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Keywords: E-bikes, Non-motorized Transport, SDG 11.2, Sustainable Mobility, Hyderabad

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The urbanization process within Pakistan, together with other developing nations, has caused severe transportation problems, resulting in traffic congestion and air pollution and creating uneven mobility access across different areas. This research analyzes how electric bikes (e-bikes) and non-motorized transport (NMT) methods can boost sustainable urban accessibility and livability within Hyderabad, Pakistan, according to Sustainable Development Goal (SDG) 11.2. Through surveys, spatial analysis, and behavioral observations, the researchers assess e-bike effectiveness in lowering car usage and releasing emissions while advancing public health. The research discovered that e-bikes hold the potential to replace 30–40% of car trips under four km distance, thus creating an annual CO_2 reduction of 12,000 tons. Lack of cycling infrastructure and public preference for motorized vehicles are the main obstacles. The suggested policies focus on infrastructure developments through built cycling paths, financial support for e-bike purchases, and planning methods that protect pedestrians.

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Contents

Introduction

Rapid population increase coupled with inadequate public transit and automobile-focused planning practices causes transportation emergencies in developing nation urban areas (Irfan Ahmed Memon et al., 2020; Marvi et al., 2022, 2023; Qureshi et al., 2022; M. Soomro et al., 2025). Hyderabad in Sindh Province demonstrates these major problems through its overloaded roads, contaminated air, and inadequate walking paths, which diminish the quality of life and economic efficiency (Marvi et al., 2024; Memon et al., 2014, 2015, 2022; Memon, Sahito, et al., 2021). SDG 11.2 by the United Nations functions as a

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priority to deploy accessible, sustainable transportation that ensures safety, yet Hyderabad stands behind many cities in adopting this standard (Memon et al., 2022; Memon, Kalwar, et al., 2021; R. Soomro et al., 2022).

The research examines e-bikes and NMT as economical alternatives to resolve transportation problems in Hyderabad. Electric bicycles provide users with assisted pedal power between manual and motorized vehicles. The practical nature of e-bikes works best during brief journeys within crowded cities because they offer eco-friendly transportation with better accessibility for people who need it. This investigation examines Hyderabad's auto-hegemonic transport system to uncover obstacles blocking NMT implementation while developing reform strategies for local policies that support SDG 11.2 targets.

Currently, cities are home to more than half of the world's population and provide a sizeable economic output, roughly 85% of the global GDP (Marvi et al., 2024; M. Soomro et al., 2025). However, cities also produce a sizable portion of the world's greenhouse gas emissions because of their dense population, exacerbating environmental problems like climate change. Therefore, addressing sustainability at the urban scale is essential to addressing more general global sustainability challenges and promoting a more fair and resilient future for all. By prioritizing sustainable urban development strategies, cities can effectively mitigate environmental impacts, enhance resource efficiency, promote social inclusion, and create healthier, more livable environments for residents. Embracing sustainable practices at the city and community levels contributes to achieving long-term developmental objectives and delivers tangible benefits that directly improve individuals' well-being and quality of life.

Figure 1

The elements of the urban form

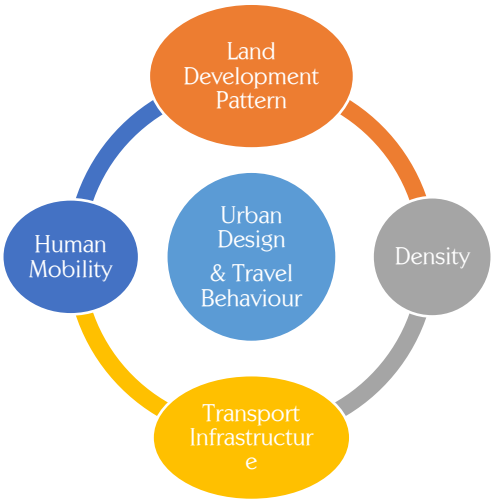


Figure 1 shows the urban form functions as a spatial depiction of a city's social dynamics, human mobility, geographic setting, and cultural indicators.

Urban form, with its impacts on both physical and non-physical aspects, is a crucial topic. Human behavior, social interaction, quality of life, urban vibrancy, a city's health, sustainability, travel habits, climate change, energy consumption, and resilient cities are all directly impacted by the components of urban form.

The innovative urbanization theory describes compact and mixed development, few parking lots, well-linked street networks, high-density urban design, and diversified land use as the characteristics that constitute an urban system. Pedestrian-friendly design in which Street-level land use includes visible, direct, short, and pedestrian and bicycle paths; pedestrian pathways along the street network; narrow streets; and accessible streets from all points.

A neighborhood planned to be either car-free or allow cars to access homes with designated pedestrian lanes in front. Walking and bicycling are encouraged with pedestrian lanes surrounded by trees that are five meters wide and a smooth side for cyclists, skaters, and other users. A different network handles vehicle circulation.

Therefore, we argue that sustainable urban transport planning uniquely enhances accessibility and livability in developing countries.

Smart transportation is directly impacted by environmental, economic, and social behavior; for this, it considers the land development of urban form that influences the travel behavior of all users. Table 01 shows the advancement of adequate transportation infrastructure at the meso and micro-scale and the provision of essential mobility services to all, showing accessibility and livability factors selected for the research.

Table 1

shows the factors of accessibility and livability

Factors At the Meso and Micro Level	
Accessibility	Livability
Density	Mix Land Use,
Mix	Traffic and Pedestrian Safety,
Connectivity	Easy Accessed and Shading Elements
Centeredness	Walkability, Improving Cycling Lanes,
Pedestrian Cycling Environment	Paving Materials, Building Height
Parking Supply and Management	Sidewalks, Crossings
Street Design and Management	Noise and Air Pollution
Transit Accessibility	Parking facility, Cleanliness & Maintenance
Public transportation Availability	Enhance public transportation services

Research Gap

The fast-growing city of Hyderabad is at risk of disregarding fundamental urban livability principles (at the meso and micro-scale), which leads to social, economic, and environmental inequality and urbanization under unjust, unsustainable, and unlivable conditions. An environment is produced by urban sprawl resulting from automobile-oriented planning, disregarding the needs of bicycles, pedestrians, and public transportation users. Modern cities that don't have an integrated transportation network system are disconnected, inaccessible, and unsustainable, which encourages the emergence of unstable urban patterns and ways of living in metropolitan areas. Unchecked urban development in modern cities lengthens travel times between locations, eventually ignoring the accessible urban environment at the human level. Subcenters, which provide a range of urban purposes and are accessible by foot or bicycle, are developing less quickly in these rapidly expanding cities than mono-functional uses.

Car mobility is predicted to decline due to public transportation's role in modal splitting. The adequate transportation infrastructure at the meso and micro-scale, which shows accessibility and livability factors in Table 01, would be selected for the research that provides essential mobility services to all.

Literature Review:

E-Bikes as Sustainable Mobility Solutions

E-bikes currently experience rapid market adoption worldwide, particularly in cities such as Amsterdam, Portland, and Kunming, because people are focused on environmental concerns and urban traffic issues (Cherry et al., 2016). The European study conducted by MacArthur et al. (2014) indicated that e-bikes replace between 15–25% of traditional car utilization. In contrast, Sun et al. (2020) established a 40% reduction in public transport use from e-bike adoption in China. The low operational expenses of €0.03/km surpass the €0.12/km cost for cars, while their small emissions of 22g CO2/km match up against 271g for vehicles based on (McQueen et al., 2020).

Challenges in Developing Countries

The preference toward motorized vehicles in Pakistan and car-centric infrastructure are barriers to adopting non-motorized transportation (Jawed et al., 2019). Public transit in Hyderabad functions separately, while research reveals that only 21% of its citizens can reach parks through walks spanning 400 meters or less (Khahro et al., 2023). Unsafe intersections and poor sidewalk conditions make residents avoid walking and cycling.

SDG 11.2 and Urban Accessibility

SDG 11.2 underlines accessibility requirements that mention public transportation must extend to a 500-meter walking range while promoting accessibility for disadvantaged population segments. The extensive growth of Hyderabad, together with its single-purpose land uses, intensifies social inequality across the city. Knowledge of NMT implementation gained from studying the Netherlands' cycling infrastructure (Fransen, 2022) and China's e-bike policies (Cherry et al., 2016) offers practical recommendations for urban planning.

Transportation System in Pakistan

Road transportation is a significant component of Pakistan's transportation system; it consists of

privately owned cars, public buses, trucks, and motorcycles. However, the country's high percentage of fossil fuel-powered cars, absence of emission control laws, poor car maintenance, and traffic jams significantly increase the country's air pollution and greenhouse gas emissions, directly affecting public health and climate change.

The lack of adequate public transportation infrastructure and services encourages private vehicle ownership, increasing fuel consumption, emissions, and traffic congestion. Low-quality fuels and inefficient engines further exacerbate the transportation sector's environmental impact.

The transportation industry in Pakistan suggests environmentally friendly and effective public transportation options, like metro trains and bus rapid transit (BRT) systems, which can lower emissions and traffic jams while promoting sustainable urban mobility. In Hyderabad, intra-city (PBS) people bus service ply from the city center towards many destinations.

One of the primary issues in Hyderabad that makes the city less livable is the average distance between homes and places of employment getting longer, the reliance on personal vehicles, and the traffic jams on the major routes, such as the autobahn, Qasimabad, and Chandni mobile market. Understanding Hyderabad and comparable cities is difficult since they have lost human size at meso and micro scales. Instead of considering the mobility of people, planning primarily finds the movement of vehicles and economic factors. Most infrastructure expenditures go toward building large, narrow highways and more corporate buildings than facilities for pedestrian mobility, which is unsustainable, especially for municipal governments.

The primary aim of this study is to elucidate the criteria essential for evaluating the walkability capacity of cities at macro, meso, and micro levels. By focusing on creating pedestrian-friendly environments and walkable streets, the research aims to highlight the interplay between urban form, transportation systems, and land development variables. Additionally, the study seeks to explore how the design and characteristics of city center environments influence the walking experience and overall urban livability.

- To investigate the correlation between urban form and non-motorized transport, emphasizing the role of walkability in promoting sustainable urban mobility.

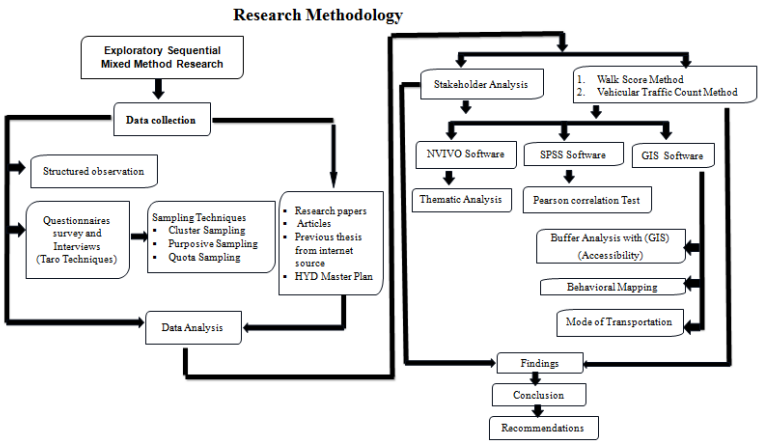
By aligning the problem statement, research aims, and objectives, this study contributes valuable insights toward creating safer, more walkable urban environments that prioritize pedestrian well-being and sustainable transportation practices.

Research Methodology

The study will employ qualitative and quantitative methodologies to evaluate the strong correlation among existing urban forms, transportation infrastructure, land development patterns, and the current state of walkability in the city. It demonstrates that two primary urban scales, the mesoscale and micro-scale, would be considered the city's walkability, which employs case study methodology. The case study location is selected from Qasimabad, Chandni Saddar, and Hyderabad's prominent Auto Bhan route neighborhoods. It is situated in the district's area and has the highest level of economic activity.

Figure 1

Flow Chart



As shown in Figure 01, the research methodology consists of two primary data collection components for urban accessibility and livability factors influencing walkability: pedestrian safety, private car ownership, and sustainable transportation modes, from the site survey and literature review. The theoretical basis for urban walkability and form is created by gathering knowledge about urban form and urban walkability from the literature.

First, based on the literature assessment, there are two primary components to studying urban form and travel behavior: land development factors and transportation systems. Transportation systems include transit systems, non-motorized user networks, and a city's roadway network and layout. Land use development reveals how the environment is arranged spatially. It comprises the mix of uses within a specific region and residential and commercial space density. The meso (city, neighborhood, and urban block) and micro-scale (street and individual building) are defined, and urban walkability elements connected to urban form are separated into two primary groupings.

Secondly, the observation study in the chosen areas examines how road design standards and traffic measures create walkable regions and how people walk there. It does this by monitoring pedestrian safety, urban accessibility, and sustainable travel modes during the tracked activity, tracking the pedestrians' route choices for walking trips, and observing the perceived subjective measurement of pedestrian density and its patterns. The objective is to observe the study areas in terms of the intricate state of their physical environments and how they serve as the background of accessibility for pedestrian safety walking activities. This will be accomplished by keeping an eye on who walks where and when what kinds of walking and modes of transportation are undertaken there, what patterns can be identified in them across various times of day and season, what occurs during the tracked and observed walking activities, and how the state of the built environment appears to have influenced them. Partitioning walking activities became one of the key aspects that the walkability observation research attempted to document. Examines how people's choice of commute mode is influenced by the physical environment surrounding their place of employment, emphasizing the usage of clean transportation.

Thirdly, the study area is used to analyze the existing urban form, transportation infrastructure, land development patterns, and the current state of walkability in the city. First, counting occurs in the three neighborhood cases using direct observation techniques (the Gate Method). Furthermore, the walk Score and vehicular traffic count method would be employed to evaluate walkability and vehicle traffic ratio. Behavioral mapping will show the data collected during the field study. The study's input, consisting of all findings counts, contains urban walkability data. Then, the urban form data of the chosen locations will be ascertained. The land set images and buffer analysis for accessibility will gather the data using Geographic Information Systems (GIS), institutional and municipal data, picture interpretation, and field research observations. The findings will analyze how urban walkability, transportation infrastructure, urban accessibility, and emission-free travel modes relate. Which urban design elements significantly influence urban accessibility and livability to create a walkable city in the case region will be determined using a scoring system to assess the findings.

Expected Outcome of the Research

The city of Hyderabad is expected to benefit from these experiences and create plans and resources to enhance livability and walkability, lessen automobile traffic in the city center, and encourage high-quality, clean transportation that provides the best possible circumstances for pedestrians.

Additionally, to improve the streets' quality of life as a livable, sustainable, or clean transit means. The results of this study would offer perceptions of how walking behavior and the built environment interact and influence one another.

By prioritizing the physical and economic aspects of accessibility in public transport systems and regulations, communities may establish more sustainable, equitable, and inclusive urban settings that promote the prosperity and well-being of all residents of the selected study area.

As the agenda for sustainable development goal (2030) and Target 11.2 critically focuses on cities and communities to improve the quality of life for people worldwide as urbanization continues to rise and more individuals migrate to urban areas, the emphasis on cities grows even brighter as key hubs for economic activity, innovation, and social progress. Therefore, to provide access to safe, affordable, accessible, and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities, and older persons.

Conclusion

The transportation emergency in Hyderabad requires the immediate development of urban mobility strategies that follow SDG 11.2 targets. Integrating e-bikes and NMT systems proves effective as a sustainable solution to decrease emissions, promote equality within cities, and create spaces for pedestrian movement. Scientific studies show that e-bikes successfully substitute 30–40% of car use for short distances, significantly reducing traffic jams and airborne pollutants. Government institutions need to implement specific measures to overcome physical and cultural obstacles preventing citizens from adopting non-motorized transport methods.

The implementation of policies should allocate funds for developing walking-friendly infrastructure alongside discount programs for individuals using low-income e-bikes and mass education schemes to modify commuter habits. Hyderabad can create sustainable transportation systems that promote both environmental resilience and better resident life quality by adopting these planning techniques into municipal frameworks. This study delivers strategic guidelines for Hyderabad's infrastructure development and substantial contributions to SDG-driven development research throughout the Global South. Future investigations should analyze how e-bike implementation affects the economy and establish guidelines for expanding NMT infrastructure networks between similar cities.

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