Assessing the Environmental Impacts of Urban Mixed Land-Use on Residential Livability: A Case Study of Hyderabad

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Abstract: *Background;* Livability is increasingly recognised as a central component of sustainable urban development, and in rapidly commercialising cities, mixed-use corridors play a critical role in shaping daily experiences.

Objective; The current research examined environmental quality conditions along four mixed-use commercial corridors to determine how spatial variations in key urban environmental stressors including noise exposure, sanitation, greenery availability and environmental infrastructure reflect the effectiveness of urban environmental management practices in dense mixed-use settings.

Methods; The current study adopted a quantitative, cross-sectional survey design. Data were collected using a structured questionnaire administered to residents and routine users located along each commercial corridor. A purposive sampling method was employed to select 96 participants who had resided in the area for at least one year. The sample was proportionally distributed across the four study corridors. Seven livability indicators were assessed, including public health, environmental quality, mobility, public space, social equity, economic opportunities, and basic utilities. Furthermore, descriptive statistics and comparative analyses were conducted to examine differences across the four locations.

Results; The findings indicate that livability varies considerably across the commercial corridors. Most indicators received the highest scores on Dr. Salahuddin Road (overall mean = 3.28), suggesting more favourable perceptions of cleanliness, utility provision, clinical accessibility, mobility, and economic potential. In contrast, Wadhu Wah Road demonstrated the lowest overall livability (overall mean = 2.80), which was associated with limited greenery, inadequate pedestrian infrastructure, elevated noise levels, and suboptimal waste management. Moreover, the rating of public utilities and social interaction remained relatively positive across all areas (mean ≥ 3.05), whereas walkability (mean range: 2.70–2.95) and the availability of public spaces (mean range: 3.09–3.28) consistently emerged as weaknesses.

Conclusion; The current study reveals that a well-planned pattern of commercial development can substantially improve living conditions and reduce congestion, environmental discomfort, and risks associated with pedestrian movement.

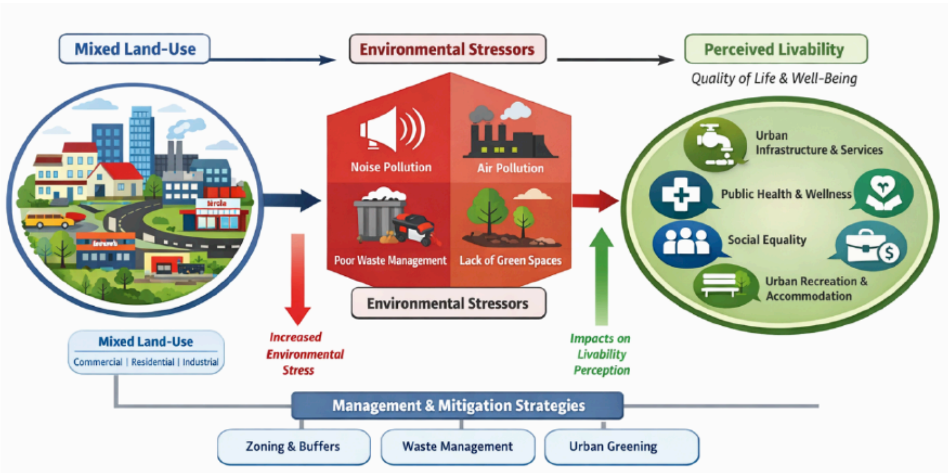

Figure 1: Schematic abstract visualising the relationship between mixed land-use, environmental stressors and perceived livability (Student, 2025).

Keywords: Quality of life, Urban health; City planning, Transportation, Environmental pollution, Public facilities, Sustainability, Livability, Commercial mixed-use districts, Urban design, Mobility, Environmental quality, Public space, Urban sustainability.

INTRODUCTION

The concept of livability has emerged as a central focus in contemporary urban studies, largely due to the growing emphasis on quality of life within rapidly evolving urban environments (Bove & Ghiraldelli, 2025; Sarr, 2022). As the migration process continues, the United Nations is reporting that by 2050 over half of the world population will live in urban centers, and this figure is projected to go up to close to 70% (United-Nations, 2018). Such population change has

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exposed urban areas to significant pressure. In addition, the planners and policy makers should rethink the ways in which the urban regions will stay habitable, inclusive and sustainable (Molaei Qelichi *et al*., 2025). As urban sprawl increases in density and intricateness, the question is how to not only maintain growth but also how to make the urban environments beneficial to the health, well-being, social stability, and economic flourishing of people (Jennings *et al*., 2024; Jodder *et al*., 2025).

Livability has been generally accepted as a multidimensional construct (Elantary, 2025; Martino *et al*., 2021). It encompasses physical, social, economic, and environmental dimensions that collectively support human well-being and satisfaction within the urban context (Dsouza *et al*., 2023; Ojobo *et al*., 2024; Schindler & Dionisio, 2024). In general notion, livability can be defined as the ability of an environment to sustain human life by providing sufficient housing, infrastructure, transportation, environmental health and safety (Baobeid *et al*., 2021; Dantzig & Saaty, 1973; Pacione, 2003). Furthermore, contemporary research highlights the significance of subjective experiences, including social connectedness, place attachment, and sense of community, in shaping perceptions of livability (Allen *et al*., 2021). Consequently, the concept of livability has come to guide practices in various fields like urban planning, landscape architecture, environmental psychology, and public policy and has been applied both objectively and subjectively (Adhikari & Roy, 2021).

Simultaneously commercial spaces have become prominent as the defining factors of urban living (Ali & Baper, 2023; Lei *et al*., 2025; Wang *et al*., 2025). Business means that the neighbourhoods are stimulated economically but they also serve to give the neighbourhoods their physical appearance and their social incline (El Azhar). In the case of mixed-use commercial areas, especially, they provide employment prospects, fundamental services, accessibility and communal spaces that facilitate community life rich in activities (Jodder *et al*., 2025; Mbata, 2024; Roy & Mishra, 2024). Scholars argue that such areas can strengthen livability through enhanced walkability, accessibility, social interaction, and perceived safety (Li, 2013; Min, 2025). However, these environments too are susceptible to swift transformation caused by commercial forces, redevelopment, as well as changing dimensions of the consumer (Al Noman *et al*.; ASHFAQ; Pandit, 2024). Conversely, these transitions may enhance or decline socio-spatial conditions thus affecting the overall standard of living in the neighboring residential regions.

Despite an expanding body of literature on livability, several gaps continue to exist. One major challenge is the lack of a unified and operational definition that reflects the diversity of urban contexts and typologies (Mouratidis & Delclòs-Alió, 2026). Although numerous studies have attempted to develop indices and frameworks, they commonly rely on macro-level indicators such as income levels, pollution data, and infrastructure provision (Das *et al*., 2022; Pang *et al*., 2024; Zhang *et al*., 2023). T These indicators come in handy during general comparisons, but again they tend to ignore minor features of trading neighbourhoods where daily action takes place. In spite of the fact that the importance of walkability, availability of civic amenities and the sense of safety are observed to play a role in the quality of life by previous studies, less studies discuss the impact of commercial redevelopment, land use changes, or changes in the composition of business. According to Schmid (2024) and Sarr (2022), the rate of commercial change can contribute to or hamper the well-being; however, it depends on whether the new change would fit into local needs, identities, and usage patterns (Sarr, 2022; Schmid, 2024). Nevertheless, the empirical research on capturing the perceptions of residents on these transitions is still wanting especially in the speedy developing urban settings, where the growth is more vigorous and usually more uncontrolled.

These research gaps point out the reason why the issue of livability needs attention in the framework of commercial typologies that have been conditioned to experience structural, functional, or socio-economic changes. Although most of the existing studies focus on residential space or the overall urban markers, business spaces constitute the day to day social and economic environment of the residents and visitors. They define people mobility, play a part of community life, contribute to the understanding of safety, and create local identity. As such, livability in these locations should be evaluated with due attention to physical environmental factors, space layout, accessibility, diversity of land use, and experiences of users. In addition to this, there are also the subjective elements of perceived livability based on comfort, familiarity, and place satisfaction, which are not easily measured.

The aim of the current study is to examine environmental quality conditions along four mixed-use commercial corridors to determine how spatial variations in key urban environmental stressors including noise exposure, sanitation, greenery availability and environmental infrastructure reflect the effectiveness of urban environmental management practices in dense mixed-use settings. Moreover, the present research will evaluate the association between these spatial attributes and perceived livability so that the evidence based information can be produced to enable the construction of more livable commercial space.

METHODOLOGY

Study Design

The current study applied a quantitative cross-sectional research design that sought to establish the level of perception of the livability of mixed land-use neighbourhoods by the residents. The main instrument was a questionnaire in form that allowed conducting a set evaluation of the residents experience in case of various urban conditions. It was designed on the perception-based analytical model whereby perception of residents towards the functionality, comfort and general quality of their neighbourhoods were accentuated. To calculate livability seven indicators were considered and all of them were operationalized by three characteristics that could be measured and rated using five-pointed Likert scale (including very poor or very good). Moreover, this method guaranteed the homogenisation of outcomes in the various city settings and facilitated a method of prioritisation systematically of the main independent variables that determined livability. This design especially adapted well to commercial and complicated environments where the heterogeneity of land-use pattern and the fluctuating service provision influences day-to-day living environment.

Study Area

The current study was conducted along four major mixed-use corridors in Hyderabad, Pakistan: Autobhan Road, Wadhu Wah Road, Dr. Salahuddin Road, and Market Road. These corridors were selected because they are highly commercialised areas with concentrated residential presence and dynamic land-use characteristics. Autobhan Road is characterised by substantial mobility flow, mid-rise residential structures, and prominent commercial facilities. Wadhu Wah Road, in contrast, has experienced vigorous yet largely unregulated commercial development, which has altered the streetscape and affected both pedestrian conditions and environmental quality. Dr. Salahuddin Road reflects comparatively regulated commercial growth supported by improved municipal oversight and more organised infrastructure provision. Market Road represents an older commercial district where residential units are closely spaced, streets remain narrow, and trading patterns follow traditional practices. Collectively, these corridors provide a broad range of mixed-use typologies that allow the current study to conduct a meaningful comparative assessment of resident-perceived livability.

Sampling Method

The purposive sampling strategy adopted in the current study was a non-probability method used to ensure inclusion of only those residents with sufficient familiarity with local conditions. Respondents were required to have lived in the study area for at least one year so that their perceptions reflected sustained experience rather than temporary impressions. A total of 96 valid responses were obtained, distributed proportionately across the four locations. Moreover, this sample size was considered adequate for capturing variation in resident perceptions while maintaining methodological consistency with the analytical framework and the tabulated findings. The sampling strategy also ensured representation across different household types, socio-economic backgrounds, and age groups, while remaining focused on long-term residents who could reliably assess neighbourhood livability.

Ranking of Significant Independent Variables

To identify and rank the key factors influencing livability in each study area, a regression-based significance testing approach was employed. After computing the mean scores for each of the seven livability indicators, a multiple regression analysis was conducted for each corridor separately, with the overall livability score as the dependent variable and all measured attributes as independent variables. Variables with a p-value < 0.05 were considered statistically significant and retained for ranking. These significant variables were then ranked in descending order of influence based on their standardized beta coefficients (β), which reflect the relative strength of their association with perceived livability. The resulting rankings for each corridor are presented in Tables **1**–**4** in the Results section, providing a clear hierarchy of livability drivers specific to each urban context.

Instrument Development

The data collection tool used in the current study consisted of a structured questionnaire that contained seven sections corresponding to the seven livability indicators assessed. Each section included three attributes that represented the central dimensions of the respective indicator. The Urban Infrastructure and Services category captured residents' perceptions regarding access to utilities, availability of public spaces, and the adequacy and safety of pedestrian infrastructure. Urban Environmental Resources evaluated cleanliness, noise levels, and the presence of greenery. Public Health and Wellness measured access to clinics, waste management practices, and perceived water quality. Social Equality assessed perceived safety, equitable service availability, and social interaction. Economic Characteristics included job opportunities, diversity of commercial activities, and affordability of housing. Urban Recreation and Accommodation focused on the condition of accommodation, availability of rest areas, and access to parks. Lastly, Ease in Urban Transport and Mobility measured access to public transportation, walkability, and traffic congestion. All items were rated on a five-point Likert scale. Furthermore, the questionnaire was reviewed by subject experts and underwent a small pilot test to ensure clarity, internal consistency, and relevance to the urban context.

Use of Perception-based Indicators

The research process utilised the perception-based indicators because residential livability is affected by the experience, interpretation and interaction of residents with their environment; urban environmental assessment literature majorly recognises that subjective evaluations associated with livability elements like comfort, safety, satisfaction and well-being that are often neglected by technical indicators (Huang *et al*. 2024). The perception-based measurements within the instrument are important in mixed land-use contexts due to the correlations between residential, commercial and institutional activities; reflecting the cumulative daily experiences rather than separate environmental qualities. The seven selected perception-based indicators align with environmental science and urban planning multidimensional livability frameworks as Herrman and Lewis (2017, p.2) cited that livability includes "*health, environmental quality, mobility, social inclusion, economic vitality, and access to services*" therefore; the subjective assessments of residents for urban systems' well-being support are viable for revealing the key urban environmental and socio-economic issues in mixed land-use corridors.

Public Health is operationalised by the perception of people regarding hospital and healthcare provider accessibility due to their importance within urban livability; the environmental health study by Satarzadeh *et al*. (2025) demonstrated that perception of security and quality of life among the patients are majorly influenced by healthcare facility affordability and quality within the congested urban areas. Following the importance, the perception-based assessment is important for identifying localised health consequences in mixed land-use regions; commercial activities could improve health services but can also worsen congestion with environmental stressors. The environmental quality indicators such as waste management, water or air quality and noise pollution were used to explore daily environmental stresses associated with mixed land-use development as Mucci *et al*. (2020) linked noise and sanitation to urban environmental satisfaction and mental health. The perception of residents highlights prolonged exposure and inconvenience levels because objective assessments often miss behavioural fluctuation and contextual sensitivity thus; perception-based assessments better explain the impacts of environmental stressors on residential comfort and livability across the business corridors.

Moreover, the mobility measured by transport quality and modes to reflect land use integration as sustainable urban mobility study illustrated that that infrastructure availability, cost and convenience affect satisfaction of citizens with transport systems (Rasca & Saeed, 2022). However, Kitosi (2023) argued that mixed land-use areas have more traffic, informal transport and pedestrian conflicts thus; perception-based mobility indicators reveals the influence of transport systems on daily life and residential social equality. The indicators of public space and social equity were correlated to social livability because as per Pineda (2022) the accessible and inclusive public spaces improve social safety and community engagement under which the perceived social equity measures perspectives of citizens on socioeconomic group access to services and opportunities. The economic opportunities integrating job opportunities and housing affordability were selected to highlight the economic effects of mixed land-use development as Zhou *et al*. (2022) implied that mixed land-use increases employment but also raise living expenses and displacement pressures. The perception of residents on employment availability and inexpensive housing reflects experienced economic realities while basic utilities like pedestrian infrastructure were included because they support environmental justice and urban sustainability (Ruiz-Apilánez *et al*., 2023) hence; perception-based assessment of utilities and pedestrian safety evaluates infrastructure based on daily use and lived experience.

Data Collection Procedure

A face-to-face household survey conducted by trained field researchers was used to collect the data. Surveys were administered during the daytime to ensure safety and accessibility for residents. The survey required approximately 10 to 12 minutes to complete, allowing respondents adequate time to consider each attribute. Completed questionnaires were checked daily to verify accuracy and completeness before being entered for analysis in

SPSS. Moreover, this approach helped minimise non-response bias and supported the collection of high-quality and reliable data.

Data Analysis

SPSS Version 26 was used for data analysis with emphasis on descriptive statistics. Attributes were averaged within each indicator, and these averages were then combined to generate site-specific indicator means. This procedure allowed comparisons of livability conditions across the four study areas and helped identify the highest and lowest performing locations. Furthermore, indicator rankings were derived from the calculated means and served as the basis for tables included in the Results section. This systematic analytical approach ensured measurement integrity and facilitated cross-comparability of the seven livability indicators.

Ethical Approval

The current study was conducted in accordance with the ethical guidelines for research involving human participants. Ethical approval was granted by the graduate research committee overseeing the thesis from which the current study is derived. All participants were informed about the voluntary nature of their involvement, and verbal consent was obtained prior to data collection. Respondents were assured that no identifying information would be collected and that their responses would be used solely for academic purposes. Moreover, all procedures related to data collection, storage, and reporting were carried out with strict confidentiality and anonymity.

RESULTS

This section reports the empirical findings of the current study on the livability of mixed land-use neighborhoods. The results are based on resident perceptions across seven key indicators of livability, which include Urban Infrastructure and Services, Urban Environmental Resources, Public Health and Wellness, Social Equality, Economy, Urban Recreation and Accommodation, and Ease in Urban Transport and Mobility. All indicators were assessed through mean attribute scores for the four study locations: Autobhan Road, Wadhu Wah Road, Dr. Salahuddin Road, and Market Road. Moreover, the following tables provide detailed results along with analytical interpretations that highlight spatial variations across neighborhoods and outline their respective strengths and limitations. These findings, when combined, support the ranking of major independent variables that influence perceived livability.

Rankings of Significant Independent Variables

The ranking of mostly influential, significant independent variables with respect to each site in terms of livability is given in this section. The variables with zero values are likely to be most influential and significant in providing the livability, unavaibility of which could has adverse effects on the residents' lifestyle.

Autobhan Road

Table **1** shows the most significant indicators from all the identified indicators which are mentioned in the above table 106. The significant level of the indicators

Table 1: Significant Independent Variable Rankings of Autobhan Road

Sr. No	Variables	Labels	Significant Level
1.	**Urban Infrastructure and Services**		
I.	Access to Utility Services	X1	0.008
2.	**Urban Environmental Resources**		
I.	Noise Pollution	X6	0.001
3.	**Social Equality**		
I.	Access to social network	X12	0.001
II.	Participation in social activities	X14	0.000
4.	**Economy**		
I.	Access To Retail Shops	X16	0.003
II.	Affordable housing	X17	0.002
5.	**Urban Recreation and Accommodation**		
I.	Supermarkets, Malls , Public Markets	X20	0.000
6.	**Ease in Urban Transport and Mobility**		
I.	Reduced Travel Time And Cost	X23	0.000

for regression test was <0.05. The significant indicators which have significant level <0.05 for Autobhan road are Access to Utility Services, Noise Pollution, Access to social network, Participation in social activities, Access to Retail Shops, Affordable housing, Supermarkets, Malls, Public Markets, Reduced Travel Time And Cost.

Wadhu Wah Road

Table **2** shows the most significant indicators from all the identified indicators which are mentioned in the above table 107. The significant level of the indicators for regression test was <0.05. The significant indicators which have significant level <0.05 for Wadhu Wah road are Water Quality, Solid waste management system, Noise Pollution, Hospital Services, Participation in social activities, Access To Employment Opportunity, Recreation Center And Public Parks, Supermarkets, Malls, Public Markets, Quality Of Urban Road Network, Alternative Modes Of Urban Transport.

Dr. Salahuddin Road

Table **3** shows the most significant indicators from all the identified indicators which are mentioned in the above table 108. The significant level of the indicators for regression test was <0.05. The significant indicators which have significant level <0.05 for Dr. Salahuddin road are Access to Utility Services, Noise Pollution,

Table 2: Significant Independent Variable Rankings of Wadhu Wah Road

Sr. No	Variables	Labels	Sig
1.	**Urban Environmental Resources**		
I.	Water Quality	X5	0.000
II.	Noise Pollution	X6	0.005
III.	Solid waste management system	X7	0.001
2.	**Public Health and Wellness Services**		
I. I	Hospital Services	X8	0.000
3.	**Social Equality**		
I.	Participation in social activities	X14	0.000
4.	**Economy**		
I.	Access To Employment Opportunity	X15	0.000
5.	**Urban Recreation and Accommodation**		
I.	Recreation Center And Public Parks	X18	0.008
II.	Supermarkets, Malls , Public Markets	X20	0.004
6.	**Ease in Urban Transport and Mobility**		
I.	Quality Of Urban Road Network	X21	0.002
II.	Alternative Modes Of Urban Transport	X22	0.000

Table 3: Significant Independent Variable Rankings of Dr. Salahuddin Road

Sr.No	Variables	Labels	Significant Level
1.	**Urban Infrastructure and Services**		
I.	Access to Utility Services	X1	0.03
2.	**Urban Environmental Resources**		
I.	Noise Pollution	X6	0.04
3.	**Social Equality**		
I.	Access to social network	X12	0.02
4.	**Economy**		
I.	Access To Employment Opportunity	X15	0.006
7.	**Ease in Urban Transport and Mobility**		
I.	Alternative Modes Of Urban Transport	X22	0.000
II.	Reduced Travel Time And Cost	X23	0.002

Table 4: Significant Independent Variable Rankings of Market Road

Sr. No	Variables	Labels	Significant Level
1.	**Urban Infrastructure and Services**		
I	Access to Utility Services	X1	0.006
II.	Provision Of Public Spaces for public event	X2	0.01
2.	**Urban Environmental Resources**		
I.	Air quality	X4	0.004
3.	**Public Health and Wellness Services**		
I.	Hospital Services	X8	0.000
II.	Sewage system	X10	0.001
4.	**Social Equality**		
I.	Security	X11	0.001
XIII.	Proximity to educational facilities	X13	0.01
XIV.	Participation in social activities	X14	0.001
5.	**Economy**		
XVII.	Affordable housing	X17	0.007

Access to social Networks, Access To Employment Opportunity, Alternative Modes Of Urban Transport, Reduced Travel Time And Cost.

Market Road

Table **4** shows the most significant indicators from all the identified indicators which are mentioned in the above table 109. The significant level of the indicators for regression test was <0.05. The significant indicators which have significant level <0.05 for Market road are Access to Utility Services, Provision of Public spaces for public events, Air Pollution, Hospital Services, Sewage System, Security, Proximity to educational facilities, Participation in social activities and Affordable Housing.

Urban Infrastructure and Services

This indicator evaluates access to essential utilities, availability of public spaces, and the condition of pedestrian infrastructure. These characteristics form the foundation of urban habitation, particularly in mixed commercial and residential environments (Table **5**).

As shown in Table **5**, across all locations, utility services received relatively high ratings, and residents emphasised the importance of reliable electricity, water supply, and waste services. In contrast, pedestrian infrastructure and street lighting consistently showed lower scores, reflecting narrow sidewalks, unsafe crossings, and limited night visibility. Furthermore, Dr. Salahuddin Road recorded the strongest performance overall, likely due to more structured commercial development and comparatively organised service provision. Wadhu Wah Road demonstrated the weakest performance in terms of public spaces, indicating a decline in recreational and community-oriented areas as commercial activity increases.

Urban Environmental Resources

This indicator examines environmental quality, including sanitation, noise levels, and greenery. The environmental condition is closely linked to comfort and overall well-being as shown in Table **6**.

Table 5: Mean Value of Attributes of Urban Infrastructure and Service With Respect to Each Site

Attributes	Autobhan Road	Wadhu Wah Road	Dr. Salahuddin Road	Market Road
Access to Utility Services	3.64	3.69	3.79	3.69
Provision of Public Spaces	3.31	3.09	3.28	3.16
Safe Pedestrian Infrastructure	2.85	2.82	3.11	2.80
Overall Mean	3.26	3.20	3.39	3.21

Table 6: Mean Value of Attributes of Urban Environmental Resources

Attribute	Autobhan	Wadhu Wah	Dr. Salahuddin	Market
Street Cleanliness	2.98	3.04	3.14	3.00
Noise Levels	2.86	2.70	2.91	2.73
Greenery Presence	2.55	2.50	2.74	2.60
Overall Mean	2.80	2.75	2.93	2.78

Perceptions of environmental conditions were moderate, and once again Dr. Salahuddin Road showed the highest overall mean. The presence of greenery remained limited in all neighborhoods, reflecting a common challenge in densely commercialised areas where open space is restricted. Furthermore, Wadhu Wah Road showed the highest noise-related disturbance, suggesting unregulated commercial expansion and increasing traffic pressure. Overall, the environmental conditions were viewed as average, with residents indicating that the quality of the environment requires considerable improvement.

Public Health and Wellness

This component covers accessibility of clinics, efficiency of waste collection, and perceived water quality, all of which directly influence health outcomes in urban areas (Table **7**).

Healthcare accessibility received favourable scores, and residents expressed satisfaction regarding the availability of clinics. Dr. Salahuddin Road had the highest score for water quality, implying comparatively stronger municipal oversight or improved supply systems. Waste management, however, was inconsistent, particularly in Wadhu Wah Road. Despite these shortcomings, overall health-related perceptions were positive across all four neighborhoods.

Social Equality

This measure reflects perceived safety, equitable access to services, and community interaction. These aspects are essential for maintaining social cohesion in dense urban settings (Table **8**).

Moderate perceptions of social equality were observed across all study sites. Residents generally expressed satisfaction with opportunities for social connection. However, Wadhu Wah Road showed slightly weaker security perceptions, possibly due to its diverse land-use pattern and reduced oversight. Furthermore, Dr. Salahuddin Road once again ranked highest, demonstrating stronger equity in service access and enhanced social engagement.

Economy

Economic livability is assessed through employment opportunities, diversity of commercial activities, and affordability of housing, all of which are crucial for long-term sustainability (Table **9**).

Table 7: Mean Value of Attributes of Public Health and Wellness

Attribute	Autobhan	Wadhu Wah	Dr. Salahuddin	Market
Access to Clinics	3.15	3.08	3.22	3.10
Waste Management	2.89	2.84	3.00	2.91
Water Quality	3.01	2.96	3.18	3.05
Overall Mean	3.01	2.96	3.13	3.02

Table 8: Mean Value of Attributes of Social Equality

Attribute	Autobhan	Wadhu Wah	Dr. Salahuddin	Market
Sense of Security	2.92	2.85	3.10	2.90
Equal Access	3.02	2.95	3.12	3.00
Community Interaction	3.21	3.15	3.29	3.18
Overall Mean	3.05	2.98	3.17	3.03

Table 9: Mean Value of Attributes of the Economy

Attribute	Autobhan	Wadhu Wah	Dr. Salahuddin	Market
Job Opportunities	3.20	3.10	3.28	3.18
Commercial Diversity	3.25	3.18	3.33	3.21
Housing Affordability	2.96	2.88	3.05	2.92
Overall Mean	3.14	3.05	3.22	3.10

Economic indicators were strong across all neighborhoods. Residents acknowledged the availability of commercial activities and employment options, consistent with the nature of mixed-use corridors. Housing affordability received the lowest mean across all roads, suggesting increasing living costs linked with intense commercialization. Furthermore, Dr. Salahuddin Road maintained the highest overall performance, reflecting a more balanced and organised economic environment.

Urban Recreation and Accommodation

This indicator represents availability of parks, rest areas, and accommodation quality, which contribute to comfort and psychological well-being (Table **10**).

Recreational facilities were limited across all locations. The availability of parks and seating areas scored low, demonstrating insufficient investment in leisure spaces. In contrast, accommodation quality was rated more positively, particularly on Dr. Salahuddin Road, indicating stronger building standards and more orderly development patterns in that area.

Ease in Urban Transport and Mobility

This indicator assesses access to public transport, walkability, and traffic congestion, which affect daily mobility conditions (Table **11**).

Mobility patterns showed that access to public transport was generally adequate. However, walkability challenges and persistent congestion were noted across all areas. Furthermore, Dr. Salahuddin Road again recorded the highest overall mean, reinforcing its consistent superiority across all livability indicators examined in the current study.

DISCUSSION

Livability has become one of the growing concepts in modern city planning, where planners are trying to provide the environment that enhances well-being, social collectiveness, and economic sustainability. Mixed-use commercial corridors are also the key elements of the urban landscape as they predetermine the availability of the necessary services, socialization, and daily mobility schemes. In addition, subjectivity of livability to the residents, especially in dynamic settings is a crucial starting point to the development of context-focused planning. The present paper has explored seven key livability indicators within four mixed use districts with significant spatial and perceptual disparities thus clearly explaining the merits

Table 10: Mean Value of Attributes of Urban Recreation and Accommodation

Attribute	Autobhan	Wadhu Wah	Dr. Salahuddin	Market
Park Availability	2.70	2.62	2.85	2.66
Seating & Rest Spots	2.89	2.80	3.00	2.84
Accommodation Quality	3.12	3.05	3.20	3.10
Overall Mean	2.90	2.82	3.02	2.87

Table 11: Mean Value of Attributes of Urban Transport and Mobility

Attribute	Autobhan	Wadhu Wah	Dr. Salahuddin	Market
Public Transport Access	3.30	3.22	3.41	3.28
Walkability	2.82	2.70	2.95	2.76
Traffic Congestion	2.60	2.52	2.70	2.55
Overall Mean	2.91	2.81	3.02	2.86

and shortcomings of commercially viable urban neighborhoods.

The results indicated that Dr. Salahuddin road has significantly better results compared to the other locations in nearly all of the indicators of livability. Its slightly orderly evolution, better local control, and even more organized commercial activity seemed to enhance satisfaction regarding utility services, environmental purity, accessibility of clinics, economic opportunities and mobility. This tendency implies that controlled commercial development accompanied by organized infrastructural investment can help to achieve better conditions of livability according to the opinions of people living in the area. Conversely, Wadhu Wah Road had lower scores consistently especially on such aspects as provision of public space, noise, walkability and waste management. These results suggest that the uncontrolled commercial development has a negative impact on the environment, safety of pedestrians, and the general access to community-supportive infrastructure.

Even amenities like electricity and water supply which are the basic amenities were also reported to be of high satisfaction in all the neighborhoods, which is the expectation of high population density in urban areas. However, the presence of pedestrian structures and other vegetation was always subpar, which demonstrates an institutional failure to consider non-motorized mobility and environmentally friendly design in the mixed-use corridors. These inadequacies directly affect the safety and walkability of cities and their psychological conditions. Besides, the issue of environmental concerns could also be witnessed since noise in many places surrounded by heavy traffic and commercial crowding were often reported as problematic. The small number of parks, rest areas and recreation facilities were also indicative of a lack of investment in community oriented urban design particularly in the older and more compact commercial precincts.

International health and environmental quality standards is important for environmental aspects for the residential livability under which it is important to compare the resident perceptions about noise, air quality, water quality and waste management with WHO and environmental science benchmarks; perception-based indicators can supplement cumulative exposure and lived environmental conditions for pollution concentrations. The **noise** pollution was poor across all four research corridors with mean values below to the standard threshold and Wadhu Wah Road demonstrated the poorest performance; WHO Environmental Noise Guidelines advocated for limiting road traffic noise to 53 dB L_den during the day and 45 dB L_night to prevent sleep disturbance, cardiovascular stress and cognitive impairment (Sustainability Directory, 2025). However, the current datasets does not measure the noise in decibels but the persistently low perception scores strongly reflected that these thresholds must be exceeded due to highly commercialized corridors with high traffic density, informal loading and mixed vehicular modes. Redondo *et al*. (2021) further established that subjective noise annoyance closely associated with objective exposure levels, especially in dense metropolitan areas where residents are exposed to noise pollution for considerable lengthy periods while the current datasets further highlighted that noise pollution is geographically increased along unregulated commercial expansion corridors like Wadhu Wah Road and Market Road. Rehman and Asghar (2016) previously found that mixed land-use corridors in developing cities (with unregulated commercial expansion) are noise hotspots due to poor zoning enforcement and traffic management however; the considerable good perception score for Dr. Salahuddin Road established that strategic commercial planning and wider road profiles can reduce noise exposure in mixed-use areas yet the study failed in finding any perception score that met WHO noise comfort criteria which consequently indicates a systemic environmental governance deficiency.

The urban environmental research by Abdur-Rouf and Shaaban (2022) already established that daytime noise levels in mixed land-use and commercial corridors of developing cities range from 60 to 75 dB with peak levels often exceeding 80 dB near crossings, bus stops and commercial loading zones; these values surpass WHO guidelines (far) and linked with many negative health effects. Following the poor noise levels, mean perception scores of 2.86, 2.70, 2.9 and 2.73 are consistently poor throughout all four corridors which consequently indicated that residents are constantly exposed to noise levels within or over the reported high urban ranges. The comparative research from South Asian cities provide more clear estimations as traffic congestion, informal public transport and roadside commercial activities elevated the roadside noise in mixed-use corridors in Karachi and Delhi to 88 and 66 dB respectively (Aziz *et al*., 2021; Chauhan *et al*., 2021). The environments of Karachi and Delhi reflected the similar functional and geographic qualities of Hyderabad as the poor perception scores for Wadhu Wah Road and Market Road are aligned with with noise exposure patterns in urban contexts; demonstrating that residents are aware of excessive noise and experiencing its cumulative effects over time. The public health concerns from extended chronic exposure to noise is beyond the discomfort as Münzel and Sørensen (2017) cited that chronic traffic noise exposure above 55-60 dB has been linked to hypertension, ischemic heart disease, sleep disorders and cognitive impairment among children and older adults. Continuous exposure increases health risks because recovery intervals are restricted in mixed-use areas with residential places in the closer proximity to overnight commercial activities hence; low perception scores across all corridors of Hyderabad indicated discomfort with physiological and environmental stress.

Moreover, the environment risks from urban noise levels went beyond human health because high noise levels undermine outdoor activities, social contact and public space functionality hence; noise in packed business corridors discourages pedestrian movement and reduces open space utilisation which consequently lowers the sustainable livability (Lawrence *et al*., 2025). Following the impact, the current datasets also demonstrated that lower environmental quality scores are correlated with poorer public space use and walkability thus; noise pollution is a confounding stressor that promotes multiple livability issues. The geographic diversity across the four corridors supported the interpretation as better perception score at Dr. Salahuddin Road reflected noise levels around 55-60 dB which are still above WHO comfort thresholds (Sustainability Directory, 20205) but less harmful than other congested corridors. Li *et al*. (2025) found that a small 3-5 dB decrease in noise can improve comfort and health in the residential settings under which the focused planning measures and regulations in mixed-use contexts like traffic slowdown, road hierarchy and loading activity separation can limit noise exposure. However, Nguyen *et al*. (2025) argued that noise regulation in many developing cities target individual sources of car horns and loudspeakers rather than systemic factors like land-use incompatibility and transport system inefficiencies but the systematic findings including the datasets of current research demonstrated that residents perceive noise as a daily occurrence rather than an occasional inconvenience while a chronic environmental stressors have worse long-term health effects than peak exposures (Adegboye *et al*., 2023).The severity of noise pollution across the study corridors revealed the exposure levels that would affect health and environmental quality proven by the comparison to complex urban noise ranges in the published literature hence; the data implied that noise in these mixed land-use areas is relative to high-risk urban environment in South Asian cities.

The air quality perceptions along Market Road should also be compared to WHO criteria as the WHO Global Air Quality Guidelines (2021) set annual mean limits of 5 μg/m³ for PM2.5 and 15 μg/m³ for PM10; lowering prior requirements due to rising health hazards from low exposure levels (WHO, 2021). According to Ghafoor *et al*. (2025), the urban areas of Pakistan (including Hyderabad) often exceeded the recommended levels of air pollution due to vehicle emissions, roadside business activity and inadequate fuel regulations while following the trend; the moderate to low air quality perception scores in the current datasets indicated that residents must suffer with visible dust and smell leading to discomfort. The perception-based air quality dissatisfaction demonstrated pollutant concentrations, exposure length and street-level outcomes; mixed land-use corridors increases vehicles and pedestrians activity but also increases inhalation risk among resident and routine user. Bonsu *et al*. (2025) cited that environmental health research found that street-level exposure of air pollution often surpasses city-level regulatory reporting averages; explaining that citizens perceive air quality more negatively due to visible flaws than restricted monitoring data therefore strategic geographic organisational and traffic flow restriction moderates the air quality perception score in the corridor of Dr. Salahuddin Road.

The datasets on water quality highlighted positively moderate (better than air and noise) yet uneven mean values as Wadhu Wah Road scored lowest with 2.96 while Dr. Salahuddin Road scored highest 3.18 for water quality perception; microbiological safety, chemical contaminant limitations and physical acceptability are key to safe drinking water but 3.4 billion people (majority from developing countries like Pakistan) in 2024 still lack safely managed sanitation services (WHO, 2025). The irregular supply systems, traditional pipelines and sewage cross-contamination are common issues undermining water sanitation in Pakistan (Kumar *et al*., 2022) but for the city of Hyderabad the moderate water quality satisfaction in the current dataset; reflected partial compliance with physical and availability expectations instead of microbiological safety regulations. According to Volf *et al*. (2025) the perceived water quality often hide the microbial contamination risks because the water clarity and acceptable taste undermine the microbiological contamination; higher satisfaction (mean values) on Dr. Salahuddin Road potentially indicate newer infrastructure or better municipal governance while lower results on Wadhu Wah Road highlighted risks associated with with informal service connections and infrastructure overload in rapid commercialising environment. However, the variations of the score and hidden risk of microbial contamination even with positive perception score reflected the need for comprehensive water quality testing and infrastructure audits; considering the importance of perception-based indicators as early warning tools in environmental assessment.

The waste management perceptions on Wadhu Wah Road and Autobhan were the weakest environmental qualities with mean values of 2.84 and 2.89 respectively, deviating from WHO and UN-Habitat urban sanitation guidelines. The WHO established that poor solid waste management causes vector-borne diseases, groundwater contamination and degraded urban aesthetics while the uneven collection, visible dumping and poor segregation are indicated by mean scores below the average positive attitude of 26.1±7.8 (Ghanadzadeh *et al*., 2014). A more updated urban environmental study in South Asia by Manna *et al*. (2025) found that mixed land-use corridors are particularly vulnerable to waste accumulation due to rapid commercial turnover and inadequate municipal capacity; but the considerable better waste management perception on Dr. Salahuddin Road with the mean score of 3.00 demonstrated that formal commercial frameworks and defined service roles can improve environmental outcomes. However, no corridors had perception scores that indicated alignment with sustainable urban waste management requirements such frequent collection, hygienic storage and environmentally safe disposal as Ikram and Boudraa (2025) affirmed that service provision for ethical governance often lags behind land-use intensification within secondary cities with fragile sustainable planning.

The misalignment of environmental perception scores with established guidelines highlighted that mixed land-use development enhances economic vitality and accessibility but increases environmental damage by violating international health and environmental standards. WHO emphasises that environmental livability is a prerequisite for public health instead of a by-product of economic success (Satarzadeh *et al*., 2025) but in mixed land-use corridors of Hyderabad, the commercial benefits are not aligned with by equivalent environmental preventions demonstrated by moderate to low perception scores for noise, air, water and waste indicators. The datasets further highlighted the gradual urban development without integrated environmental management as the Dr. Salahuddin Road better scored for majority indicators but even this research corridor failed to meet WHO environmental standards. Following to failure to meet established standards, the findings promoted urban environmental assessment recommendations by Wang *et al*. (2024) for stronger regulatory enforcement, frequent environmental monitoring and land-use planning that integrates environmental health standards rather than treating them as residual issues. The comparison of people' perceptions with environmental standards demonstrated that continuous environmental quality deficits limit the livability of mixed land-use communities in Hyderabad thus; Noise pollution, poor air quality, unsafe water and poor waste management endangered the public health and urban sustainability due to weak compliance with WHO standards.

The study of mixed-use outcomes is context-specific which is further reinforced by the present study as compared to the European-based research. As an example, Bahr (2024) in Switzerland discovered that urban lands and urban greenery positively affect the satisfaction with life, but differences in the effects were shown among people of different ages (Bahr, 2024). The older adults found green elements more helpful but the younger ones found great benefit with heterogeneous land use. This is a more refracted and demographically divergent impact which is generally missing in demonstrating the findings in Hyderabad where the deficiency in greenery was global and not age-specific. In addition, the paper of Ma *et al*. in peri-urban China states that mixed-use development is a two-sided phenomena. On the one hand, the compatibility of the mixed use can facilitate the decrease in residential vacancy and improve the city vitality (Ma *et al*., 2022). Disordered mixed use on the other side may intensify decline, and has a threat to livability. This duality is very much similar to the results of the present study since regulated and structured commercial areas like Dr. Salahuddin Road worked much better compared to uncontrolled areas like Wadhu Wah Road. Taken together, these opposite studies support the fact that success in the mixed-use development does not come naturally. Rather, it rests on supportive planning, environmental care and sensitivity to local background, both of which are important in sustainable urban development of the Global South and the Global North.

In general, the present research promotes a number of global findings that have been established. Mixed use business streets have the potential to improve the livability in the city, but the success is significantly contributed by how much regulation is in place, investment infrastructures and controlling environments (Hamidi, 2025; Li *et al*., 2024; Siegert *et al*., 2025). In addition, regions that are created by organised planning are likely to have favourable results in terms of movement, physical health, environmental ease, and financial prospects, whereas unmanaged or hastily filling regions are more likely to construct an unfavourable scenario (Alipour *et al*., 2025; Jinollo *et al*., 2025; Sepetis *et al*., 2024). These findings highlight the necessity of combined approach planning solutions that incorporate priority in walkability, provision of public space, waste management and environmental improvement in an attempt to facilitate long-term livability in mixed-use urban environment.

Interpretation of Results from Environmental Engineering Perspective

The environmental engineering perspective reflected that land-use intensity, traffic dynamics, and infrastructural deficiencies promoted environmental degradation in mixed land-use corridors of Hyderabad. The development of mixed land-use without complimentary environmental infrastructure upgrades stressed the urban systems by causing pollution, service inefficiencies and environmental degradation under which the environmental indicators include noise, cleanliness, greenery, waste management and congestion have moderate to low mean ratings. The environmental stress in study corridors is driven by land-use intensity as daily population loads; freight activity and service demand grow with high business density without increasing any utility capacity or environmental buffers. Environmental engineering literature by Manzueta *et al*. (2024) emphasises that noise, solid waste, vehicular emissions and wastewater generation rise non-linearly when residential and commercial functions coexist at high intensity hence; the continuously low environmental resource mean values of on Wadhu Wah Road and Market Road (2.75 and 2.78 respectively) demonstrated that these corridors surpassed their environmental carrying capacity leading to poor air quality, noise, and waste management.

The traffic flows are another major environmental stressor across all indicators as Fattah et al. (2021) cited that moderate public transit access, low pedestrian access and continuous congestion highlighted the inefficient traffic management rather than mobility shortages while He *et al*. (2025) added that “*stop and go*” traffic increases PM2.5, NOx and CO emissions. Following the impact, Market Road and Wadhu Wah Road have substantial independent variability in air quality and noise pollution despite similar transport access scores because environmental engineering models affirmed that traffic congestion causes more pollution than free-flow conditions at similar traffic volumes. The noise pollution is also associated with to traffic engineering problems as the mixture of big trucks, motorbikes, rickshaws and buses on shared routes generate acoustic energy due to diverse engine types and uneven speeds hence; heterogeneous traffic streams always produce higher noise than homogenous flows (Montanino *et al*., 2021). However, the considerable better environmental performance at Dr. Salahuddin Road reflected that more uniform traffic flow, larger road profiles and clearer functional segmentation minimise noise propagation while promoting the importance of traffic planning in environmental control.

Infrastructure deficiencies also contributed towards pollution and environmental degradation as public health and environmental resource indicators highlighted waste management, sanitation and greenery difference on Wadhu Wah Road. Manna *et al*. (2025) cited that poor solid waste management with irregular collection, no transfer stations and roadside dumping causes secondary contamination via leachate formation, blocked drainage and vector proliferation however; moderate waste management scores on corridors of Autobhan and Dr. Salahuddin Road reflected partial system functionality but with insufficient infrastructural capacity to manage commercial waste growth. The lack of flora along all highways affects environmental engineering as the urban greenery passively controls pollution by controlling noise and airborne particle (Kumar *et al*., 2019) yet the low greenery scores implied missed low-cost environmental mitigation opportunities to manage infrastructural stress. The water quality and the importance of the sewage system on Market Road also highlighted the infrastructural stress as Zeydalinejad *et al*. (2024) cited that old sewer networks in mixed-use regions associated with the risks of leakage and cross-contamination of commercial effluents into residential systems. The elevated importance of sewage systems as an independent variable established that residents of Hyderabad are experiencing system overload symptoms like odours, blockage or sporadic service that all are engineering failure modes in rapidly commercialising corridors.

Moreover, the geographic consistency of high performance by Dr. Salahuddin Road across most indicators illustrated the infrastructure alignment as its comparative higher mean scores indicated better land-use intensity, transport design and service capacity synchronization. According to Zhu and Zhang (2025) environmental engineering principles focused on redundancy, safety aspects and demand projections to improve infrastructure performance but the poor performance of Wadhu Wah Road is subjected to reactive development under which infrastructure is retrofitted rather than strategically designed resulting in inefficiencies and environmental externalities. The datasets collectively established that urban development without engineering integration causes environmental degradation in these corridors but mixed-use development with traffic management, waste processing and green infrastructure would improve livability; the quantitative scores demonstrated that land-use transition undermined environmental engineering interventions in Hyderabad, resulting in decreasing environmental quality despite economic and mobility benefits.

Strengths and Limitation

The study systematically assesses livability in mixed land-use corridors using seven clear indicators, providing a structured framework for comparative resident experiences. It encompasses four neighborhoods with varying commercial levels to analyze the impact of urban form on perceived livability. Data collection involved self-administered questionnaires and face-to-face interactions, enhancing measurement consistency and response accuracy. Descriptive statistical methods effectively report findings that inform planning and policy interventions. However, limitations include a purposive sampling approach, which may not fully represent all demographics, and the inherent subjectivity of self-reported data, though acceptable for livability studies. Despite these limitations, the research offers valuable evidence for urban management and planning.

POLICY IMPLICATIONS- RECOMMENDING ENVIRONMENTAL MANAGEMENT AND ENGINEERING-ORIENTED INTERVENTIONS

The policy implication recommend following targeted environmental management and engineering interventions to address deficiencies in mixed land-use corridors due to the importance of environmental variables like noise pollution, waste management, air quality and limited greenery:

A) Zooning Buffer and land-use regulation should be strengthened to reduce environmental externalities of mixed-use intensification as all four research corridors have major noise pollution and moderate environmental resource scores; reflecting that business and residential activities are spatially intermingled without buffering. Planning policy should include transitional zoning buffers like service lanes, landscaped strips or low-impact business frontages between high-traffic commercial zones and residential areas as Zeydalinejad *et al*. (2024) found that minimal geographic separation, building orientation constraints and setback laws can minimise noise propagation and vehicular emissions. The enforcement of zoning that limit heavy vehicular access during peak residential hours and noise-intensive commercial activities near housing environment would benefit corridors like Wadhu Wah Road and Market Road because unregulated commercialisation has increased environmental stress.

B) Waste collection systems need route reduction, decentralised facilities and performance-based service solid waste management and sanitation were major issues on Wadhu Wah Road but waste management mean scores were moderate across all locations; demonstrating that collection frequency and capacity inefficiencies rather than service absence from an environmental engineering perspective. According to Ghanadzadeh *et al*. (2014) and Manna *et al*. (2025) municipalities should optimise collection routes using demand-based scheduling to manage commercial waste peaks under which creating multiple transfer points or enclosed garbage collection facilities within crowded corridors reduces roadside dumping and secondary pollution. However, the addition of monitoring tools like service audits or community reporting systems are also important to prevent accountability and efficiency because unmanaged garbage accumulation poses public health problems and environmental deterioration.

C) Crowded corridors should prioritise urban greening methods as cost-effective environmental mitigation tools because currently all communities have minimal greenery due to negligible green infrastructure but Kumar *et al*. (2019) established that urban vegetation passively controls noise, air quality, microclimates and psychological well-being. Following the benefits, policy interventions require mixed-use complexes to provide street trees, vertical greening and small parks in underutilised locations thus; corridor-specific greening initiatives and pedestrian infrastructure modifications would improve environmental comfort and public health.

The datasets and policy implication correlations, established that land-use growth and environmental management systems misaligned in Hyderabad which consequently lead to livability challenges in mixed-use areas therefore; zoning buffers, engineering waste collection and urban greening can improve environmental performance and livability across the business corridors of Hyderabad.

CONCLUSION

The current study assessed livability among residents in four mixed land-use districts across seven major indicators. The results showed that Dr. Salahuddin Road consistently performed at a higher level than the other locations, reflecting the positive influence of structured commercial development and coordinated service delivery. Moreover, infrastructure quality, access to public health care, economic prospects, and mobility emerged as the strongest contributors to perceived livability, whereas pedestrian infrastructure, greenery, and recreational spaces remained weak. Overall, the current study indicates that appropriate land-use planning and balanced urban services can substantially improve neighborhood conditions and support sustainable change in rapidly urbanizing areas.

DECLARATIONS

Conflict of Interest

The authors declare no conflicts of interest.

Data Availability

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

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