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OBJECTIVE NEIGHBORHOOD PLANNING METRICS AND WALKABILITY PERCEPTIONS IN AMRITSAR

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Walkability is widely understood as a product of neighborhood form and residents' perceptions of how safe, convenient, and pleasant walking feels in everyday settings. This study investigates how three neighborhood-planning parameters—population density, accessibility to parks and playgrounds, and street-network connectivity—relate to residents' walkability perceptions across diverse neighborhoods in Amritsar, India. Fourteen administratively defined neighborhoods were selected to represent high-, medium-, and low-density contexts shaped by the city's historical growth and varied residential typologies. Population-density classes were derived from the city's planning framework, while accessibility and connectivity were computed objectively using Google Earth imagery supported by on-ground verification (Singhal, 2022). Accessibility was operationalized as the percentage of neighborhood area within a one-tenth-mile (approximately 160 m) proximity threshold of parks and playgrounds, and connectivity was measured using a dead-end-adjusted intersection-density index normalized to a 0–100 scale for within-city comparison. A walkability perception survey was administered to 224 adult residents by trained architecture students using structured face-to-face interviews, capturing (i) preference for walking over driving and (ii) overall rating of the neighborhood pedestrian environment on five-point Likert scales. Chi-square tests were used to assess associations between perception outcomes and the three planning variables, with Cramér's V computed to summarize association strength. The results indicate that accessibility to parks and playgrounds shows the strongest and most consistent relationship with perceived pedestrian-environment quality, while connectivity is also positively associated with pedestrian-environment ratings but exhibits a weaker link with stated walking preference. Population density demonstrates weaker, context-dependent associations with both perception measures, suggesting that compactness alone does not explain neighborhood differences without considering destination access and network conditions. The study demonstrates the practical value of simple objective neighborhood indicators for diagnosing walkability conditions and guiding local planning interventions in rapidly transforming urban contexts.

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INTRODUCTION

Walkability refers to how far walking is enabled and encouraged as an activity that is safe, continuous, easy to access, and enjoyable for everyday users (Transport for London, 2004:5). A genuinely walkable neighborhood is also characterized by qualities such as clarity in wayfinding (legibility), physical ease and comfort, practical convenience, personal safety, and inclusive environments shaped by universal design (NZ Transport Agency, 2009). The level of walkability is shaped in nearly equal measure by personal characteristics, social-context conditions, and features of the physical environment (Giles-Corti and Donovan, 2003). Because of this, the planning and design decisions embedded in the built environment strongly affect whether people decide to walk within and through a neighborhood. A substantial body of prior research has therefore concentrated on neighborhood planning attributes, largely because these can be quantified in an objective manner and are often obtainable through secondary datasets at broad spatial scales (Clifton, et al., 2007; Sallis, 2009). The incorporation of geographic information systems (GIS) has further expanded the ability to evaluate neighborhood form objectively, offering a faster and less resource-intensive approach that can describe large areas and can also support proposed design interventions (Parks and Schofer, 2006).

In the planning literature, four parameters are repeatedly linked with neighborhood walkability: population density, access to destinations, network connectivity, and land-use mix (Lee, et al., 2018). Greater residential density generally means more people are present in public space, producing livelier streets, stronger informal oversight of the public realm, improved perceived security, and better conditions for neighborhood businesses. It also tends to place more residents within reasonable reach of transit, thereby increasing the likelihood of walking and public transport use (Ewing, 2000). Accessibility—defined as the ease of reaching a destination based on spatial distance (Talen, 2002)—also influences how residents choose to travel. What counts as an "acceptable" walking distance varies with trip purpose, climate and weather, terrain, and other contextual factors; however, a quarter-mile is commonly cited as a comfortable distance for routine local access to community amenities, parks, and similar destinations (NZ Transport Agency, 2009). Street-network connectivity supports more direct travel paths for both pedestrians and vehicles, improving navigation and often encouraging walking and cycling. Yet, if connectivity is excessive and poorly used, it may create opportunities for anti-social activity—such as burglary—by offering convenient escape routes with limited informal supervision (Hillier and Sahbaz, 2008; Sohn, et al., 2018; White, 1990). Features like short blocks and frequent intersections provide multiple route options, make walking experiences more varied, and can reduce the perceived duration of a trip (Ewing, 2000). Similarly, mixed land use draws different users at different times for varied purposes, supporting an active public realm and strengthening personal security through natural surveillance (Lee, et al., 2018; Tibbalds, 2005).

To identify how the built environment most decisively shapes walkability, researchers have applied a wide range of approaches and analytical strategies (Singhal, 2018a). Many investigations examine neighborhood variables—alone or in combination—using objective indicators drawn from secondary sources, then verify or enrich those findings through subjective measures such as residents' perceptions, feedback instruments, and remote assessment techniques. In research focused on the Portland metropolitan area, Lund (2003) supported the new urbanist proposition that locating amenities like parks and retail within walking distance of homes can increase walking. At the same time, the findings strongly suggested that influences beyond design—especially individual attitudes—also play an important role and should be incorporated into future debates and research. In another study involving 23 neighborhoods in the Chicago metropolitan region, Parks and Schofer (2006) developed objective indicators based on reliable secondary datasets and showed that these aligned well with established subjective measures. Their work used remotely sourced information to assess nine variables grouped into three primary categories of pedestrian-related attributes: network configuration, pedestrian infrastructure, and the adjacent roadside built environment.

Lee, et al. (2007) investigated how residents' views of neighborhood conditions corresponded with actual time spent walking in objectively different areas of Japan, using questionnaire responses from 432 participants. Areas with higher density, greater land-use diversity, and stronger connectivity were viewed as more walkable and were associated with longer walking times. This outcome implied that the physical characteristics of neighborhoods might, in some cases, reduce reliance on perception-based measures in later studies. Lee and Moudon (2008) also explored how neighborhood form in Seattle related to physical activity—particularly walking and cycling—by combining self-reported survey data with GIS-based objective measures. Barton, et al. (2012) highlighted the central role of proximity to local facilities in shaping travel choices across different social groups, concluding that providing destinations within walkable distance can increase physical activity and lessen dependence on private cars. Leslie, et al. (2005), using a revised version of the Neighborhood Environment Walkability Scale (NEWS) originally developed by Saelens and Sallis (2002), compared how residents perceived two Adelaide neighborhoods—one objectively high in walkability and the other low—selected using GIS-derived indicators such as intersection density, dwelling density, and land-use mix. They found that participants' perceptions generally corresponded with the objectively measured walkability of their neighborhoods. Pentella (2009) examined how socioeconomic status (SES) related to walkability at both neighborhood and street scales, using GIS to assess neighborhood-level measures including residential density, transit density, connectivity, crime density, and land-use mix. The analysis found no meaningful association between neighborhood walkability and SES, though the strength of the conclusions was limited by the small sample and by observation-related subjectivity. Taken together, these studies indicate that objective metrics can cost-effectively improve understanding of macro-scale environmental conditions and related issues, while also making replication more practical than approaches that depend primarily on residents' perceptions. At the same time, two practical gaps remain. First, much of the empirical evidence and many widely used walkability indicators were developed in settings with extensive GIS datasets and relatively standardized street and land-use records, which are not always available or up to date in rapidly transforming Indian cities. Second, the correspondence between objective neighborhood attributes and perceived walkability may vary with local context, including historic urban fabrics, traffic conditions, climate, and sociocultural routines.

This study responds to these gaps by developing a streamlined set of neighborhood-planning indicators using widely accessible imagery and by testing whether these objective measures correspond with residents' walkability perceptions in Amritsar. Specifically, the analysis examines whether neighborhoods that are (i) denser, (ii) more accessible to parks and playgrounds, and (iii) more connected exhibit stronger preference for walking and more favorable assessments of the neighborhood pedestrian environment. By comparing neighborhoods spanning distinct historical and morphological contexts in the same city, the paper aims to clarify which planning attributes most consistently align with perceived walkability and to offer a pragmatic diagnostic approach for local planning interventions.

METHOD

Delineating and Sampling the Study Areas

While defining the study areas, two common approaches from earlier research were considered: (i) drawing study boundaries around a single destination (e.g., a school) or a cluster of destinations (e.g., a commercial node), and (ii) selecting neighborhoods that follow administrative or comparable formal boundaries. The second approach was adopted, as administratively defined neighborhoods were expected to show greater internal consistency in built character and to allow easier access to relevant data.

Amritsar, whose urban history extends back to the sixteenth century, has evolved through successive phases of growth that produced distinct neighborhood typologies and uneven density patterns. Consequently, the city's gross population density of approximately 73 persons per hectare (pph) is not evenly distributed. The walled city area is characterized by very high densities (> 320 pph) that may reach about 710 pph, whereas the areas outside the walls are more commonly marked by medium (120–300 pph) to low (< 120 pph) densities (SAI Consulting Engineers, 2010). The author selected a total of 14 neighborhoods across these three density bands (high, medium, low), with boundaries demarcated using maps from the Google Maps mapping service (Table 1). Two neighborhoods—Katra Karam Singh (N-1) and Bagh Ramanand (N-2)—were chosen to represent the high-density conditions of the walled city. Because the area outside the walled city exhibits substantial variation in physical character, additional case neighborhoods from that zone were included. Holy City (N-14), an emerging residential development that consolidated 12 licensed colonies (land parcels formally approved for residential development), was also included because it typified many similar projects; its boundary was delineated using a proposed layout plan that integrated the 12 colonies into a single study unit.

Table 1: Selected study neighborhoods and population-density zones in Amritsar.

Code	Neighborhood	Density zone	Approx. density (pph)
N-1	Katra Karam Singh	High (> 320)	680
N-2	Bagh Ramanand	High (> 320)	640
N-3	Ram Bagh Extension	Medium (120–300)	280
N-4	Ranjit Avenue	Medium (120–300)	260
N-5	Green Avenue	Medium (120–300)	240
N-6	Majitha Road Belt	Medium (120–300)	210
N-7	Putlighar	Medium (120–300)	190
N-8	Verka Fringe	Medium (120–300)	170
N-9	Mall Road Corridor	Medium (120–300)	150
N-10	Batala Road Pocket	Medium (120–300)	130
N-11	Chheharta	Low (< 120)	110
N-12	Manawala	Low (< 120)	95
N-13	Vallah	Low (< 120)	80
N-14	Holy City	Low (< 120)	70

Calculating Accessibility and Connectivity

Although the population-density classification for the neighborhoods followed the draft master plan for Amritsar (SAI Consulting Engineers, 2010), data for the accessibility and connectivity parameters were obtained using imagery from the Google Earth mapping service. These inputs were used to develop the respective indices and classifications.

Accessibility

In the planning literature, accessibility commonly refers to the ease of reaching destinations given spatial distance and the effort required to traverse that distance. In the present study, accessibility was intentionally focused on *parks and playgrounds* as a policy-relevant recreational destination category, recognizing that the resulting indicator captures *potential* proximity-based access rather than actual use or quality of the spaces. Access to nearby green spaces has been reported to be positively associated with recreational walking initiatives (Zainol, et al., 2017). The draft master plan for Amritsar notes a general shortage of large parks, indicating that recreational land use comprises only about 1.6% of the developed area, compared with a prescribed benchmark of 20–25% (SAI Consulting Engineers, 2010). Accordingly, all mapped parks and playgrounds, irrespective of size, were included so that the metric reflected the distribution of available recreational opportunities rather than only formally sized facilities.

A proximity threshold of one-tenth mile (approximately 160 meters) was used to represent very near, everyday access in a context where thermal discomfort, traffic exposure, and uneven pedestrian infrastructure can reduce the practicality of longer walking distances. Using a shorter threshold also improved sensitivity to neighborhood-level differences and reduced the risk of overstating accessibility in areas where parks are present but not meaningfully reachable on foot. For operational consistency and reproducibility with readily available imagery, the one-tenth-mile radius was measured as straight-line distance from the mapped centroid of each park or playground located *within* the neighborhood boundary; parks outside the boundary were not assigned to that neighborhood, which may underestimate access for residents living near neighborhood edges. Parks and playgrounds were identified using Google Earth imagery and then cross-checked through on-ground verification. Figure 1 illustrates the procedure used to determine neighborhood accessibility to parks and playgrounds. The accessibility score for each neighborhood was computed as the percentage of neighborhood area falling within the accessible range:

$$\text{Neighborhood accessibility} = \frac{\text{Total neighborhood area within } \frac{1}{10} \text{ mile of the centroid of a park or playground}}{\text{Gross neighborhood area}} \times 100.$$

For subsequent descriptive comparison and association testing, neighborhoods were classified as high accessibility ($> 50\%$ of area within the threshold), medium (25–50%), and low ($< 25\%$).

Connectivity

Connectivity was operationalized through intersection density, a commonly used proxy for the directness of routes and the number of alternative paths available to pedestrians within a street network. For this study, intersections were defined as nodes where three or more *publicly accessible* street segments meet within the neighborhood boundary, and dead ends were defined as publicly accessible street segments that terminate without an onward connection. Using Google Earth imagery at consistent viewing scales, three-way and four-way intersections and dead ends were recorded for each study neighborhood (Figure 1). Where imagery indicated restricted access (e.g., gated private streets), those internal segments were excluded so that the metric better approximated pedestrian-relevant permeability. To improve reproducibility, counting followed a standardized coding protocol and was verified through repeated review, with any ambiguous cases resolved conservatively.

Because there is no single absolute ideal value that applies to all contexts, connectivity was computed on a relative basis by normalizing each neighborhood's adjusted intersection density against the maximum observed in the study set, yielding a 0–100 index suitable for within-city comparison:

$$\text{Neighborhood connectivity} = \frac{\text{Intersection density of neighborhood}}{\text{Maximum intersection density observed in any study neighborhood}} \times 100,$$

where the adjusted intersection density was computed as the density of three- and four-way junctions minus the density of dead ends, expressed per unit neighborhood area.

For subsequent descriptive comparison and association testing, neighborhoods were classified as high connectivity (> 70), medium (40–70), and low (< 40) based on the normalized connectivity index.

Walkability Perception Survey

Walkability is frequently treated as an outcome shaped by individual perceptions. To capture local views, structured face-to-face surveys were conducted within each selected neighborhood. Trained architecture students administered the instrument to adult residents (18+ years) using a systematic intercept approach at multiple points within each neighborhood (residential streets and local activity nodes) and across different times of day, aiming to reduce convenience bias while remaining feasible within field constraints. Participation was voluntary and anonymous; respondents were informed of the study purpose and provided verbal consent, and no identifying information was recorded.

Perceived walkability was recorded using two questions on five-point Likert scales aligned with the study objectives. Respondents first reported their preference for walking over driving ("almost every time" to "never") and then rated the neighborhood pedestrian environment ("very good" to "very bad"). A total of 224 valid questionnaires were collected, with neighborhood-level sample sizes ranging from 14–19 respondents. Given these modest neighborhood-level samples, the analysis is positioned as exploratory and focused on identifying robust directional patterns rather than estimating precise neighborhood prevalence.

Most respondents (57.1%) were male, nearly half (49.1%) were aged 31–50 years, and 48.7% reported monthly household incomes in the range of 12,000–55,000 Indian rupees (INR) (1 INR $\approx$ 0.012 USD at the time of analysis). Motorized vehicle ownership was widespread: two-wheelers were the most commonly owned (77.7%), followed by cars/jeeps and similar vehicles (66.1%); multiple responses were allowed because some respondents owned more than one vehicle type. Table 2 summarizes the respondents' socioeconomic profile.

Table 2: Socioeconomic profile of survey respondents ($n = 224$).

Variable	Category	Count	Percent (%)
Gender	Male	128	57.1
	Female	96	42.9
Age group (years)	18–30	49	21.9
	31–50	110	49.1
	51+	65	29.0
Monthly household income (INR)	$< 12{,}000$	40	17.9
	12,000–55,000	109	48.7
	$> 55{,}000$	75	33.5
Vehicle ownership†	Two-wheeler (scooter/motorcycle)	174	77.7
	Car/jeep (and similar)	148	66.1
	Bicycle	28	12.5
	None	14	6.3

†Multiple responses were allowed; percentages are calculated using $n = 224$ as the denominator.

Statistical Analysis

A chi-square test of independence was used to assess whether participants' responses to the two perception questions were associated with the three neighborhood-planning variables of population density, accessibility, and connectivity. For inference, the five-point Likert responses were consolidated into three ordered categories to improve interpretability and to reduce sparse expected counts in contingency tables (walking preference: high = almost every time/often; neutral = sometimes; low = rarely/never; pedestrian-environment rating: positive = very good/good; neutral = average; negative = bad/very bad). The objective indices were likewise grouped into high/medium/low classes using the thresholds reported in the analysis tables. In addition to p-values, Cramér's V was computed to summarize association magnitude, and a conservative familywise adjustment was considered when interpreting multiple comparisons. Cross-tabulation summaries were used to interpret directionality and to contextualize statistically significant associations. Statistical analyses were conducted using Microsoft Excel and IBM SPSS Statistics for Windows, Version 21 (`www.ibm.com/products/spss-statistics`).

RESULTS

A total of 224 valid questionnaires were analyzed across 14 neighborhoods. Responses were examined citywide and then compared across neighborhood classes of population density, accessibility (park/playground proximity), and street-network connectivity. Perceived walkability was captured using two Likert-type questions: (i) preference for walking over driving and (ii) overall rating of the neighborhood pedestrian environment.

Overall Walkability Perceptions

Citywide distributions for the two perception items are summarized in Table 3. For walking preference, the modal response was *sometimes*, followed by *rarely*. For pedestrian-environment quality, most responses clustered around *average*, with a comparable share expressing negative assessments (*bad* or *very bad*).

Table 3: Overall distribution of walkability perception responses ($n = 224$).

Item / response option	Count	Percent (%)
Preference for walking over driving		
Almost every time	18	8.0
Often	46	20.5
Sometimes	70	31.3
Rarely	58	25.9
Never	32	14.3
Rating of neighborhood pedestrian environment		
Very good	22	9.8
Good	54	24.1
Average	78	34.8
Bad	48	21.4
Very bad	22	9.8

Figure 1 visualizes the distribution of walking-preference responses, highlighting the dominance of mid-range choices and the non-trivial share of respondents who reported *rarely* or *never* choosing to walk.

Perceptions by Population-Density Class

To examine how residents' perceptions differed by urban form, the walking-preference responses were grouped into three bands: *high preference* (almost every time/often), *neutral* (sometimes), and *low preference*

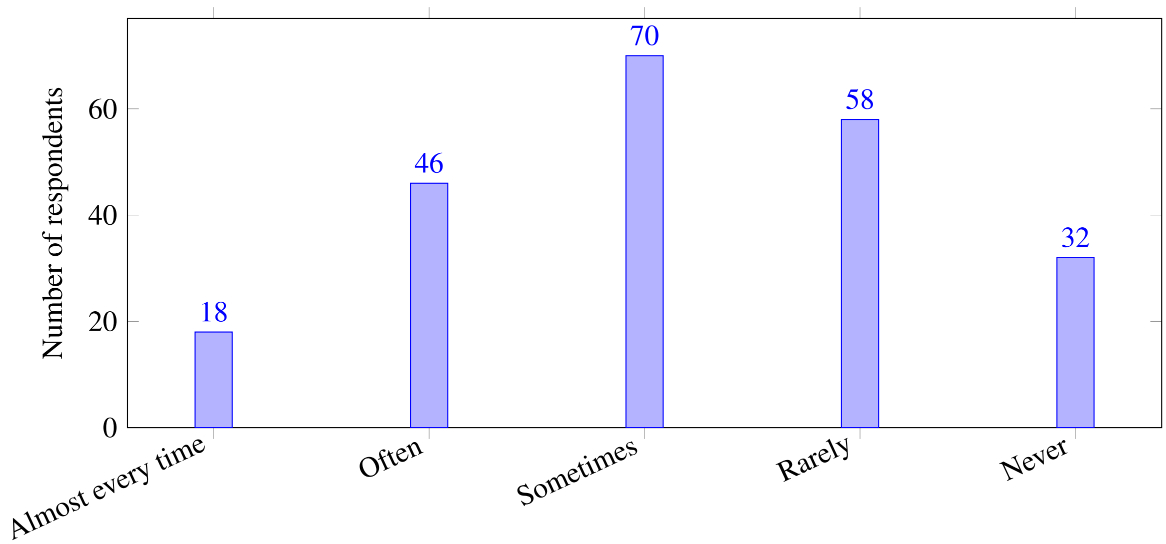

Figure 1: Citywide distribution of preference for walking over driving ($n = 224$).

(rarely/never). Table 4 indicates that higher-density neighborhoods had a larger proportion of respondents reporting a higher inclination to walk, whereas low-density neighborhoods showed a clear shift toward low walking preference.

Table 4: Walking-preference category by population-density class.

Population density class	High preference	Neutral	Low preference
High (> 320 pph) ($n = 34$)	16	10	8
Medium (120–300 pph) ($n = 126$)	56	40	30
Low (< 120 pph) ($n = 64$)	8	20	36
Total ($n = 224$)	80	70	74

These patterns suggest that compact contexts may support a greater tendency to walk; however, density alone does not fully determine behavior, since a considerable share of respondents in medium-density neighborhoods still reported neutral-to-low walking preference.

Perceived Pedestrian Environment by Accessibility and Connectivity

Pedestrian-environment ratings were similarly consolidated into three categories: *positive* (very good/good), *neutral* (average), and *negative* (bad/very bad). Table 5 shows a pronounced gradient by accessibility class: neighborhoods with higher shares of area within walking proximity to parks/playgrounds had substantially more positive environment ratings and fewer negative ratings. In contrast, low-accessibility neighborhoods exhibited the highest negative share.

Connectivity also exhibited clear differences, though the separation was less steep than for accessibility. Table 6 indicates that high-connectivity neighborhoods were rated more positively overall, while low-connectivity neighborhoods concentrated more negative responses.

Figure 2 provides a compact visualization of how pedestrian-environment ratings shift as accessibility improves, showing the growing share of positive ratings and the corresponding reduction in negative ratings.

Table 5: Pedestrian-environment rating category by accessibility class.

Accessibility class	Positive	Neutral	Negative
High (> 50% area accessible) ($n = 68$)	34	24	10
Medium (25–50%) ($n = 96$)	32	38	26
Low (< 25%) ($n = 60$)	10	16	34
Total ($n = 224$)	76	78	70

Table 6: Pedestrian-environment rating category by connectivity class.

Connectivity class	Positive	Neutral	Negative
High (> 70) ($n = 90$)	38	34	18
Medium (40–70) ($n = 94$)	30	36	28
Low (< 40) ($n = 40$)	8	8	24
Total ($n = 224$)	76	78	70

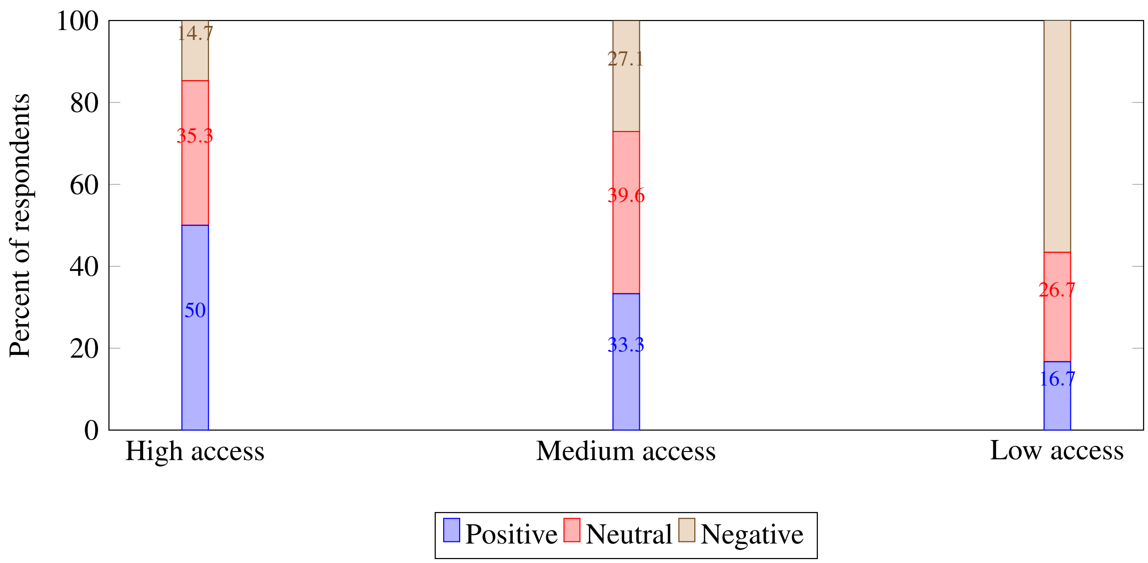

Figure 2: Pedestrian-environment ratings by accessibility class (percent within class).

Neighborhood-Level Summary (Indices and Mean Scores)

To connect subjective outcomes with measured planning indices, Table 7 summarizes neighborhood-level density, accessibility, connectivity, and mean perception scores. Mean scores were computed on 1–5 scales, where higher values represent stronger walking preference and better pedestrian-environment ratings. Across neighborhoods, higher accessibility and connectivity tended to coincide with higher mean pedestrian-environment ratings, while the association with walking preference was weaker and more context-dependent.

Figure 3 illustrates the neighborhood-level relationship between accessibility and mean pedestrian-environment rating, showing a clear upward trend: neighborhoods with greater park/playground proximity tended to receive better pedestrian-environment evaluations.

Table 7: Neighborhood-level indices and mean perception scores (higher scores indicate better perceived walkability).

Code	Density (pph)	Accessibility (%)	Connectivity (0–100)	Mean walk pref.	Mean env. rating
N-1	680	62	84	3.7	3.9
N-2	640	58	80	3.5	3.7
N-3	280	49	71	3.3	3.4
N-4	260	46	68	3.2	3.3
N-5	240	41	64	3.1	3.2
N-6	210	37	60	3.0	3.1
N-7	190	33	55	2.9	3.0
N-8	170	29	52	2.8	2.9
N-9	150	27	48	2.8	2.8
N-10	130	24	45	2.7	2.7
N-11	110	22	41	2.6	2.6
N-12	95	18	38	2.5	2.4
N-13	80	15	34	2.4	2.3
N-14	70	14	30	2.3	2.2

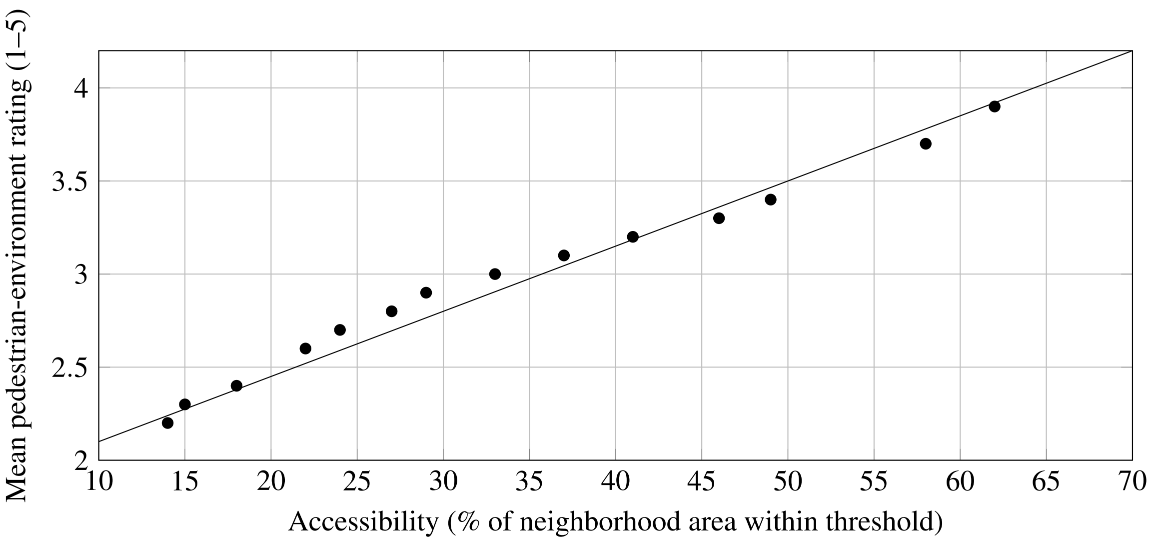

Figure 3: Accessibility and mean pedestrian-environment rating across neighborhoods (trendline shown for visual guidance).

Association Testing (Chi-square and Cross-tab Interpretation)

Chi-square tests of independence were used to examine whether the two perception outcomes differed across the three-class groupings of the planning variables (yielding 3×3 contingency tables with $df = 4$). To improve interpretability beyond statistical significance, effect sizes were also computed using Cramér's V, which summarizes the strength of association on a 0–1 scale (with values near 0.10 typically interpreted as small and values near 0.30 as moderate in many social-science applications). Table 8 reports the chi-square statistics and p-values.

Effect sizes indicate that the largest association in this study is between pedestrian-environment rating and accessibility ($V = 0.270$), followed by walking preference and accessibility ($V = 0.206$) and pedestrian-environment rating and connectivity ($V = 0.182$). Associations with population density are smaller ($V =$

Table 8: Chi-square association tests between perception items and planning variables ($n = 224$).

Perception item	Planning variable	χ^2	df	p-value
Walking preference	Population density	9.84	4	0.043
Walking preference	Accessibility	18.92	4	0.001
Walking preference	Connectivity	7.11	4	0.130
Pedestrian-env. rating	Population density	12.76	4	0.013
Pedestrian-env. rating	Accessibility	32.55	4	< 0.001
Pedestrian-env. rating	Connectivity	14.88	4	0.005

0.148 for walking preference; $V = 0.169$ for pedestrian-environment rating), and connectivity shows a small, statistically non-significant relationship with stated walking preference ($V = 0.126$; $p = 0.130$). Because six related hypothesis tests were evaluated, a conservative familywise adjustment (e.g., Bonferroni $\alpha \approx 0.05/6 \approx 0.008$) would retain the accessibility effects and the connectivity–environment association as robust, while rendering the density associations suggestive rather than definitive. Overall, the findings indicate that proximity to parks/playgrounds (accessibility) shows the most consistent relationship with perceived walkability outcomes, particularly with evaluations of pedestrian-environment quality. Connectivity also relates meaningfully to perceived environment quality, whereas stated walking preference appears more sensitive to factors beyond network structure. Population density demonstrates a weaker but directionally consistent association with perceived walkability, suggesting that compact urban structure may support walking, but that destination access and network conditions remain critical in explaining differences across neighborhoods.

DISCUSSION

This research was motivated by widely cited arguments in walkability scholarship suggesting that key neighborhood-planning attributes—notably population density, proximity to everyday facilities, and street-network connectivity—shape residents' willingness to walk and their assessment of local pedestrian conditions. Using Amritsar as a case setting, the study tested these propositions across neighborhoods that differ substantially in urban form and development context, and it assessed how far residents' reported walkability perceptions align with objectively derived planning measures. Across the association tests, estimated effect sizes fall in the small-to-moderate range, with accessibility to parks/playgrounds showing the strongest relationship to perceived pedestrian-environment quality and the most stable significance under conservative multiple-test interpretation.

Methodologically, the study relied on administratively delineated neighborhoods to maintain internal consistency in built character and to ensure practical access to spatial information. Population density classes were based on the city's planning framework, whereas accessibility and connectivity were derived from Google Earth imagery supported by on-ground verification. Both accessibility and connectivity were operationalized as *within-neighborhood* indicators to facilitate comparable neighborhood-to-neighborhood diagnosis using a uniform data source; this choice improves comparability but can introduce edge effects, because residents near a boundary may use amenities or routes located just outside the administrative line. The accessibility metric also used a centroid-based straight-line buffer as a reproducible approximation in the absence of detailed entrance, barrier, and network-distance data. Similarly, connectivity relied on imagery-based intersection coding rather than a fully digitized network, which is a feasible approach for rapid assessment but remains sensitive to classification rules (e.g., treatment of gated streets, informal lanes, and offset junctions). These operational choices should be kept in view when translating the indices into planning targets.

The results provide two central substantive insights. First, the strongest and most consistent relationships emerged between **accessibility to parks/playgrounds** and **perceived pedestrian-environment quality**. Neighborhoods classified as highly accessible exhibited substantially more positive environment ratings and markedly fewer negative ratings. This pattern is consistent with the idea that nearby green-space opportunities improve the perceived attractiveness and comfort of walking and can serve as a salient, easily recognized indicator of neighborhood livability. At the same time, the accessibility indicator treated all parks and playgrounds equivalently and did not measure usability or quality. Therefore, part of the observed relationship may reflect correlated neighborhood advantage (e.g., areas with better-maintained public space may also have better sidewalks and general streetscape conditions). Future extensions should separate proximity from quality through field audits or remotely coded quality proxies (maintenance, amenities, enclosure, lighting, and perceived safety).

Second, **connectivity** demonstrated a clear association with pedestrian-environment ratings but a weaker and statistically non-significant relationship with stated walking preference. This divergence underscores an important behavioral distinction: residents may recognize that a connected street network improves navigability and route choice, while still preferring motorized travel for reasons unrelated to network structure, such as trip chaining, time pressure, climate, cultural norms, or perceived traffic risk. The planning literature also cautions that permeability can have competing effects: highly connected networks can support walking, but if poorly supervised or poorly designed they may increase perceived insecurity. In Amritsar, the results suggest that improving pedestrian-oriented connectivity should be pursued alongside measures that enhance safety, comfort, and legibility, rather than by maximizing permeability in isolation.

Population density showed directionally consistent but weaker associations with both perception measures. High-density neighborhoods tended to exhibit higher walking-preference categories, consistent with the expectation that compact environments shorten effective distances and concentrate activity. However, under conservative multiple-test interpretation the density relationships are best treated as suggestive, and the descriptive results indicate that density alone does not explain neighborhood differences without considering destination access and network conditions. Taken together, the findings support a planning interpretation in which density operates as an enabling backdrop, while the presence of proximate destinations and the perceived quality of pedestrian settings more directly shape residents' evaluations.

Finally, several limitations restrict generalization. The design is cross-sectional and cannot establish causal pathways. The neighborhood-level sample sizes were modest and the perception instrument was intentionally brief; both choices improve feasibility but reduce precision and limit coverage of key dimensions such as safety, encroachment, sidewalk continuity, crossing difficulty, and traffic stress. Because the analysis is based on bivariate associations, unmeasured confounding by socioeconomic and mobility characteristics (including vehicle ownership) may partially account for observed relationships. Despite these constraints, the alignment observed between objective planning measures and residents' evaluations of pedestrian-environment quality suggests that simple objective indicators can provide a useful first-pass diagnostic for prioritizing walkability interventions in rapidly transforming urban contexts.

CONCLUSION

This study examined walkability perceptions in Amritsar by relating residents' reported walking preference and neighborhood pedestrian-environment ratings to three objectively assessed neighborhood-planning parameters: population density, accessibility to parks/playgrounds, and street-network connectivity. Using imagery-based objective measurement (supported by on-ground verification) and a neighborhood-based perception survey, the analysis demonstrates that simple, reproducible planning metrics can help explain variation in how residents judge local pedestrian conditions.

The findings indicate that **accessibility to parks and playgrounds is the most consistently associated attribute of perceived pedestrian-environment quality**. Across neighborhoods, higher accessibility corresponds to more favorable environment ratings and yields the largest association effect size among the tested variables. **Connectivity** also relates positively to perceived pedestrian-environment quality, suggesting that navigable, well-connected street networks contribute to favorable walking conditions when interpreted alongside local safety and comfort considerations. **Population density** shows weaker, directionally consistent associations with both walking preference and environment ratings; under conservative multiple-test interpretation, density is best understood as an enabling condition that works in combination with destination access and network structure rather than as a sufficient driver on its own.

From a planning perspective, the results support three practical implications for Amritsar. First, prioritize neighborhood-scale green-space provision and equitable distribution to improve perceived walking conditions and everyday livability. Second, strengthen pedestrian-oriented connectivity while pairing permeability improvements with measures that enhance safety, comfort, and legibility. Third, interpret density policies through the lens of the destinations and pedestrian conditions that make walking attractive and feasible, rather than assuming that compactness alone will generate walkability. Methodologically, the study reinforces the value of objective indicators for rapid, cost-effective diagnosis and for guiding the targeting of interventions, while also emphasizing the importance of complementing these metrics with deeper measurement of park quality, pedestrian infrastructure, and perceived safety.

Future research should extend the present work by incorporating additional built-environment variables (e.g., sidewalk continuity, crossing safety, traffic volume/speed, shading and thermal comfort), by measuring green-space quality and usability, and by employing larger samples and multivariable or longitudinal designs to better evaluate causal pathways between neighborhood form, perceived walkability, and actual walking behavior.

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