety & Security and Accessibility & Connectivity form the strongest axes of the livability profile, confirming their dominant influence on the overall evaluation. These dimensions represent the structural foundation of street livability, reflecting expert prioritization of pedestrian safety, traffic management, and accessibility on commercial streets. The Sociability & Vibrancy dimension occupies a moderate position within the radar profile. This suggests that while street life, informal activities, and pedestrian interaction contribute positively to the street environment, their influence remains secondary to functional and safety related considerations. In contrast, Comfort & Amenities and Management & Aesthetics display shorter radii on the radar chart, indicating relatively weaker contributions to the overall index. These findings reveal deficiencies in shading, seating, cleanliness, maintenance, and visual quality—factors that strongly influence pedestrian experience but are often underemphasized in infrastructure-oriented planning approaches. Overall, the radar chart highlights an uneven livability profile, characterized by strong social vibrancy, moderate accessibility and safety, and comparatively weaker comfort and management conditions.

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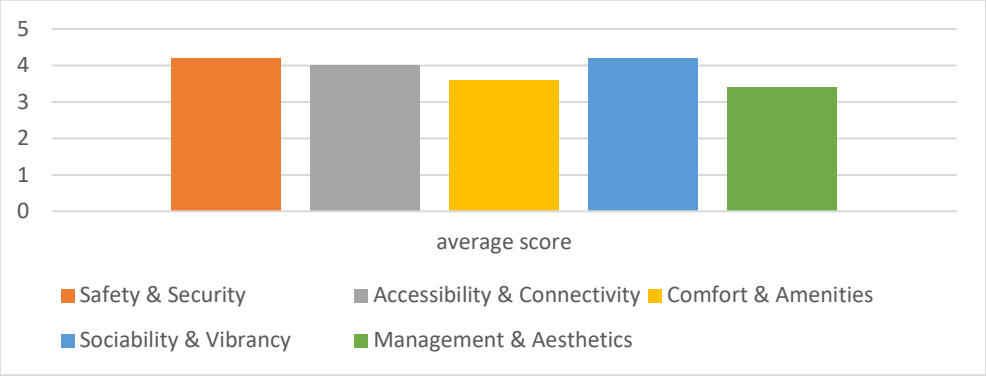

Figure 7. Parameter comparison – Bar Chart (by author).

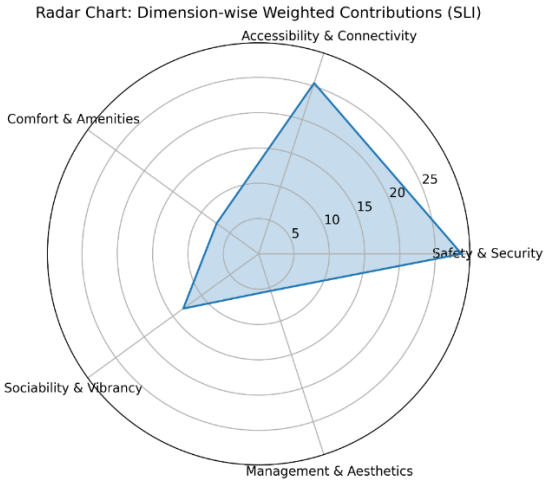

Figure 8. Parameter comparison – Radar Chart (by author).

4.3. Behaviour Observation Analysis

4.3.1. Streetscape Elements

A 30-meter-wide street runs from the west to the east of the study area, featuring different types of building uses from node 1 to 6 with broader sidewalks of 9 to 10 meter from node 1 to 3 and 4m to 2.4m wide from node 4 to 6. The sidewalk boosts access to shops, promoting lively public spaces and diverse activities. The area between node 3 and 4, predominantly a school zone, experiences less foot traffic, other than school hours. Meanwhile, node 3 to 6 are undergoing new mid and high-rise development, emphasizing vehicular movement and resulting in narrower 4.5 meter sidewalks. The older buildings present in node 1 to 3 contribute to a strong sense of community, including a 50-year-old school. The newer constructions in node 3 to 6, offer modern amenities and are attractive for their extensive connectivity. Street vendors and hawkers are notably more prevalent in nodes 1 to 3, attracted by the bustling shop fronts, whereas nodes 4 to 6 with fewer hawkers due to the presence of office complexes.

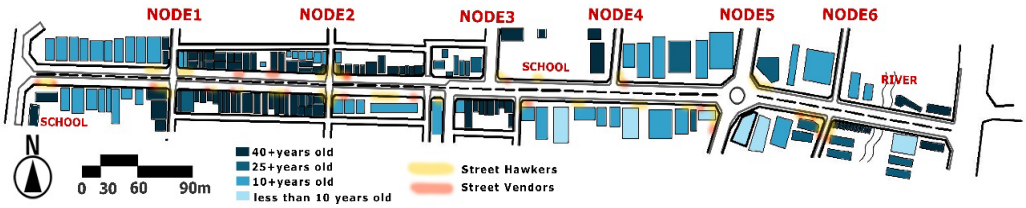

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Figure 9. *Shows existing aged building, street hawkers, street vendors and sidewalk in Sir Thyagaraya Road, Thyagaraya Nagar, Chennai.*(by author).

4.3.2. Built-Use and Activity

Nodes 1 to 3 are lined with shopping centers, commercial establishments, and public buildings, ensuring a steady flow of pedestrians and vehicles throughout the day. Node 4 faces less crowd due to longer school walls. Wider sidewalks from Node 1 to Node 3 promote walking and cycling. Node 1 to 6 expansive walkways across all nodes encourage foot and bicycle traffic, contributing to overall health benefits. A variety of transportation options are accessible, encompassing public transport services, auto-rickshaws and bike-sharing programs. Parking is conveniently distributed, featuring car parking spaces in Node 3 to 6, as well as multi-level parking specifically at Node 3 for Node 1 and 2. Street furniture around trees in all nodes creates inviting spaces for relaxation, allowing people to engage in conversations and enjoy their surroundings. Node 1 to 3 are enhanced with interactive installations, informational kiosks, and Node 5 is adorned with statues, enriching the space's appeal and promoting social interaction. The buildings in Node 1 to 3, with their older, low-rise buildings, emphasize a human-scale environment that invites lingering and community bonding. New constructions in Nodes 4 to 6 introduce a different scale, which might detract from the intimate communal atmosphere present in the earlier nodes.

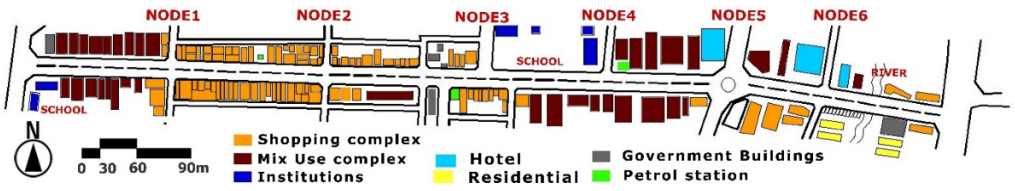

Figure 10. Shows building use typology in Sir Thyagaraya Road, Thyagaraya Nagar, Chennai.. *by author).*

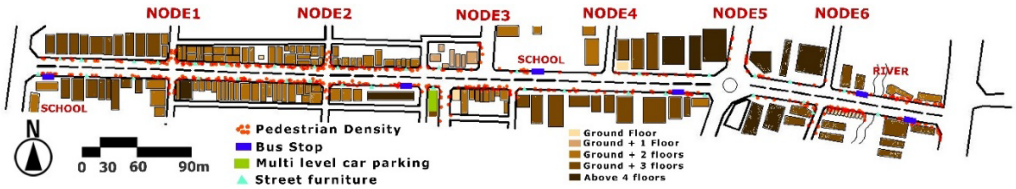

Figure 11. Shows pedestrian density, street furniture, bus stop and multi level car parking in Sir Thyagaraya Road, Thyagaraya Nagar, Chennai.*(by author).*

4.3.3. Social Activities

The study area stands out for its bustling shopping centres, particularly around Node 1, 2 and 3. A significant landmark is an over 50-year-old school situated between Node 3 and 4, established a profound connection with the local community. Node 4 to 5 is distinguished by towering office buildings and international hotels, attracting newcomers and contributing to the charm of the area. Node 6 is recognized for its convention centers and shopping malls, attract visitors from the surrounding neighbourhood. Visually, the avenue is adorned with trees across all nodes, creating a welcoming vibe for guests. Node 1 and 2 are especially notable for their vibrant and fashionable exteriors, displaying the latest trends and inviting people to explore. The visual progression from Node 4 to 6 is characterized by recent developments, contemporary architecture, and skyscrapers, enhancing the area's aesthetic appeal. There's a strong community bond, especially in Node 1 and 2, where local ownership of small to medium-sized shops for over 50 years has fostered a sense of belonging. This enduring relationship has deepened the connection between residents and these shopping hubs, making them a favoured spot. This collective effort empowers each individual to contribute to their community's growth and engage in local events. Notably, the expansive sidewalks

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in Node 1, 2, and 3 become stages for local talent on weekends, attracting larger audiences and boosting community interaction compared to other nodes.

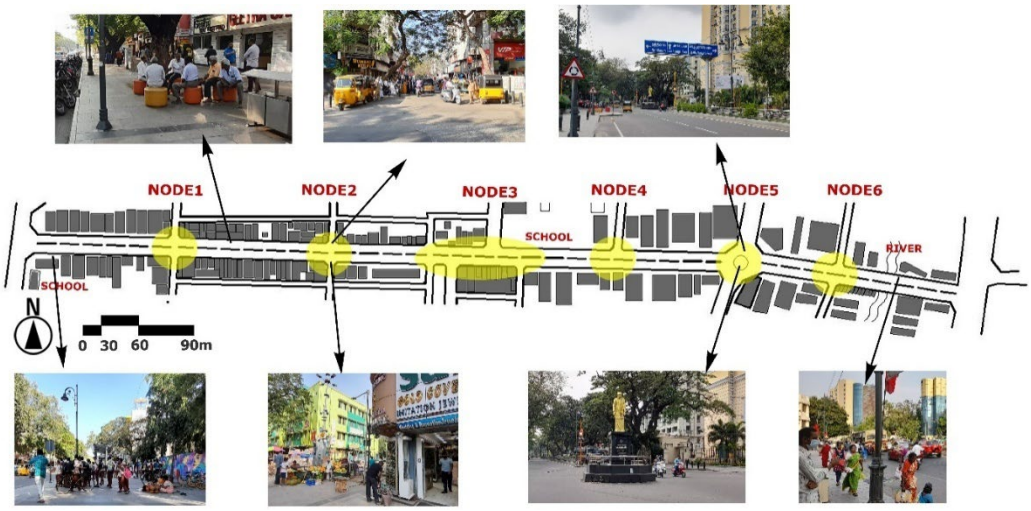

Figure 12. Shows social activities in Sir Thyagaraya Road, Thyagaraya Nagar, Chennai.*(by author).*

4.3.4. Street Safety

Street lights across all nodes, plays an important role in ensuring that people can move around and engage in activities conveniently after sunset. Node 1, 2, and 3 primarily consisting of shopping complexes, feature shorter plot frontages with more transparent façades that interact with the sidewalk, facilitating pedestrian movement. From Node 3 to 4, a school compound wall designed with artworks maintain interest for sidewalk users. In contrast, Node 5 and 6, characterized by high-rise buildings, are equipped with low compound walls, offering clear views and sightlines to the road, thus contributing to a sense of safety and visual connection. Traffic calming measures are implemented across all nodes, including speed breakers and pedestrian crossings, to ensure the safety of both pedestrians and drivers. In terms of shade and shelter, tree canopies provide natural protection, enhancing comfort for pedestrians. Furthermore, all nodes emphasize universal accessibility, ensuring inclusive and accessible to individuals with physical challenges. This inclusivity facilitates the movement of disabled people across all nodes, underscoring a commitment to safety and accessibility for all community members.

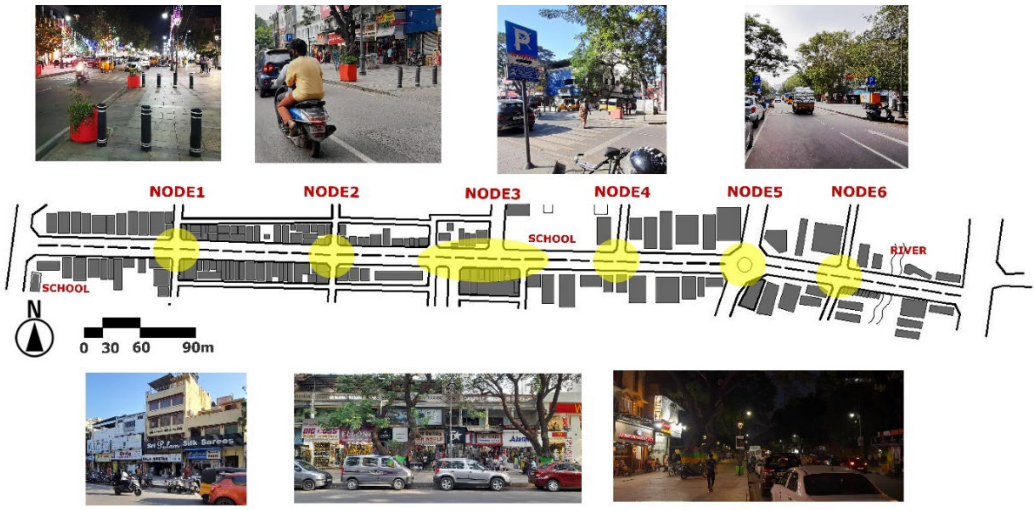

Figure 13. Shows street lights, pedestrian crossing, parking and universal accessibility in Sir Thyagaraya Road, Thyagaraya Nagar, Chennai. *(by author).*

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4.3.5. Tree Mapping

Nodes 1, 2, and 3, there is a significant presence of tree canopies, which enhances the area's greenery and provides shade. However, Nodes 4, 5, and 6 also support with fewer tree canopies, with their new developments. Despite this, the tree canopies in Nodes 1, 2, and 3 are well-maintained, partly due to fewer new developments, facilitating various activities such as street hawkers and vendors selling goods under the shade of the trees. These spaces also become gathering points for people to sit, chat, and enjoy the greenery, contributing positively to their psychological well-being. The greenery is noticeable across all nodes, especially from node 4 to node 6, where planter boxes along the sidewalks and greenery in the central median of the road are prominent. The presence of tree canopies and a large number of plants in the sidewalks and medians plays an important role in filtering air pollution and creating cleaner air throughout the area. Additionally, these tree canopies serve as a noise buffer, helping to reduce noise pollution and create a more tranquil environment.

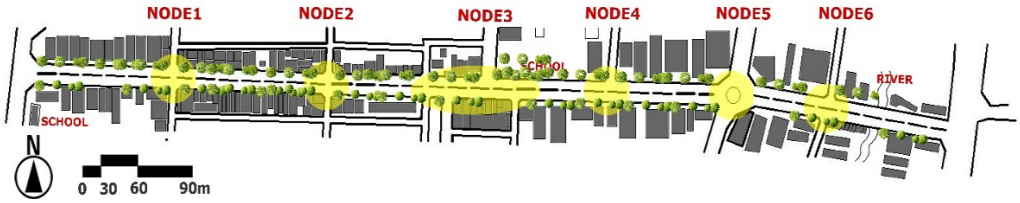

Figure 14. Shows tree mapping in Sir Thyagaraya Road, Thyagaraya Nagar, Chennai.*(by author).*

5. Discussion

The results of the structured perception survey were analyzed using the Analytic Hierarchy Process (AHP) to derive relative weights for the five street livability dimensions. AHP was employed to prioritize indicators through pairwise comparison of dimensions based on expert judgment, enabling a systematic evaluation of their relative importance in shaping street livability. The derived weights were subsequently applied to the normalized perception scores to compute the weighted contribution of each dimension to the overall Street Livability Index (SLI). The results are summarized in Table 7. The analysis shows that Safety & Security (27.8%) and Accessibility & Connectivity (24.2%) together account for more than half of the overall livability score, indicating the dominant influence of pedestrian safety and mobility infrastructure on the perceived quality of commercial streets. Sociability & Vibrancy (12.6%) also contributes significantly, reflecting the importance of street activity, informal interactions, and commercial dynamism in shaping the character of the corridor. In contrast, Comfort & Amenities (7.2%) and Management & Aesthetics (5.3%) demonstrate relatively lower contributions. These results highlight critical gaps in pedestrian comfort, environmental quality, and street management. Addressing these aspects through targeted design and operational interventions could substantially improve the overall livability performance of the corridor.

5.1. Dimension-Wise Insights

The results of the Street Livability Index reveal an uneven performance across the five evaluated dimensions, highlighting the complex relationship between infrastructure provision, social activity, and street management in commercial environments. Among the evaluated dimensions, Safety and Security (4.07 /5) recorded the highest score, largely due to the presence of active street edges, adequate lighting conditions, and continuous pedestrian activity that enhances natural surveillance. However, persistent conflicts between pedestrians and vehicular traffic reduce the perceived level of safety. In particular, uncontrolled parking behavior and informal traffic movements create points of conflict at several locations along the corridor.The dimension of Sociability & Vibrancy (4.03/5) demonstrate that commercial streets can maintain strong social vibrancy even in environments where infrastructure conditions are imperfect. The presence of dense retail activity, informal street vendors,

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and continuous pedestrian movement contributes to a dynamic public realm, which enhance social surveillance and urban vitality. The dimension of Accessibility and Connectivity (3.81/5) also performed relatively well. The corridor benefits from strong integration with public transport networks, including bus routes, auto-rickshaw stands, and metro connectivity, which significantly increases pedestrian accessibility. However, despite the presence of pedestrian infrastructure, challenges such as sidewalk encroachments, uneven pavement surfaces, and irregular walkway continuity limit universal accessibility. These conditions particularly affect vulnerable users such as elderly pedestrians and persons with disabilities. In contrast, Comfort and Amenities (3.52/5) emerged as one of the weaker dimensions in the livability assessment. The limited availability of seating areas, shading structures, and pedestrian resting spaces reduces overall comfort, especially in the tropical climatic conditions of Chennai. Thermal discomfort, combined with pedestrian congestion and limited environmental amenities, negatively influences the overall pedestrian experience along the corridor.

Finally, Management and Aesthetics (3.25/5) recorded the lowest performance among the five dimensions. Issues such as visual clutter from signage, irregular utility placement, lack of greenery, and limited maintenance of street infrastructure contribute to a reduced aesthetic quality of the streetscape. These findings indicate that while the corridor functions as a vibrant commercial space, the absence of systematic management and environmental improvements significantly affects the overall livability of the street environment. Overall, the dimension-wise results suggest that Thyagaraya Road exhibits strong social vitality but faces functional challenges related to comfort, management, and pedestrian space organization**.** The corridor therefore represents a typical example of a commercially successful yet infrastructurally constrained street environment in rapidly urbanizing cities.

5.2. Comparison with National Frameworks

When compared with national street design guidelines and policy frameworks in India, the findings reveal both alignment and limitations. Standards such as those issued by the Indian Roads Congress, transit-oriented development policies promoted by the Ministry of Housing and Urban Affairs, and complete street initiatives implemented in several Indian cities primarily emphasize infrastructure provision and geometric design standards. The case study corridor generally complies with several baseline requirements outlined in these guidelines, such as the provision of pedestrian crossings, minimum sidewalk widths, and basic lighting infrastructure. These aspects explain the relatively strong performance observed in the Safety and Accessibility dimensions of the Street Livability Index. However, the findings also reveal important limitations in these frameworks. Existing national guidelines focus primarily on physical infrastructure compliance**,** while qualitative dimensions such as pedestrian comfort, social interaction, and street vibrancy receive relatively limited attention. In addition, informal street activities such as street vending and spontaneous social interactions are often treated as regulatory challenges rather than integral components of commercial street environments. As a result, there is a noticeable mismatch between the formal design standards prescribed in policy documents and the lived realities of commercial streets**.** The results of this study therefore suggest that while Indian frameworks provide an important infrastructure baseline, they remain insufficient for evaluating the broader experiential qualities that define livable commercial streets.

5.3. Comparison with International Frameworks

A comparison with international street assessment frameworks further highlights the significance of the findings. Global evaluation tools such as the Healthy Streets Framework, the Pedestrian Environment Review System, and the Global Walkability Index adopt more comprehensive approaches for assessing pedestrian environments. For instance, the Healthy Streets framework places strong emphasis on factors such as pedestrian comfort, air quality, environmental quality, and opportunities for social interaction. These factors correspond closely with the relatively

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low scores observed in the Comfort and Amenities dimension in this study, indicating that environmental quality remains an underdeveloped aspect of the corridor. Similarly, the Pedestrian Environment Review System provides a systematic scoring methodology for evaluating pedestrian infrastructure and perceived safety conditions. If applied to the case study corridor, such a framework would likely capture the negative impacts of pedestrian–vehicular conflicts and irregular sidewalk conditions observed in the audit results. The Global Walkability Index, developed for several Asian cities, emphasizes pedestrian perceptions and behavioral responses to street environments. The perception survey conducted in this study reflects similar concerns regarding pedestrian comfort, safety, and accessibility, suggesting that user experience plays a critical role in shaping the livability of commercial streets. Taken together, these comparisons indicate that international frameworks often integrate both infrastructure quality and experiential dimensions in their evaluation models. The proposed Street Livability Index developed in this study contributes to this growing body of research by providing a context-sensitive assessment framework that captures the unique spatial and social dynamics of commercial streets in Indian cities.

6. Policy and Planning Implications

The findings of this study emphasize that infrastructure provision alone is insufficient to ensure livable street environments. While pedestrian facilities such as sidewalks and crossings are necessary, they must be complemented by effective street management strategies addressing parking behavior, vendor integration, and pedestrian vehicular conflicts. Second, the analysis highlights the need for integrated street design approaches that balance mobility, social activity, and environmental comfort. Commercial streets function as transport corridors but also as important social and economic public spaces. Planning interventions should therefore incorporate amenities such as shading structures, seating, greenery, and improved streetscape management to support pedestrian comfort and social interaction. Third, the Street Livability Index framework developed in this study can serve as a decision-support tool for evaluating and prioritizing street improvement projects. By combining objective audits with perception-based indicators, the framework provides a systematic method for identifying spatial variations in street performance and guiding targeted interventions in commercial districts.

Based on the findings, several strategic interventions can be identified, and listed in Table 8.

Table 8. Shows identified strategic interventions.

Time Frame	Strategic Intervention	Description / Purpose
Short-term interventions	Installation of shading structures along pedestrian corridors	Improve pedestrian thermal comfort and walkability, especially under hot climatic conditions.
	Regulation and spatial organization of vending zones	Organize informal vending activities to maintain pedestrian flow while preserving street vibrancy and economic activity.
	Improved signage and Wayfinding	Enhance navigation, safety awareness, and accessibility for pedestrians and visitors.
Medium-term interventions	Redesign of pedestrian crossings and conflict zones	Reduce pedestrian–vehicular conflicts through improved crossing design, traffic calming, and intersection management.
	Improved management of utilities and street furniture	Reorganize utility placements, lighting, and street furniture to optimize sidewalk usability and reduce visual clutter.

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	Introduction of greenery and environmental enhancements	Improve environmental quality through tree planting, landscaping, and micro-climate regulation.
Long-term interventions	Institutionalization of street management frameworks	Establish coordinated governance mechanisms for continuous monitoring and management of commercial street environments.
	Strengthening collaboration between municipal authorities, businesses, and community stakeholders	Promote participatory street management involving local businesses, vendors, and residents to sustain long-term livability improvements.

Such multi-level interventions can support the transformation of commercial streets into more inclusive, comfortable, and sustainable public spaces.

6.1. Limitations of the Study

Despite its contributions, this research has several limitations. First, the analysis is based on a single case study corridor, which may limit the generalizability of the findings to other urban contexts. Commercial streets in different cities may exhibit varying spatial configurations, socio-economic dynamics, and governance structures. Second, the perception survey represents pedestrian experiences at a specific point in time. Seasonal variations, festival periods, and peak commercial events may significantly influence pedestrian volumes, street activity, and perceived livability conditions. These temporal variations were not fully captured in the present study. Third, while the use of the Analytic Hierarchy Process provides a systematic approach for deriving indicator weights, the weighting process still relies on expert judgments that may introduce subjective bias. Future studies could explore additional statistical validation techniques or participatory approaches to strengthen the weighting framework.

6.2. Future Research Directions

The Street Livability Index framework could be applied across multiple commercial corridors in different Indian cities to enable comparative analysis and improve the robustness of the index. Such cross-city studies would help identify common patterns and context-specific factors influencing street livability. Second, future work could incorporate longitudinal data collection, capturing variations in pedestrian activity and environmental conditions across different seasons and time periods. This would allow a more dynamic understanding of street performance. Third, emerging technologies such as GIS-based spatial analysis, pedestrian movement tracking, and real-time environmental monitoring could be integrated into the assessment framework to provide more detailed and objective measurements of street conditions. Finally, further research may explore how participatory planning approaches involving local businesses, residents, and municipal authorities can contribute to more effective street management and long-term improvements in commercial street livability.

7. Conclusion

The results indicate that the corridor performs relatively well in terms of Safety & Security and Accessibility & Connectivity, which together account for more than half of the overall livability score. These dimensions highlight the importance of pedestrian infrastructure, lighting, and connectivity to public transport in shaping positive street experiences. The dimension of Sociability & Vibrancy also contributes significantly, reflecting the dynamic commercial activity and social interaction characteristic of busy urban retail corridors. However, the findings reveal notable deficiencies in Comfort & Amenities and Management & Aesthetics, which scored comparatively lower in the index. The absence of adequate shading, seating, greenery, and organized street management reduces

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pedestrian comfort and environmental quality. Overall, the analysis suggests that while the corridor demonstrates strong commercial vitality and pedestrian activity, improvements in environmental amenities and operational management are essential to achieve higher levels of street livability.

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Abbreviations

The following abbreviations are used in this manuscript:

SLI	Street Livability Index
TFL	Transport for London
PERS	Pedestrian Environment Review System
TRL	Transport Research Laboratory
GWI	Global Walkability Index
PLOS	Pedestrian Level of Service
PPS	Project for Public Spaces
NACTO	National Association of City Transportation Officials
IRC	Indian Roads Congress
DDA	Delhi Development Authority
S.U.R.E.	Specifications for Urban Road Execution
NMT	Non-Motorised Transport
ITDP	Institute for Transportation and Development Policy
MoHUA	Ministry of Housing and Urban Affairs
AHP	Analytic Hierarchy Process

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