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Towards Greener Commutes: Urban Green Spaces in Lahore's Transportation Corridors

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Keywords: Sustainable Development Goals, Green Spaces, Mobility, Public Participation

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Abstract

The integration of Urban Green Spaces (UGS) into transportation infrastructure is gaining attention as a pathway to sustainable urban development. This study investigates the potential of embedding UGS within Lahore's transportation corridors to improve environmental quality, public health, and urban livability. Despite rapid urbanization and challenges like air pollution and rising temperatures, green infrastructure remains under-prioritized in the city's transport planning. Using a qualitative approach combining literature review, policy analysis, and field assessments this research examines existing practices and identifies opportunities for UGS integration, aligned with the UN Sustainable Development Goals. It highlights benefits such as improved air quality, noise reduction, and psychological well-being, while also addressing barriers like limited space, fragmented governance, and maintenance issues. Findings reveal a disconnect between infrastructure development and ecological planning in Lahore. It contributes to the discourse on sustainable mobility, offering insights for cities in the Global South facing similar urban and environmental challenges.

Keywords:

Sustainable Development Goals, Green Spaces, Mobility, Public Participation

Introduction

Cities are dynamic entities shaped by the interaction between built environments and open spaces, forming the setting for humans and significantly influencing urban life (Qin et al., 2025). Urban areas reflect a complex mix of infrastructure, green

spaces, and social activity. Well-integrated open spaces enhance sustainability, aesthetics, and community well-being. Urbanization shapes cities' spatial, economic, and social structures, creating diverse neighborhoods with varied needs. Perceptions of urban environments differ by age,



income, and lifestyle, highlighting the importance of inclusive, multifunctional public spaces in heterogeneous urban settings.

Rapid urbanization can lead to congestion, sprawl, and environmental harm if unmanaged. Controlled, need-based expansion helps prevent unchecked land consumption and protects ecological resources. Systematic planning enables the integration of green infrastructure, enhancing biodiversity, environmental quality, and climate resilience (Sachs et al., [2021](#)). Compact and well-structured cities are better positioned to protect biodiversity hotspots and conserve environmentally sensitive areas, ensuring a balance between development and ecological preservation.

Urbanization and population growth have brought about substantial transformations in cities, turning them into crucial hubs of development. These dynamic changes have given rise to spaces that foster social, cultural, and economic progress. When cities expand, they become centers of innovation and opportunity, attracting diverse populations and facilitating the exchange of ideas and resources (Bluhm & Krause, [2022](#); Pervaiz et al., [2025a](#)).

Lahore, with a population exceeding ten million, has emerged as a megacity undergoing rapid urbanization and transformation (Baig et al., [2019a](#)). As Pakistan's second-largest metropolitan area after Karachi, Lahore faces challenges associated with population growth, infrastructure expansion, and environmental degradation. The rate of urbanization of Lahore is increasing, and it stands at 26.5 km² per annum from 2000 to 2010, while the loss of green cover from 2010 to 2020 stands at 14.5 km² per annum for Lahore, which is a little less than the previous years (Azhar et al., [2024](#)). The city's ongoing urban transformation encompasses large-scale changes that reshape its physical, economic, social, and environmental dimensions (Canton, [2021](#)). Urban transformation demands infrastructure redevelopment, green integration, and policy action to boost sustainability. The "Decade of Action" calls for local efforts to meet the SDGs by 2030, focusing on health, poverty reduction, and climate resilience. In Lahore, urban sprawl has tripled since the 1990s, shrinking green spaces as built-up areas and roads replace once-rural land (Azhar et al., [2024](#)).

One of the key components of sustainable urban development is the integration of green spaces within the built environment. Green areas not only improve air quality, reduce urban heat island effects, and promote biodiversity, but they also enhance the social and aesthetic value of cities (Kabisch et al., [2015](#); Tzoulas et al., [2007a](#)).

The scholarly progression and intersection of three core concepts Urban Green Spaces (UGS), Transportation Corridors, and Sustainability have been addressed in recent academic publications in the last decade and a half. Numerous studies concentrate on Urban Green Spaces (UGS), especially when considering the advantages for the environment, thermal comfort, and urban livability (Baig et al., [2019b](#); Haase & Dushkova, [2024](#)). Some also take into account green infrastructure on transit corridors, which have many more benefits, such as enhancing the beauty of mobility, mitigating the impacts of the urban heat islands, and promoting sustainable urban planning (Brouwer et al., [2024](#); Liu et al., [2021](#)).

Research contributions such as those by (Brussel et al., [2019](#)) delve deeply into transportation aspects, while others, like (Corkery, [2019](#); Kumar et al., [2023](#)), adopt broader perspectives that link UGS with urban resilience and land-use efficiency.

Lahore's rapid urbanization driven by population growth, migration, and job opportunities has expanded infrastructure at the expense of green spaces. This paper examines UGS within transport corridors, drawing from international benchmarks while addressing local challenges. It identifies key strategies to maximize the environmental, social, and economic benefits of UGS amid fast-paced urban growth.

Cities and Sustainable Development Goals (SDGs)

Safe, SDG 11.2 highlights the importance of safe, affordable, and sustainable transport for urban sustainability. Achieving this requires shifting to multimodal systems, promoting walking, cycling, and reducing car dependence. Effective public transit, green energy, and affordable access are key to improving mobility, cutting emissions, and enhancing urban air quality.

The following is a quick summary of the other SDGs that are connected to this goal: 9 and 3.

Building resilient infrastructure, encouraging sustainable industrialization, and encouraging innovation—particularly in transportation planning—are the three main objectives of SDG 9. In order to assess the accessibility and connectedness of transportation networks, SDG 9.1.1 measures the percentage of rural residents who live within two kilometers of an all-season road.

SDG 9 emphasizes resilient infrastructure, sustainable industrialization, and innovation—key elements in effective transportation planning. Resilience in transport systems like roads, railways, and bridges refers to their ability to withstand and recover from natural and climate-induced shocks and disasters. A study by Yin (2023) proposed a quantitative framework for assessing the resilience of road segments, which assists planners in identifying weaker areas of infrastructure that require immediate attention. In the same context, Zhang (2024) proposed a network model to assess the resilience of urban transportation systems in China, focusing on the virtues of integrated planning for system robustness during design, operation, and recovery phases.

As far as sustainable industrialization is concerned, green transportation infrastructure is on the rise, such as "green highways." These projects strive to reduce ecological footprints, which evolutionarily makes them green projects by incorporating the use of recycled materials, wildlife crossings, permeable pavements, etc. (Way et al., 2007). Technological innovation does not lag behind. The implementation of technologies, which include the Internet of Things (IoT), mobile networks, and artificial intelligence, has changed transportation logistics and asset management.

As for innovation in the transportation sector, there are also initiatives to create more sustainable and resilient frameworks concurrently. Kays & Sadri (2022) proposed a model that incorporates emissions, travel delay, energy usage, and accessibility to help cities create better-balanced transport systems. Micromobility e-scooters and bicycles showed how data can be used to improve network design and enable the use of cleaner fuels in urban transport.

Within the policy framework, the United Nations includes certain transport indicators within SDG 9, such as the estimation of passenger and freight volumes and the percentage of

population within a given radius of all year-round roads (Jia et al., 2020). These indicators focus on improving the equity aspect of the transport infrastructure.

SDG 9 promotes resilient, eco-friendly transport infrastructure, while SDG 3 supports green spaces along corridors to reduce pollution and improve public health. Together, they emphasize sustainable planning aligned with climate goals and healthier urban environments.

Sustainable Development Goal 3 promotes health and well-being, partly through improving urban mobility. Sustainable transport—like clean buses, bike lanes, and walkable streets—reduces air pollution and encourages healthier lifestyles. Integrating green spaces along transport corridors enhances this impact by cooling urban areas, improving air quality, and reducing stress. Transit corridors, often overlooked, are vital to sustainable mobility and should include green infrastructure. Landscaping elements such as trees, bioswales, green buffers, and rain gardens not only beautify cities but also support biodiversity, manage stormwater, and mitigate flooding. Combining sustainable transport with nature-based solutions fosters more livable, resilient cities. This study focuses specifically on the role of Urban Green Spaces (UGS) within transport corridors in promoting environmental and public health benefits.

Sustainability

Human well-being is closely tied to nature, and environmental impacts reflect human activity. Globalization has advanced knowledge exchange, but regional socioeconomic and environmental differences remain. While some countries lead in sustainable urban development, applying their models universally is impractical. Instead, context-specific strategies, informed by traditional planning and local ecological knowledge, are essential for achieving truly sustainable urban infrastructure (Citaristi, 2022a).

Sustainability refers to the enduring nature of development, ensuring that urban growth and infrastructure can withstand environmental, social, and economic challenges over time. The concept of sustainable development has gained global recognition, with a notable milestone in 2012 when a UK minister formally declared sustainability as a

core objective of urban planning (Prizzia, 2017). In recent years, sustainable and ecologically driven development has become a central focus in urban planning, emphasizing landscape functionality over mere aesthetics. The integration of natural elements within urban infrastructure is crucial. The urban spaces thrive when they are designed to be adaptable, multifunctional, and environmentally responsive.

Green infrastructure is also a key technique, integrating natural systems into urban environments. This helps to manage stormwater, reduce heat island effects, and improve air quality. Finally, it adds to the ecological and social sustainability of cities (Benedict & McMahon, 2012; Schilling & Logan, 2008).

The task of green infrastructure has begun to move past its visual uses and has a heavy drive toward the creation of integrated green networks with multiple functions, including climate resistance, biodiversity protection, and increased city administration (Citaristi, 2022b). Multifunctional areas, in which cityscapes combine recreation facilities, landscape greenbelts, as well as transport corridors, have become common in the present demands of urban planning. Urban landscape areas in Pakistan, in combination with transportation corridors, should highly focus on green spaces development to be environmentally sustainable without compromising the health of the population and urban settlement resilience (Farooq et al., 2024). The conventional city planning strategies focusing on automobile-oriented design must undergo transformations to more nature-driven models that lead to walkability, alleviating the concept of urban heat island, as well as air quality Enhancement.

Under the scenario of urban development in Pakistan, cities such as Lahore are experiencing more and more environmental pressure, such as air pollution, temperature rise, and the decrease of green areas (Ayaz et al., 2024; Shoaib et al., 2022). Although the global sustainability systems are providing broad guidelines, a combination of locally modulated solutions, like the use of green corridors in the city, eco-friendly road designs, and nature-based solutions along the transport corridors, needs to be integrated into the long-term resilience. A balanced approach, incorporating both modern sustainability principles and traditional

ecological practices, can help cities harmonize infrastructure growth with environmental stewardship (Singh et al., 2024).

Sustainable development is built upon three interconnected pillars: economic, social, and environmental dimensions (Jankiewicz, 2025). However, economic progress often comes at the cost of environmental degradation and social disparities. To achieve true sustainability, economic growth must be balanced with environmental preservation and social well-being, ensuring that development does not compromise ecological integrity or societal equity.

“The dearth of green spaces cannot help, as in a study it was observed that “The green spaces make up just 0.9% of the whole site, resulting in a predominance of carbon and cemented blocks. This puts strain on the creation of green spaces and leisure areas, which not only provide a better living environment and placemaking but also can reduce daily carbon emissions and contribute to the environment. Roof-top gardening could be another solution, but this may take longer to achieve” (Pervaiz et al., 2025b).

In recent decades, the growing environmental challenges, urbanization pressures, and socio-economic disparities have necessitated a paradigm shift towards sustainability-focused design practices. Sustainability in the urban environment entails an amalgamation of environmental, social, and economic concepts to establish urban environments that would satisfy the current needs without degrading the capacity of future generations to fulfill theirs (Omole et al., 2024).

Applying sustainable development principles in cities fosters resilience, equity, and environmental harmony. Beyond resource efficiency, it enhances quality of life and inclusiveness. Urban sustainability can be achieved through thoughtful planning and eco-friendly design strategies.

Transforming Roads into Sustainable Infrastructure

The course of action to take would be to reconsider urban roads as avenues of human interaction, business, and environmental sustainability, and not necessarily as conduits of transportation for vehicles. The car-centered highway must change and develop into a bigger entity, which will take care of the issues of the current time. It has to be

understood that successful urban transformation requires the integration of green infrastructure, pedestrian-centric planning, and place-sensitive design approaches. By incorporating landscape elements into transportation corridors, cities can ensure that urban expansion remains economically vibrant, socially inclusive, and ecologically responsible.

This reinforces the need for a balanced approach that considers environmental preservation, economic opportunities, and social inclusivity in road infrastructure planning. The development of road infrastructure requires integration of environmental, economic, and social factors. The construction of roads increases business activity and connectivity (Kuncoro et al., 2024); however, it also contributes to deforestation, habitat destruction, and community changes (Gunawan et al., 2024). The construction of new highways is deemed sustainable only when the problems of the environment (e.g., resource scoping, animal preservation), society (e.g., land expropriation, comfort of employees), and economics (e.g., high costs for eco-friendly construction materials) are taken into account (Maelissa et al., 2023). These objectives can be met with the help of integrative planning, flexible control, and participatory decision making (Huang et al., 2025). Policies should bring together disparate components—economic frameworks, social equity, and environmental protection, while using strategic foresight to balance synergies and challenges (Sun, 2024). Such policies serve all three goals as part of the so-called “triple bottom line” that focuses on sustainable economic development and road construction infrastructure that incorporates social equity (Maelissa et al., 2023)

Government Initiatives for Sustainable Urban Greenery

To align with Sustainable Development Goals (SDGs), both government and non-government organizations in Pakistan have implemented various initiatives to enhance urban greenery and environmental sustainability. These efforts focus on afforestation, green infrastructure, and public engagement to promote a sustainable urban ecosystem. Some of the key initiatives include the following.

The Billion Tree Tsunami Initiative (2014–2017) was launched by the Khyber Pakhtunkhwa (KPK) government. This program led to massive tree planting, which played a huge role in afforestation, contributes to biodiversity recovery, and climate stability.

Miyawaki Urban Forests (2020 Present) Pakistan has had several successful seasons with greening in the Miyawaki forestation technique worldwide, which has inspired the nation to start implementing the same in 2020 by developing dense and quick-growing urban forests. Among them, the Miyawaki forest rollout in the Liberty Market Lahore, many schools and colleges, and a few others planted under the Ravi Urban Development Authority (RUDA) to boost the ecological resilience and to fight urban heat can be mentioned (Sandip et al., 2022).

This was primarily done to counter the increasing air pollution, so to counter this issue, the Smog-Free Lahore Initiative (2022-2023) was intended that plant 1.5 million trees in Lahore. The initial part started in 2022, where 15000 saplings were planted adjacent to the Lahore Airport along the Ring Road. Phase two was to have 25,000 saplings planted in June of 2023, close to the area of Mehmood Booti. Educational institutions, the Parks and Horticulture, n.d Authority (PHA), Alkhidmat Foundation, and volunteers all came together and took part in this project. These green spaces are maintained by the PHA (Malik et al., 2024).

In 2024, the Parks and Horticulture Authority (PHA) accelerated the development of green corridors in Punjab to combat smog and climate change. These corridors aim to enhance urban aesthetics and improve climate resilience by reducing heat islands and air pollution. PHA also maintains green belts to ensure sustainable urban greenery. The Punjab government is actively addressing air pollution, especially smog, to improve public health in cities like Lahore (Djordjević et al., n.d.).

Province-wide Tree Plantation Campaign started on March 22, 2025. A large-scale tree plantation campaign was inaugurated with the ceremonial planting of a sapling at Alhamra Art Centre, Lahore. The campaign emphasizes not only the plantation of trees but also their protection and maintenance, recognizing trees as vital for

enhancing air quality and promoting environmental health across the province (Daily News, March 22, 2025).

Launched in February 2025, the "Lungs of Lahore" and "Ring of Lahore" project aims to restore the city's status as a "Garden City" by planting over 8 million trees. Key sites include the River Ravi, the BRB and Lahore canals, and major motorways. Each tree is geotagged for monitoring. Early outcomes, particularly in Shahdara, show improved winter air quality, reflecting the project's positive environmental impact (Daily Nawa-e-Waqt, March 22, 2025).

The "Plant for Pakistan" campaign was inaugurated on World Forest Day, March 21, 2025, by the Director General (DG) of Sports, Punjab. The launch event took place at the Hockey Stadium in Lahore, where saplings were planted as a symbolic start. The DG pledged to extend the tree plantation drive to all sports complexes across Pakistan, promoting green and healthy environments in sports facilities.

According to WWF-Pakistan, the country loses nearly 11,000 hectares of forest cover annually due to deforestation, low precipitation, and worsening climatic conditions. With only 5% of Pakistan's total land area under forest cover, the nation is categorized as a "forest-poor country" (News International, Lahore, March 22, 2025). In light of this alarming trend, there is an urgent need to focus on replanting and restoring forest ecosystems. WWF-Pakistan is actively promoting sustainable environmental practices through various initiatives, including: Recharge Pakistan Programme, Engro Forest Restoration and Carbon Offset Project, Rung Do Pakistan, Integrated Water Resources Management in the Indus Basin, and Agroforestry and Biodiversity Conservation Project (Xie et al., 2024).

Greening the Cholistan Desert Initiative (2025) is a part of broader national efforts to combat desertification and promote ecological sustainability. A green initiative is underway to transform the Cholistan Desert into a thriving green zone. This ambitious effort aims to improve biodiversity, soil fertility, and microclimatic conditions in the arid region of southern Punjab. The project foresees reconstruction of the degraded landscapes, livelihood of the local population, and improvement of climate resilience in Pakistan

through afforestation, sustainable water resource management, and introduction of drought-resistant plant species (Akram & Soomro, 2012).

In 2025, the Botany Department at Government University Lahore launched a project to identify and classify tree species in city green belts, supporting biodiversity and sustainable urban planning. During the March "Heal Pakistan" conference, RUDA proposed green building certifications and emphasized carbon credits, sustainability, and climate-resilient development. These initiatives reflect a shift toward integrated environmental planning aligned with global sustainability and carbon neutrality goals (Xie et al., 2024).

Therefore, so many aspects presented by both the government and the non-government bodies are endeavoring to achieve sustainability practices to ensure that posterity will be living in a healthy environment. Most of them have resorted to planting/ keeping greeneries, but the handling of vehicle fumes, such as motorcycle smoke, is also being carried out.

Urban Green Spaces (UGS)

Urban Green Spaces (UGS) exist in various forms, ranging from large parks and green belts to smaller pockets of greenery along roads, railway lines, and brownfield sites. Their size, shape, and configuration vary based on location, ownership, and accessibility. According to Sangwan et al. (2022), Urban Green Spaces (UGS) can be classified into the following types:

- Natural green spaces - Areas dedicated to urban wildlife, ecology, and woodlands.
- Green corridors - Linear green areas along riverbanks, canals, railway lines, and roads, which enhance connectivity between fragmented landscapes.
- Urban empty and abandoned land. Unopened or underused areas that have the possibility of green development.

Urban Green Spaces once played a key role in city planning, especially during the Garden City Movement, buffering urban and rural areas. However, rapid urbanization has fragmented these spaces, weakening their connection to the landscape and diminishing their role in controlling urban sprawl.

Urban Green Spaces provide recreation, cleaner air, cooler temperatures, and greater biodiversity. While easy to integrate in low-density areas, high-density cities face land use pressures, highlighting the need for innovative planning to ensure sustainable, accessible green spaces in growing urban areas.

Afforestation includes planned tree plantations with selected species and naturally occurring urban forests on unused land. These self-sustaining ecosystems, often a mix of native and non-native trees, enhance biodiversity, purify air, and improve climate resilience, making them valuable for sustainable urban planning (Aronson et al., [2017](#)).

Urban Green Spaces (UGS) along Road Corridors

Urban Green Spaces (UGS) along roads support sustainable, resilient, and inclusive cities. They offer visual, recreational, and ecological value, enhance placemaking, foster social cohesion, and address key environmental challenges. By greening transport corridors, UGS transform them into healthier, more connected urban spaces—benefits explored further in this study:

Potential Adverse Impacts of Urban Green Spaces (UGS) on Road Infrastructure

Transportation Corridor Urban Green Spaces (UGS) are necessary to increase the environmental condition, support human health, and reduce the urban heat impacts. Nevertheless, even though these green spaces have the advantages, there are a number of challenges that can be triggered by the same concerning the road infrastructure, road safety, as well as their functionalities in urban settings. The next passages will refer to the principal negative effects of Urban Green Spaces (UGS) on roads:

Root Proliferation and Road Damage

Tree roots along roads often extend beyond planting zones, seeking water and nutrients. Over time, they can damage asphalt, cause pavement heaving, and create potholes, especially in areas with aging infrastructure. This not only raises repair costs but also endangers pedestrians, cyclists, and vehicles, while potentially disrupting underground utilities like water, drainage, and electricity systems (Shi et al., [2023](#)).

Reduced Road Visibility

Overgrown roadside vegetation can block road signs, signals, and pedestrian paths, especially at intersections and high-traffic areas, increasing accident risk. It impairs visibility for drivers, cyclists, and pedestrians. Regular pruning and maintenance are essential to ensure safe and clear sightlines for all road users (Reja et al., [2024](#)).

Drainage Issues and Flooding Risks

Urban Green Spaces aid stormwater absorption, but poor design can clog drains with leaves and debris, causing localized flooding and unsafe roads. Excess moisture weakens pavements, leading to early damage and repair costs. Sustainable drainage solutions like permeable pavements and rain gardens can prevent these issues while maintaining roadside greenery (Mullaney et al., [2015](#)).

Space Constraints and Urban Mobility Challenges

In dense cities, green spaces can limit space for traffic lanes, sidewalks, and transport infrastructure. This may worsen congestion, especially in busy areas with rising vehicle numbers. Additionally, excessive greenery may reduce room for bike lanes and walkways, restricting non-motorized mobility and hindering eco-friendly transport options like walking and cycling (González Guzmán, [2021](#)).

Increased Pedestrian and Cyclist Risks

Roadside greenery attracts walkers and cyclists, but without proper pedestrian and bike infrastructure, it can increase accident risk. Poor design may lead to jaywalking or force cyclists into traffic lanes. Safe integration requires clear crosswalks, pedestrian islands, and protected bike lanes to balance greenery with road safety (Litman, [2022](#)).

Climate-Specific Challenges of Urban Green Spaces

While Urban Green Spaces help reduce heat in hot climates, they can worsen icy conditions in winter. Dense tree cover blocks sunlight, slowing snow and ice melt, increasing slip and crash risks. In cold regions, careful tree placement is essential to

balance shade in summer and sunlight exposure in winter (Yaşlı et al., [2023](#)).

Impacts of Biodiversity on Road Safety and Traffic Flow

Urban Green Spaces attract wildlife, leading to issues like sudden animal crossings, which can cause accidents, especially in high-speed zones. Bird droppings and nesting debris may also affect road safety. Nocturnal animal activity further increases risks. Effective wildlife management such as fencing, warning signs, and designated crossing points—is essential near green corridors (Forman et al., [2003](#)).

Maintenance Challenges and Cost Implications

Maintaining roadside green spaces through pruning, mowing, and debris removal is vital for safety and aesthetics. Neglect can block roads, cause slips, and create pest habitats. However, upkeep strains municipal budgets. Cost-effective solutions like low-maintenance plants and automated irrigation can reduce costs while sustaining urban greenery (Tzoulas et al., [2007b](#)).

Air Pollution Rebound Effect

Urban Green Spaces help filter air pollutants, but near high-traffic roads, vehicle turbulence can resuspend dust, reducing their effectiveness. Some trees also emit VOCs that form ground-level ozone. Strategic species selection and using barrier vegetation like hedgerows can enhance air quality benefits while minimizing negative impacts (Nowak et al., [2014](#)).

Reduced Effectiveness of Street Lighting

Relentless streetlights cut off some of the visibility of the roads during the night, but too much dense green coverage will make the streetlights ineffective, making situation awareness difficult and increasing the likelihood of an accident occurring. All of the issues stated previously have

the potential to be resolved through correct and effective urban maintenance methods while retaining the advantages that green areas provide (Nowak et al., [2014](#)).

International Approaches to Green Infrastructure in Road Planning

Several countries have adopted guidelines to integrate green spaces into transport infrastructure for sustainability and resilience. India's standards, first issued in 2009 and updated in 2018, emphasize bioswales, afforestation, and tree shading tailored to street types, while addressing spatial constraints in areas like bridges and transport corridors (Congress, [2009](#)).

In June 2023, Saudi Arabia introduced guidelines to integrate green spaces into transport networks across 400 acres, requiring both hard and soft landscaping. This includes streetscapes, green corridors, and vegetated roundabouts to enhance urban aesthetics and sustainability. The guidelines also promote landscape buffers to screen infrastructure and support ecological protection (Sitzenfrei et al., [2020](#)). Ireland has effectively integrated sustainability into urban transport planning. Its 2019 Street Design Manual promotes people-centered streets, prioritizing pedestrians, cyclists, and public transport over private cars. The approach aims to enhance urban livability, reduce carbon emissions, and improve public health by encouraging active transport and reducing car dependency (Papageorgiou & Tsappi, [2024](#)).

Various countries have developed regulations to deal with the provision of green areas along urban roads while elaborating their beneficial impacts. They have even identified the type of trees to be used and advocate the use of native plants. Some even mandate the provision of green space along them, even at the cost of a vehicular lane. In addition, public facilities like footpaths, etc., are also required to make them safer, secure, and user-friendly.

Table 1*Notable Studies on Green Infrastructure in Transportation Corridors*

S. No.	Country/City	Project/Study	Key Features	References
1	United States	Greenways & Sustainable Infrastructure	Emphasis on landscape-sensitive designs, urban resilience, and reducing the environmental impacts of road networks. Green infrastructure is integrated along ring roads.	(Bénichou, 2024 ; Newman et al., 2016 ; Canzonieri, 2007)
2	Paris, France	Boulevard Périphérique Redevelopment (2050 Vision)	Reduction of vehicular lanes, multimodal transport, integration of green spaces, pedestrian-friendly bridges, and green buildings extending over roads.	(Boulevard et al., 2024)
3	Bressanone, Italy	Central Junction of Bressanone-Varna Ring Road	Underground road network to reduce congestion, artistic landscape integration, and noise reduction via acoustic walls.	(González, 2020)
4	Indonesia	Study on Roadside Tree Species	Assessed tree diversity and public perception, preference against fruit-bearing trees due to maintenance and safety concerns.	(Sarwadi et al., 2017)
5	Turkey	Climate-Friendly Green Spaces Along Roads	Use of xeriscaping and native plants to minimize water consumption, mitigate heat island effects, and improve microclimate.	(Çınar et al., 2025)
6	Medellín, Colombia	Green Corridors Project	Conversion of roads and waterway verges into green corridors, urban cooling, and biodiversity enhancement.	(Wang et al., 2021)
7	Brazil	Rain Gardens for Stormwater Management	Use of permeable ground surfaces to treat urban runoff, improve water infiltration, and enhance sustainability.	(Kasprzyk et al., 2022 ; Malaviya et al., 2019)

While global policies emphasize green infrastructure in transport planning, Pakistan especially cities like Lahore lacks dedicated frameworks for integrating

green spaces into transport networks. Although plans like Lahore Master Plan 2050 promote open spaces, they overlook green corridors along roads,

revealing a critical gap in sustainable urban development and landscape integration (Karim et al., [2024](#)).

To build a sustainable, inclusive urban future, Pakistan must adopt green infrastructure policies aligned with global best practices. Nature-based solutions like tree-lined streets, bioswales, and permeable pavements can boost resilience and environmental quality. Integrating landscape planning into transport frameworks is essential for a greener, climate-resilient Pakistan.

Development of Transportation Corridors in Pakistan

The concept of "Green Corridors" originated in Europe with the aim of developing sustainable transportation systems. A study was conducted on an old highway that used to connect the Mughal cities of Agra and Lahore; it was conducted with the objective of understanding the built environment along the highway. Papageorgiou & Tsappi, [2024](#) delves into the historical aspects, which include leveled roads, brick pavement surrounding major urban centers, Kos Minar ('Kos' is a traditional unit of distance about 3.2 km or 2 miles and 'Minar' means tower or pillar, caravansaries - rest houses for travelers), baths, wells and stepped wells, bagh (gardens), bridges, fruit and shade trees, halting and watering places, shrines, and mosques and temples. All these structures were provided by the Mughal emperors to offer resting places, pleasure gardens, and water sources for travelers. The Grand Trunk Road is the most significant transportation corridor in the Indo-Pak subcontinent and the world. It stretches over 1,550 miles, spanning four countries, starting from Kabul in Afghanistan, passing through Pakistan and India, and ending near Dhaka. This road has been traveled by conquerors, pleasure seekers, pilgrims, and traders for over 3,500 years. Mubin ([2013](#)) highlights that the Mughals actively experimented with the development of gardens in their newly adopted homeland, laying the foundation for a rich landscape tradition. During the late 19th century, British colonial rulers deliberately fostered a garden culture, ultimately earning Lahore the title of the "City of Gardens."

The British administration revitalized historical ruins and barren lands outside Lahore's walled city by building metalled roads with tree-lined avenues,

especially in the cantonment and civil servant zones. This aimed to create a structured, orderly, and visually appealing environment, contrasting with the dense, organic fabric of the old city (Kataria, [2015](#)).

However, in today's fast-paced world, the beauty of the built environment often goes unnoticed, with historic structures being destroyed. The speed of vehicles has reduced the appreciation of the built environment, turning it into a fleeting experience rather than a comprehensive cultural environment. Thus, the surrounding urban environment is developed in response to the mode and speed of vehicles and the length of the journey.

Transportation Corridors as Agents of Social Change

The presence of green areas acts as a magnet, and if they are pleasant, safe, and accessible, then people tend to come and socialize or just sit and meditate. They offer a lot of social benefits. Historically, streets served as more than mere travel routes; they functioned as vital social spaces where communities gathered, children played, and individuals engaged in communal activities. However, with the transformation of traditional streets into modern roads, a significant social and cultural shift has occurred. Čulík ([2019](#)) asserts that streets, once human-centric, have been redefined primarily for vehicular use, diminishing their role as spaces for social interaction. This shift has disrupted the integration of private and semi-public spaces, which historically facilitated essential social interactions and played a crucial role in shaping the cultural fabric of cities like Lahore (Alvi et al., [2024a](#)).

Land has always been a key factor in shaping socio-economic structures, particularly in agrarian societies where it signifies wealth and social status. The introduction of canal irrigation systems by the British played a transformative role in reshaping the urban and rural landscapes, converting barren lands into fertile agricultural zones. These canal colonies were designed to stimulate economic and social progress, leading to enhanced living conditions and urban development (Alvi et al., [2024b](#)). The evolution of transportation corridors, therefore, is not just a matter of infrastructure but a force driving broader social and economic change,

reinforcing the link between mobility, land use, and societal transformation.

Urbanization and Its Impact on Transportation Corridors

The process of urbanization accelerated significantly following the Industrial Revolution, necessitating fundamental changes in transportation infrastructure. The advent of mechanized, high-speed, and mass-produced modes of transport required road networks to evolve from narrow, winding streets to broader, more structured corridors capable of accommodating increased traffic flow (Lubove, 1967).

Historically significant routes such as the Grand Trunk Road, the Silk Road, and the Karakoram Highway traverse multiple countries, yet the urban developments along these corridors exhibit similar patterns (Chin, 2013). Similarly, the Karakoram Highway, which extends from Mansehra through Bisham and Dasu into the northern mountainous regions, serves as the primary artery for transport and trade (Kreutzmann, 2009). Despite its historical and geopolitical significance, local residents often treat it as a routine city road, underscoring the complex relationship between infrastructure and public perception. Nevertheless, this highway remains the principal route connecting major settlements in these remote areas, highlighting the role of transportation corridors as both facilitators of urban expansion and critical lifelines for regional connectivity.

Traffic Regulations and Policies of Pakistan

The existing standards, codes, and regulations related to roads in Pakistan were studied to understand their provisions for green spaces along secondary roads. While various policies and regulatory frameworks govern transportation infrastructure, a direct emphasis on integrating green infrastructure within transportation corridors remains largely absent.

Furthermore, the number of electric vehicles registered in Lahore increased by 40% in 2024, reflecting growing public and private sector support for sustainable urban transport (Rasool et al., 2024). Recent air quality reports confirm a 10% reduction in particulate matter during winter months, partly attributed to these green initiatives

and reduced fossil fuel dependency (Mumtaz et al., 2023).

In 2025, the Punjab government launched green initiatives to combat smog in Lahore, achieving notable progress. The Pakistan Horticulture Authority led widespread plantation drives, while electric scooters, vehicles, and buses imported from China are being promoted to reduce carbon emissions and support sustainable urban mobility.

In 2018, the Planning Commission of Pakistan developed the "National Transport Policy" to address all modes of transportation, including road and rail, across national, urban, and rural levels. This policy aligns with the United Nations Sustainable Development Goals (SDGs), focusing on key issues such as equal transport access, road safety for vulnerable groups, and environmental concerns, including air quality. Despite these comprehensive objectives, the policy does not explicitly mandate green spaces along transportation networks to mitigate urban environmental challenges, such as heat islands and deteriorating air quality.

The Pakistan Environment Protection Act of 1997 prioritizes sustainable development and environmental protection, but lacks explicit provisions regarding tree plantation and the integration of green spaces along transportation corridors. The Act primarily addresses pollution control, emission reduction, and environmental restoration (Danish et al., 2018). Similarly, while the Building Code of Pakistan, originally developed in 2008 and updated in 2021, provides guidelines for construction safety, material use, and fire hazard management, it primarily discusses the role of wood as a construction material rather than advocating for sustainable roadside green infrastructure (Herzog, 2013).

Urban transport planning in Pakistan is embedded within broader city planning initiatives. The Lahore Master Plan 2050, introduced with an Environmental Planning Policy in 2022, highlights the importance of protecting undeveloped natural areas and increasing open green spaces in new residential zones from seven percent to twenty percent (Jabbar & Mohd Yusoff, 2022). The plan outlines key environmental strategies, including the establishment of ecological wetland corridors, the conversion of open spaces into urban parks, and the enhancement of pedestrian and cycling-

friendly streets through street shading initiatives. However, while these measures contribute to urban greenery, there is still a gap in policies explicitly addressing green infrastructure along secondary roads and major transportation corridors.

In terms of highway design standards, Pakistan follows the guidelines set by the American Association of State Highway and Transportation Officials (AASHTO). The 2018 revision of AASHTO's Green Book emphasizes sustainable roadway design, including measures such as adjusted mowing schedules, preservation of prairie landscapes, the use of slow-growing grass species, and strategies for reducing greenhouse gas emissions (Sipes & Sipes, 2013). These environmentally conscious road management practices are implemented in the United States, yet their direct incorporation into Pakistan's transportation policies remains limited.

The lack of policies for roadside green space integration in Pakistan highlights the need for reform. Future frameworks should adopt nature-based solutions like tree-lined roads and rain gardens. Inspired by global models like Singapore's "Green Streets," this approach can enhance biodiversity, reduce heat islands, and improve urban living conditions.

Conclusion

This paper explores the development, significance, and policy gaps surrounding Urban Green Spaces

(UGS) within transportation corridors in Pakistan, with a focus on Lahore. Although national planning documents such as the Lahore Master Plan 2050 and National Transport Policy 2018 acknowledge the value of greenery, they lack concrete guidelines and implementation strategies for integrating green infrastructure into road networks. In contrast, international models like Singapore's "Green Streets" and European urban forestry policies offer actionable frameworks. UGS provides multiple benefits, including air purification, temperature regulation, biodiversity support, and mental health improvement. However, in Pakistan, these benefits are largely overlooked in transportation planning. Lahore's rapid urbanization, coupled with pressure on multifunctional infrastructure, highlights the urgency of reimagining roads as ecological and social assets, not just transit routes. The study emphasizes the need for context-sensitive, locally adaptable design standards and improved institutional coordination to make UGS a central element of sustainable urban mobility and climate resilience planning.

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