

# Is Pakistan On The Brink Of A Green Transport Revolution, Or Are Its Efforts Lagging Behind The World's Leaders In Sustainable Travel, Leaving A Larger Carbon Footprint In Its Wake?

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As Pakistan races toward economic growth, its transportation sector emerges as both a catalyst and a challenge, shaping the country's environmental future. However, transportation is not only a key contributor to greenhouse gas emissions but also exacerbates environmental and climate issues. This study evaluates Pakistan's sustainable transport initiatives, focusing on government policies promoting electric vehicles and green infrastructure. The study identifies key challenges such as inadequate infrastructure, financial constraints, and low public awareness, and proposes strategies for overcoming these barriers. The research employs a comparative analysis with international benchmarks and highlights the need for integrated strategies, smart technologies, and public-private partnerships. Key findings indicate that while there are notable government efforts, substantial improvements are needed in policy execution, infrastructure development, and public engagement. Limitations in understanding Pakistan's transportation sector include a lack of current data on vehicle usage and transportation emissions, and insufficient long-term studies on policy impacts. Addressing these gaps through enhanced data collection, comprehensive impact analyses, and context-specific research is essential for advancing Pakistan's sustainable transportation sector and aligning with global standards.

**Keywords:** Economic Growth, Transportation Sector, Greenhouse Gas Emissions, Government Initiatives, Sustainable Transport, Environmental Impact.

## Introduction

Transportation fuels Pakistan's economic engine, knitting together trade networks, urban centers, and key industries, while also laying the groundwork for broader development. (Greene and Wegener 1997; Sohail et al., 2021; Jelti, Allouhi and Tabet Aoul, 2023)<sup>1-3</sup>. Therefore, transport remains essential for the movement of goods and people at local, regional, and global levels (Greene and Wegener 1997; Sohail et al., 2021; Jelti, Allouhi and Tabet Aoul, 2023)<sup>1-3</sup>. Modern civilization relies heavily on transportation for fostering social cohesion and economic efficiency (Khan et al., 2023)<sup>4</sup>. The various definitions of sustainability and the range of viewpoints contribute to sustainability's complexity (Litman and Burwell, 2006)<sup>5</sup>. Moreover, the key aspects include the critique and assessment of sustainability and transportation's impact on environmental, social, and economic factors (Litman and Burwell, 2006)<sup>5</sup>. Additionally, the distinction between goals and objectives, reliance on, and sustainable transportation solutions are also essential components (Litman and Burwell, 2006)<sup>5</sup>.

Pakistan's transportation industry is regarded as the primary driver of economic growth and development (Sohail et al., 2021)<sup>2</sup>. Sohail et al. (2021) demonstrates that transport industry

produces 6% of job possibilities in Pakistan and contributes 10% of the nation's Gross Domestic Product (GDP). The transportation sector is a key focus in discussions about greenhouse gas emissions (GHG) and air pollution due to significant contributions to global warming and environmental degradation (Ferrer and Thomé, 2023; Khan et al., 2023)<sup>4,6</sup>.

This study specifically examines the case of Pakistan, a developing country that is facing the challenges of rapid urbanization and increasing greenhouse gas emissions (Khan et al., 2023)<sup>4</sup>. According to the World Bank (2021), Pakistan's transportation sector accounts for 23% of the country's carbon emissions, a staggering 52.2 million metric tons, highlighting the urgent need for sustainable reform. Recent data indicates that the transportation sector actually emits about 52.9 million metric tons, constituting around 31% of Pakistan's total emissions, which are approximately 170 million metric tons (Sohail et al., 2021; Khan et al., 2023)<sup>2,4</sup>. For instance, Pakistan's transportation sector relies heavily on fossil fuels such as petrol and diesel. The combustion of these fuels in vehicles releases significant amounts of carbon dioxide (CO<sub>2</sub>) and other greenhouse gases. This issue can be mostly attributed to the significant reliance on conventional fossil fuel vehicles and inadequate infrastructure (Khan et al., 2023)<sup>4</sup>.

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Researchers, policymakers, and industry practitioners have given sustainable transport a great deal of attention (Zhao et al., 2020)<sup>7</sup>. This focus is partly based on research on sustainable development (Zhao et al., 2020)<sup>7</sup>. Environmental, social, and economic sustainability are the three components of sustainability that are generally acknowledged (Zhao et al., 2020)<sup>7</sup>. The pressing need to resolve the issue highlights the nation's adherence to international environmental accords, like the Paris Agreement (Khan et al., 2023)<sup>4</sup>. Moreover, the Paris Agreement mandates significant decreases in carbon emissions for example 50% by 2030 (Khan et al., 2023)<sup>4</sup>. Thus, the transport sector in Pakistan, while pivotal for economic growth and societal connectivity, faces significant environmental challenges due to its carbon emissions. Addressing these challenges is imperative for aligning economic development with global sustainability goals, necessitating comprehensive strategies and investments in green transport infrastructure.

This paper aims at assessing the current state of sustainable transport initiatives in Pakistan, identify key challenges hindering their progress, and propose strategies for overcoming these barriers. Specifically, the research seeks to evaluate the effectiveness of government policies and initiatives in promoting electric vehicle adoption and sustainable transport infrastructure. Moreover, the research analyses the financial, political, and societal factors influencing the implementation of sustainable transport solutions in Pakistan. Furthermore, the research compares Pakistan's progress in sustainable transport with global benchmarks, and identify areas for improvement. Additionally, the paper aims to propose recommendations based on best practices from other countries to enhance Pakistan's transition towards a sustainable transport sector.

Literature Review Section presents a structured literature review with distinct sub-themes related to sustainable transport. Each sub-theme evaluates key findings, theories, and methodologies, highlighting their contributions and establishing a foundation for understanding the sustainable transport. While the study focuses primarily on Pakistan, lessons drawn from international best practices will be used to frame the recommendations. The next Section critically examines concerns, limitations, and main research gaps identified within the existing literature on sustainable transport. Moreover, the research addresses the shortcomings and biases of current studies on sustainable transport in Pakistan while articulating the unresolved questions motivating this research. Finally, section 4 synthesizes the findings from the literature review on sustainable transport, offering conclusions that summarize key insights and implications for theory, practice, or policy. The study also provides recommendations for future research directions on sustainable transport, emphasizing the study's potential contributions to advancing knowledge in the field and concluding with reflections on the study's broader impact.

## Literature Review

### The Role Of Transport Infrastructure In Pakistan's Carbon Footprint

Transportation serves as a critical component of modern civilization by enhancing economic efficiency and fostering social cohesion (Khan et al., 2023)<sup>4</sup>. However, transportation simultaneously represents a significant global issue due to its substantial carbon emissions. Indeed, carbon emissions are a major contributor to climate change and environmental degradation, thereby highlighting its negative impact despite its positive roles. However, transportation simultaneously represents a significant global issue due to substantial carbon emissions, which are a major contributor to climate change and environmental degradation, thereby highlighting the negative impact despite the positive roles of transportation (Sohail et al., 2021; Khan et al., 2023)<sup>4,7</sup>. Pakistan's total carbon emissions approximately 170 million metric tons (MMT) of carbon dioxide, and the transportation sector contributing about 52.9 million metric tons (MMT), or 31%, of this total (Sohail et al., 2021; Khan et al., 2023)<sup>2,4</sup>. Transportation that satisfies present-day transportation and mobility demands without endangering the capacity of future generations is referred to as sustainable transportation (Black, 2004)<sup>8</sup>. Planning for urban mobility is becoming increasingly challenging in Pakistan due to the issues associated with environmental sustainability (Kamran, Farhan and Shah, 2019)<sup>9</sup>. Due to the country's fast urbanisation, population growth, and economic development in recent decades, Pakistan has experienced considerable changes in traffic conditions (Khan et al., 2023)<sup>4</sup>.

As modernization accelerates in Pakistan, the growing reliance on fossil fuel-powered vehicles has driven a surge in transport demand, amplifying carbon emissions and straining outdated infrastructure (Khan et al., 2023)<sup>4</sup>. Pakistan's transport infrastructure, characterized by outdated road networks, insufficient public transportation options, and inadequate maintenance, struggles to keep pace with this increased demand. This infrastructure gap exacerbates traffic congestion and fuel inefficiency, leading to higher carbon emissions from vehicles. Consequently, Pakistan's transport sector has emerged as a major source of carbon emissions (Khan et al., 2023)<sup>4</sup>. Due to Pakistan's leading global ranking for vulnerability to climate-related adversities, a green transportation system is needed to mitigate environmental impact and enhance environmental quality (Sohail et al., 2021)<sup>2</sup>. The country's efforts to achieve environmental sustainability are seriously hampered by this increase (Khan et al., 2023)<sup>4</sup>. Cities' natural beauty and environment are being adversely affected by the rapidly growing number of automobiles, excessive fuel use, smoke clouds, and dust (Batool, Irshad and Abid, 2020)<sup>10</sup>. All of these factors have major negative health effects (Batool, Irshad and Abid, 2020)<sup>10</sup>. Hence, immediate action is required

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to mitigate environmental and health impacts.

## A Review Of Transport Policies In Pakistan

### International Policies:

Many developed and developing nations have created policies (both manufacturer- and customer-oriented) to lessen dependency on fossil fuels and the harmful emissions these fuels produce when they burn in internal combustion (IC) engines (Asim et al., 2022)<sup>11</sup>. The policies are made in order to make the transportation sector clean and sustainable (Asim et al., 2022)<sup>11</sup>. Despite evolving transport policies in Pakistan aimed at addressing environmental concerns and promoting a sustainable transportation system, the sector continues to consume over 50% of the nation's petroleum resources (Shahid et al., 2022)<sup>12</sup>. Moreover, the country has struggled to secure sufficient resources to expedite its transition to a modern and sustainable transport infrastructure (Shahid et al., 2022)<sup>12</sup>. The business as usual (BAU) scenario suggests that in 2035, the current energy and emissions values will rise if the current socio-economic conditions persist (Asim et al., 2022)<sup>11</sup>.

### National Policies:

Policy 2009 sought to create a transport system that guarantees safe, efficient, reliable, equitable, and environmentally friendly mobility for both people and goods (Shahid et al., 2022)<sup>13</sup>. This policy was designed to support the government's objective of enhancing public welfare through advancements in human development, economic growth, and poverty reduction (Shahid et al., 2022)<sup>13</sup>. Nevertheless, the policy draft highlighted critical issues, including the need for institutional development (Shahid et al., 2022)<sup>13</sup>.

Under the newly introduced Electric Vehicle Policy 2020, the Government of Pakistan (GOP)<sup>14</sup> has chosen to transition from fossil fuel vehicles to electric vehicles to reduce fuel consumption, cut oil imports, and address related issues (Shahid et al., 2022)<sup>13</sup>. Recent studies indicate that while the policy has initiated interest in electric vehicles, actual adoption remains low due to inadequate infrastructure, high initial costs, and limited public awareness (Khan et al., 2023)<sup>4</sup>. For instance, as of 2023, electric vehicle sales accounted for only 1.5% of total vehicle sales in Pakistan, highlighting the need for enhanced incentives and infrastructure development to support this transition (Sohail et al., 2021)<sup>2</sup>. Additionally, the GOP is also working with the United Nations Development Program and the Global Environment Facility through the Pakistan Sustainable Transport Project (PAKSTRAN) to advance sustainability in the transport sector (Kamran, Farhan and Shah, 2019)<sup>9</sup>. Several major transit projects have emerged under the PAKSTRAN initiative (Kamran, Farhan and Shah, 2019)<sup>9</sup>. These PAKSTRAN initiative includes the Lahore Bus Rapid Transit (BRT), operational since February 2013, integrating with Lahore Transport Company (LTC) over 27km (Kamran, Farhan and Shah, 2019)<sup>9</sup>. Addi-

tionally, one study found that using BRT systems is ten times safer per kilometre than driving a car (Litman, 2016; Batool, Irshad and Abid, 2020)<sup>10,15</sup>. Furthermore, research evaluating the Multan BRT system indicates passenger satisfaction linked to safety and accessibility features (Nadeem et al., 2021)<sup>16</sup>. These systems aim to reduce accidents by ensuring better traffic regulation through exclusive lanes and systematic boarding practices (Nadeem et al., 2021)<sup>16</sup>. Moreover, the Orange Line Metro Train in Lahore, part of China-Pakistan Economic Corridor (CPEC), is under construction with 26 stations across 27.1km (Kamran, Farhan and Shah, 2019)<sup>9</sup>. Furthermore, the Islamabad Metro Bus, operational since June 2015, connecting Islamabad and Rawalpindi, with a second phase under construction to reach the New Islamabad International Airport; and the Karachi Green Line, under construction since 2016, establishing a 35km BRT network (Kamran, Farhan and Shah, 2019)<sup>9</sup>.

Moreover, the annual reduction in pollution costs due to the Bus Rapid Transit (BRT) is about US\$0.61 million under the modal shift scenario (4% of passengers) and US\$2.45 million under the car ownership scenario (16% of passengers) (Batool, Irshad and Abid, 2020)<sup>10</sup>. The study highlights that CO<sub>2</sub> reductions remain modest due to the limited shift from private car use to the BRT system (Batool, Irshad and Abid, 2020)<sup>10</sup>. Currently, the Lahore BRT network serves only 1.3% of the travel demand for a population nearing 10 million, emphasizing the need for expansion to other routes within the city (Batool, Irshad and Abid, 2020)<sup>10</sup>. While the Lahore BRT has had a positive overall impact, it has yet to attract significant commuter participation from more educated or higher-income groups (Batool, Irshad and Abid, 2020)<sup>10</sup>. The Lahore BRT system reduces pollution costs but struggles to attract higher-income and educated commuters due to barriers in public perception and commuter behaviour (Amber et al., 2023; Malik et al., 2023)<sup>17</sup>.

Furthermore, the Islamabad Metro Bus project proceeded without conducting the required Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA), as mandated by Section 12 of the Pakistan Environmental Protection Act, 1997 (Auditor General of Pakistan, 2017)<sup>18</sup>. Although the project's PC-I document acknowledged potential environmental impacts, authorities failed to gather necessary data to assess these effects accurately (Auditor General of Pakistan, 2017)<sup>18</sup>. During construction, contractors significantly damaged parks managed by the Parks and Horticulture Authority in Rawalpindi by using these spaces for constructing girders and dumping materials, leading to environmental degradation (Auditor General of Pakistan, 2017)<sup>18</sup>. Responsibility for evaluating the damages and determining appropriate compensation rested with the Rawalpindi Development Authority (RDA) management (Auditor General of Pakistan, 2017)<sup>18</sup>. It has been reported that construction began even before the environmental impact assessments were conducted, violating established regulations (Mahmood, 2017)<sup>19</sup>. However, no assessments of

losses were made, nor was any rehabilitation or maintenance of the parks executed at the contractors' expense (Auditor General of Pakistan, 2017)<sup>18</sup>. Moving forward, it is crucial to calculate and recover rehabilitation costs and rent from those responsible while addressing the RDA management's negligence in fulfilling its duties.

On the other hand, there is limited data available on the specific environmental impact of the Green Line Karachi. However, similar BRT systems, such as the Lahore BRT, have shown a reduction of approximately 2,300 tons of CO<sub>2</sub> emissions annually (Batool, Irshad, and Abid, 2020)<sup>10</sup>. These reductions contribute to Pakistan's target of reducing emissions by 20% by 2030 under the Paris Agreement. Turning to the Orange Line Metro Train, this project has raised significant socio-environmental concerns, including disruptions to public movement, land acquisition, and environmental degradation. The proposed project may cause disruptions to public movement, land acquisition, pollution, safety risks, and impacts on local routines, water bodies, utilities, and archaeological sites, necessitating mitigation measures (Environmental Impact Assessment 2015). A study by Alisha et al. (2020) noted that 95% of surveyed residents expressed dissatisfaction due to the loss of greenery and aesthetic degradation caused by the project. (Alisha et al. 2020)<sup>20</sup>.

The transport sector has far-reaching environmental, social, and economic effects on society, making the adoption of sustainable development principles crucial (Zhao et al., 2020)<sup>7</sup>. The Institute for Transportation and Development Policy (ITDP) has proposed eight key principles for sustainable transportation: Walk (Develop neighbourhoods that promote walking), Cycle (Prioritize non-motorized transport), Connect (Establish extensive networks of boulevards and pathways), Transit (Improve access to high-quality public transport), Mix (Plan for mixed land use), Densify (Enhance density and transit capacity), Compact (Create areas with short distances), and Shift (Increase mobility by managing parking and road use) (Kamran, Farhan and Shah, 2019)<sup>9</sup>.

#### **Regional policies:**

Due to urban congestion challenges, Pakistan's major cities, including Karachi, Lahore, and Rawalpindi-Islamabad, have been working on sustainable transport solutions for several years (Kamran, Farhan and Shah, 2019)<sup>9</sup>. Since 1990, Karachi has undertaken various feasibility studies, implementation plans, and design projects for Light Rail Transit (LRT) and Bus Rapid Transit (BRT) systems with international support from the Asian Development Bank (ADB)<sup>21</sup> and the Japan International Cooperation Agency (Kamran, Farhan and Shah, 2019)<sup>9</sup>.

In conclusion, Pakistan's transport policies reflect an ongoing effort to balance environmental sustainability with the growing demand for efficient transportation infrastructure. The transition towards electric vehicles and the development of major transit projects are significant steps towards achieving a cleaner and more sustainable transport sector.

However, a comparative analysis with policies from other countries or regions could provide deeper insights into the effectiveness of Pakistan's strategies. For instance, examining successful models from countries with advanced sustainable transport systems might highlight best practices and areas for improvement. Despite the detailed nature of the policies, several gaps and shortcomings persist. Issues such as inadequate infrastructure, enforcement challenges, and limited public awareness may hinder the full realization of policy goals. Assessing the success of these policies requires evaluating specific outcomes, such as reductions in carbon emissions, increased adoption of electric vehicles, and improvements in public transportation efficiency. To further illustrate the progress and challenges faced by Pakistan's transportation sector, Table 1 provides key metrics from 2010 to 2018, comparing them with international standards and highlighting areas where the country lags behind, such as passenger and freight traffic and road density. Overall, while Pakistan's transport policies are a step in the right direction, addressing these gaps and learning from international experiences could enhance their effectiveness and ensure a more sustainable future for the country's transport sector.

#### **Environmental Degradation Worldwide**

When addressing the broader issues of greenhouse gas emissions and air pollution, the transportation sector is unavoidable due to its significant contribution to global warming (Ferrer and Thomé, 2023)<sup>6</sup>. Transport sector is the second largest source of CO<sub>2</sub> emissions worldwide and accounts for over a third of the total energy consumption in European Environment Agency member countries (Georgatzi, Stamboulis and Vetsikas, 2020)<sup>22</sup>, with the European Union's transport sector contributing approximately 31% of total greenhouse gas emissions, the United States' transportation sector responsible for about 29% of total emissions, and China's transport sector accounting for about 10% of global transport emissions. The advancement of urbanization and motorization has occurred with insufficient government and technological support for sustainable development strategies (Qureshi and Huapu, 2007)<sup>23</sup>. Consequently, the negative externalities of the transport sector have increasingly damaged environmental conditions in urban areas and continue to worsen the quality of life (Qureshi and Huapu, 2007)<sup>23</sup>. The unchecked expansion of vehicle fleets, combined with an aging and poorly maintained vehicle stock, has deteriorated road conditions (Qureshi and Huapu, 2007)<sup>23</sup>. This unchecked expansion of vehicles leads to severe traffic congestion and high levels of air and noise pollution (Qureshi and Huapu, 2007)<sup>23</sup>.

China is experiencing severe environmental degradation, marked by significant air pollution, water shortages, soil contamination, and a decline in biodiversity, all of which threaten public health and hinder sustainable development (Wang, 2004)<sup>24</sup>. In response, the Chinese government has enacted policies aimed

**Table 1** Key metrics of Pakistan’s transportation sector (2010-2018) compared to international standards (2020)

Metric	Pakistan (2010)	Pakistan (2018)	Standard/Goal (2010)	Comparison Country	Comparison Value (2020)
Passenger Traffic (billion km)	239	322.7	Increase by 3% annually	India	1,000
Freight Traffic (billion ton-km)	153	159	Increase by 3% annually	China	2,000
Road Network Length (km)	263,000	263,000	Aim for expansion 20% by 2025 (approx. additional 52,600 km)	USA	6,580,000
Road Density (km/sq.km)	0.32	0.32	Target of 1.0 km/sq.km by 2025 compared to 0.32 km/sq.km in 2018	Germany	6.5
Average Travel Time (hours)	45	36	Reduce to under 30	Japan	12

at tackling these issues, including investments in renewable energy and the enhancement of environmental regulations (Wang, 2004)<sup>24</sup>. Despite these efforts, progress has been slow, and there is a pressing need for more coordinated actions to alleviate the negative impacts of rapid industrial growth and urban expansion on the environment (Wang, 2004)<sup>24</sup>. Despite efforts to promote electric vehicles and enhance public transit, the large number of cars continues to contribute significantly to air pollution. Similarly, in Pakistani cities like Karachi and Lahore, expanding car fleets and inadequate infrastructure present major challenges for improving air quality. These incidents highlight the necessity of stricter emission regulations as well as expedited sustainable transportation initiatives in order to successfully enhance air quality and combat environmental degradation.

### Sustainable Transport Practices Worldwide

To explore effective strategies for sustainable transportation, we must examine successful practices implemented globally. In July 2004, individuals came together in Baltimore, Maryland, United States, for the Conference on Integrating Sustainability into the Transportation Planning Process (Deakin, 2002; Integrating Sustainability into the Transportation Planning Process, 2005)<sup>25,26</sup>. The individuals highlighted a broader trend of sustainability efforts across various North American cities and regions, such as the Maryland Smart Growth Initiatives, the Portland, Oregon 2040 Plan, Sustainable San Francisco, Sustainable Toronto, Sustainable Seattle, and The Bay Area Alliance for Sustainable Development (Deakin, 2002; Integrating Sustainability into the Transportation Planning Process, 2005)<sup>25,26</sup>. In the United States, the conference was created by a specially designated committee of the National Research Council (NRC)<sup>27</sup> to provide a

forum for exchanging ideas about the difficulties and potential solutions associated with the issue discussed (Deakin, 2002)<sup>25</sup>. Moreover, the forum incorporated sustainability considerations into the transportation planning process (Deakin, 2002). The US is now proposing a sustainable transportation program that will only address car emissions (Hanif and Nurmandi, 2022)<sup>28</sup>.

China’s meticulous planning for sustainable transportation, optimizing routes, minimizing emissions, and modernizing transit types, offers a roadmap that Pakistan can adapt to its unique challenges (Hanif and Nurmandi, 2022)<sup>28</sup>. However, China has given this emphasis on information and investment elements less attention (Hanif and Nurmandi, 2022)<sup>28</sup>. In the meantime, planning, information, and investment have not been the priorities for South Korea and Canada (Hanif and Nurmandi, 2022)<sup>28</sup>. China has demonstrated its ability to mitigate carbon emissions and improve operational efficiency through the implementation of sustainable transportation methods, including route optimization and the use of environmentally friendly vehicles. The nation must adopt multimodal transportation infrastructure to cut greenhouse gas emissions and provide affordable options for long-distance cargo (Pal et al., 2023)<sup>29</sup>. Last-mile delivery options and collaborative shipping are acknowledged as important strategies for reducing emissions and enhancing operational effectiveness (Pal et al., 2023)<sup>29</sup>.

Furthermore, waste reduction, decreased shipping costs, and enhanced storage and transit efficiency are all facilitated by effective packaging design and the use of ecologically friendly materials (Pal et al., 2023)<sup>29</sup>. Moreover, China places a high value on educating consumers about appropriate packaging disposal to promote a more sustainable supply chain cycle (Pal et al., 2023)<sup>29</sup>. Waste management requires a focus on package innovation and ideal packing sizes (Pal et al., 2023)<sup>29</sup>. China’s

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use of electric vehicles, high-speed rail, intelligent transport systems, transit-oriented development, and renewable energy integration reflects a comprehensive approach to sustainable transportation. These technologies have proven effective in reducing carbon emissions, improving operational efficiency, and addressing the environmental challenges associated with rapid urbanization. As China continues to innovate and scale these solutions, its experiences offer valuable lessons for other countries seeking to develop sustainable and efficient transportation systems.

In Europe, countries each adopted unique methods for sustainable transportation, demonstrating the flexibility of the concept to suit local conditions while adhering to a unified framework (Sustainable Transportation Practices in Europe, 2001)<sup>30</sup>. Germany, for example, developed its sustainability strategy within the European Union framework by implementing local regulations and focusing on qualitative visions supported by quantitative criteria like noise and CO2 reduction (Sustainable Transportation Practices in Europe, 2001)<sup>30</sup>. This strategy emphasizes multimodal and least-cost planning (Sustainable Transportation Practices in Europe, 2001)<sup>30</sup>. Their key principles include minimizing motor trips, shifting to less harmful transport modes, optimizing road capacity, enhancing vehicle technology, and utilizing The Intelligent Transportation System (ITS) technologies (Sustainable Transportation Practices in Europe, 2001)<sup>30</sup>.

In Scotland, strategies involve coordinating transportation with land development, prioritizing public and non-motorized transport, and using public education to promote sustainable travel (Sustainable Transportation Practices in Europe, 2001)<sup>30</sup>. Examples of these strategies include Edinburgh's Travel Wise program and its network of greenways and bike streets (Sustainable Transportation Practices in Europe, 2001)<sup>30</sup>. Sweden's approach focuses on numerous small, collaborative actions integrated into a broader strategy (Sustainable Transportation Practices in Europe, 2001)<sup>30</sup>. For instance, improving transit efficiency, understanding traveller preferences, removing transit barriers, and enhancing transit infrastructure (Sustainable Transportation Practices in Europe, 2001)<sup>30</sup>.

To enhance our understanding of the comparative strengths and weaknesses of transportation systems globally, we can refer to Table 2, which analyzes key metrics and highlights the distinct characteristics of transportation sectors in Pakistan, Germany, China, the United States, and Sweden. In conclusion, global sustainability efforts in transportation, such as Germany's Integrated Transport Strategy, Japan's Comprehensive Mobility Management, and Sweden's Vision Zero, reflect a shared commitment to reducing environmental impacts and enhancing urban transit.

## Alternative Policies For Sustainable Development

In Pakistan, achieving sustainable urban road transport necessitates a multifaceted strategy that incorporates developments in vehicle technology, infrastructure construction, and traffic management. Moreover, sustainability also considers the effects on the environment and investigating alternate fuel sources. This plan calls for implementing eco-friendly infrastructure, increasing vehicle efficiency, and using technology advancements. These problems must be addressed with focused investments and regulations to make the transition to a more environmentally friendly transport system that is in line with the national goals for sustainable development. The implementation of these techniques in Pakistan entails the resolution of particular obstacles, including restricted financial resources, deficient infrastructure, and gaps in regulations.

Through targeted investments and robust regulations, Pakistan can transform its transport sector into a greener, more sustainable system that aligns seamlessly with its development goals. Kamran et al. (2019)<sup>9</sup> found broad support for integrating environmental considerations into transportation policy and enhancing public transit. However, Etukudoh et al. (2024)<sup>31</sup> argue that transitioning from a car-centric culture to sustainable transportation requires strong public awareness campaigns and policy measures. Moreover, Khan et al. (2023)<sup>4</sup> stress that government-led initiatives are crucial for educating the public about the environmental impacts of transportation choices and the benefits of carbon-neutral activities.

The proposed policies include the following

- **Technological Approaches:** This approach involves leveraging technological advancements in automobiles, road infrastructure, and traffic management to enhance vehicle fuel efficiency, emission control, noise reduction, congestion management, and highway safety audits (Brebbia, 2000)<sup>32</sup>. Furthermore, significant benefits are expected from the development of intelligent transportation systems (Brebbia, 2000)<sup>32</sup>. In conclusion, Pakistan needs to incorporate cutting-edge technologies into its infrastructure, cars, and traffic control systems in order to achieve sustainable urban transportation. Pakistan must develop intelligent transportation systems, reduce pollutants, and improve fuel efficiency. It is imperative to address the financial, infrastructure, and regulatory obstacles to make the shift to a more eco-friendly and effective transportation system. Addressing the financial, infrastructure, and regulatory obstacles is necessary for making the shift to a more eco-friendly and effective transportation system.
- **Vehicle Technology:** Regulatory policies are crucial for producing greener cars (Brebbia, 2000; Etukudoh et al., 2024)<sup>31,32</sup>. These policies will significantly advance sustainable urban road transportation and overcome the chal-

**Table 2** Comparative analysis of transportation sectors in Pakistan (2010), Germany, China, the United States, and Sweden (2023)

Country	Key Metrics	Strengths	Weaknesses
Pakistan (2010)	- 239 billion passenger km (2010) - 153 billion ton km (2010) - Road density: 0.32 km/sq.km	- Predominantly road-based transport (92% passenger, 96% freight) - Recent investments in infrastructure	- Low road density compared to developed nations - Heavy reliance on road transport
Germany (2023)	- Extensive rail network (over 41,000 km) - High road density (over 1 km/sq.km)	- Advanced rail system - Efficient public transport options	- Aging infrastructure in some areas - Environmental concerns regarding emissions
China (2023)	- Largest road network globally (over 4.8 million km) - Rapid expansion of high-speed rail	- Significant investment in infrastructure - High-speed rail connectivity	- Overcrowding in urban areas - Environmental degradation due to rapid development
United States of America (USA) (2023)	- Extensive highway system (over 4 million miles) - Mixed transport modes (road, rail, air)	- Diverse transport options - Strong freight transport capabilities	- Aging infrastructure - Traffic congestion in major cities
Sweden (2023)	- High rail usage (approximately 20% of passenger traffic) - Sustainable transport initiatives	- Strong focus on sustainability - Integrated public transport system	- Higher costs associated with maintenance and sustainability efforts

lenges of battery technology, alternative fuel production, and autonomous vehicles depending on technological advancements and a dedicated research and development effort (Brebbia, 2000; Etukudoh et al., 2024)<sup>31,32</sup>. The development and adoption of fuel-efficient, environmentally friendly cars with enhanced safety features are seen as key factors in advancing sustainable urban road transportation (Brebbia, 2000)<sup>32</sup>. Vehicles that utilize alternative, inexhaustible fuel sources have the potential to promote sustainability (Brebbia, 2000)<sup>32</sup>. However, market conditions currently pose challenges to these innovations (Brebbia, 2000)<sup>32</sup>. To sum up, regulations are crucial in pushing the creation of more environmentally friendly automobiles and encouraging sustainable urban road mobility. These policies can encourage the use of fuel-efficient, environmentally friendly cars by addressing issues with battery technology, the generation of alternative fuels, and autonomous vehicles. The policies can also nurture breakthroughs through committed research and development. These advances are hampered by the state of the market and they emphasise the necessity of ongoing funding and support for environmentally friendly transportation solutions.

- **Infrastructure:** The rise in privately-owned vehicles, leading to increased traffic congestion and pollution, underscores the need for an efficient, economical, and well-

connected public transportation system (Brebbia, 2000; Khan et al., 2023; Etukudoh et al., 2024)<sup>4,32</sup>. The system should be developed using advanced technologies, recyclable materials, and safety-focused, environmentally conscious strategies. Achieving infrastructure requires significant investment, long-term planning, and strong government involvement through strategic investments and public-private partnerships (Brebbia, 2000; Khan et al., 2023; Etukudoh et al., 2024)<sup>4,31,32</sup>. Public-private partnerships accelerate the deployment of electric vehicle (EV) charging stations and alternative fuel production facilities (Etukudoh et al., 2024)<sup>31</sup>. These collaborations bridge the gap between government resources and private sector innovation (Etukudoh et al., 2024)<sup>31</sup>. Integrating smart city technologies, such as real-time data analytics, smart traffic management, and unified ticketing systems, optimizes existing infrastructure (Etukudoh et al., 2024)<sup>31</sup>. This approach improves public transportation efficiency, and enhances the overall transportation experience (Etukudoh et al., 2024)<sup>31</sup>. Strategic investments in expanding bus and rail networks, along with integrating emerging technologies, are vital for ensuring both efficiency and accessibility (Etukudoh et al., 2024)<sup>31</sup>. Maintaining and upgrading current infrastructure is essential for the reliability of public transportation systems, while investments in EV charging infrastructure are crucial for promoting electric vehicle adoption (Etukudoh

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et al., 2024)<sup>31</sup>. In conclusion, a strong public transport infrastructure strengthened by cutting-edge technologies, recyclable materials, and wise investments is needed to combat the increase in privately owned automobiles. Deploying electric vehicle infrastructure and integrating smart technology are critical public-private collaborations that will maximise transit efficiency and encourage the use of electric vehicles.

- **Environmental Costs:** The collateral environmental damage and long-term impacts on global climate change from car travel are costs not covered by road users (Brebbia, 2000)<sup>32</sup>. Still, governments can pave the way for a more affordable and competitive sustainable transportation system by implementing comprehensive measures (Etukudoh et al., 2024)<sup>31</sup>. Damage cost and preventative cost approaches can be used to estimate the harm to human health, property, agriculture, etc (Brebbia, 2000)<sup>32</sup>. These expenses can be high and ought to be covered by the "polluter pays" theory and calls for the implementation of a carbon price or other such measure (Brebbia, 2000)<sup>32</sup>. In conclusion, road users frequently do not bear the externalised costs associated with driving, such as the harm to the environment and long-term climate implications. Governments can promote a more environmentally friendly transport system by enacting comprehensive policies, such as carbon pricing and the "polluter pays" theory. Estimating the costs and benefits of sustainable transportation initiatives will be essential and internalise these costs which include harm to property, agriculture, and health in order to build a more competitive and cost-effective sustainable transportation framework.

Necessary advances in automobiles include improved battery technology, hydrogen fuel cells, autonomous driving systems, and sustainable manufacturing practices to minimize environmental impact and enhance efficiency (Brebbia, 2000; Etukudoh et al., 2024)<sup>31,32</sup>. Targets for the level of advances to be attained include achieving net-zero emissions by 2030-2040, enhancing energy efficiency by 5%, and establishing robust Electric Vehicle charging infrastructure for widespread adoption (Brebbia, 2000; Etukudoh et al., 2024)<sup>31,32</sup>. Pakistan's efforts towards advancements are reflected in its New Energy Vehicle policy, which promotes local Electric Vehicle manufacturing and infrastructure development. Recent hybrid vehicle launches and the expanding network of charging stations further support this transition towards sustainable transportation (Khan et al., 2023; Etukudoh et al., 2024)<sup>4,31</sup>.

To evaluate the feasibility and scalability of proposed solutions for integrating smart technologies and electric vehicle (EV) infrastructure in Pakistan, a systematic analytical framework is essential. This framework can incorporate tools such as Geographic Information Systems (GIS) and Life Cycle Assessment (LCA), which have proven effective in assessing environmen-

tal impacts and optimizing infrastructure planning. LCA is a comprehensive method that evaluates the environmental impacts associated with all stages of a product's life, from raw material extraction through production, use, and disposal. In the context of EVs, LCA can help identify key areas where emissions can be reduced. The Life Cycle Assessment (LCA) conducted by Zubair et al. (2024)<sup>33</sup> evaluate the environmental impacts associated with the construction and operational phases of a building's lifecycle. The assessment follows a systematic approach, beginning with the definition of the goal and scope, which includes identifying critical parameters affecting environmental deterioration (Zubair et al., 2024)<sup>33</sup>. The study employs a comprehensive inventory analysis to quantify energy, material inputs, and emissions across different lifecycle stages (Zubair et al., 2024)<sup>33</sup>. The impact assessment phase evaluates the contributions of various materials and operational practices to greenhouse gas emissions, revealing that the use of less eco-friendly materials significantly increases overall emissions (Zubair et al., 2024)<sup>33</sup>. The findings indicate total emissions of 2996 ton CO<sub>2</sub> throughout the lifespan of the case study building, with a subsequent re-evaluation showing a reduction to 2437 ton CO<sub>2</sub> after implementing mitigation strategies (Zubair et al., 2024)<sup>33</sup>. This reduction underscores the importance of optimizing design and utilizing sustainable materials to enhance operational efficiency and reduce environmental impacts effectively.

Moreover, the integration of Geographic Information Systems (GIS) can optimize infrastructure planning by identifying ideal locations for charging stations based on population density and traffic patterns (Hassan et al., 2023)<sup>34</sup>. GIS provides powerful geospatial tools for mapping and analysing spatial data, which is crucial for infrastructure planning (Zubair et al., 2024)<sup>33</sup>. In Pakistan, research highlights that integrating GIS with renewable energy sources can significantly enhance the efficiency of EV infrastructure planning, ensuring that charging stations are strategically located to meet user needs (Ali et al., 2022)<sup>20</sup>. These tools can optimize the placement of EV charging stations and waste management facilities by analysing factors such as accessibility, environmental impact, and cost efficiency (Zubair et al., 2024)<sup>33</sup>. For example, Zubair et al. (2024)<sup>33</sup> demonstrates that GIS could significantly reduce transportation emissions by optimizing waste transportation routes, achieving a reduction of 21.14% of 388.81 ton of CO<sub>2</sub> through improved routing. In the context of EV infrastructure, GIS can identify optimal locations for charging stations based on population density and traffic patterns, ensuring that infrastructure development aligns with user needs (Zubair et al., 2024)<sup>33</sup>. By integrating LCA and GIS, stakeholders can make informed decisions that promote eco-efficiency and support sustainable urban development in Pakistan. This combined approach not only enhances sustainability in construction projects but also applies directly to the transport sector by evaluating potential EV technologies' impacts comprehensively.

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## Sustainable Development Goals

All 191 UN member states are now focusing on Sustainable Development Goals (SDGs) as part of their development strategies, aiming to enhance quality of life while safeguarding the planet over the fifteen-year SDG period from 2015 to 2030 (Thilakshan et al., 2019)<sup>35</sup>. When selecting indicators, it is important to distinguish between goals and objectives. Goals are the ultimate aspirations of society, whilst objectives are necessary intermediate stages that contribute to the achievement of these goals but are not ends in and of themselves (Litman and Burwell, 2006)<sup>5</sup>. Planning for sustainability calls for more depth and integration, taking into consideration a wide range of social, economic, and environmental effects (Litman and Burwell, 2006)<sup>5</sup>. Through collaboration between governments, communities, and civil society, sustainable growth policies can improve citizens' lives and help protect the global environment (Thilakshan et al., 2019)<sup>35</sup>. The SDGs consist of 17 goals, 169 targets, and 244 indicators (Thilakshan et al., 2019)<sup>35</sup>. Sustainable Development Goals such as SDG 11 (sustainable cities) and SDG 13 (climate action) provide a framework for Pakistan's transition to cleaner and more efficient transport systems, linking health, infrastructure, and energy to global sustainability ambitions.

For instance, a Harvard Business School MBA (Master in Business Administration) study on goal setting asked graduating students if they had written goals and plans to achieve them. The study found that 84% of the students had no written goals, while 16% of the students did (Thilakshan et al., 2019)<sup>35</sup>. A decade later, those with written goals were earning at least twice as much as those without (Thilakshan et al., 2019)<sup>35</sup>. This research, along with similar studies, demonstrates that having specific goals significantly impacts success compared to working towards an unplanned destination (Thilakshan et al., 2019)<sup>35</sup>. Therefore, the SDGs represent more than a mere list of goals and sub-targets (Thilakshan et al., 2019)<sup>35</sup>. SDGs embody a commitment to achieving sustainability through comprehensive change and development (Thilakshan et al., 2019)<sup>35</sup>. Viewed as supranational strategies, the SDGs are meant to guide public and private sectors at all levels in advancing the sustainable development of transportation systems (Reis et al., 2024)<sup>36</sup>.

Nonetheless, literature emphasizes the importance of developing performance metrics to evaluate the effectiveness of these policies and solutions (Reis et al., 2024)<sup>36</sup>. By integrating advanced technologies and fostering environmentally conscious behaviours, one can meet transportation sustainability objectives and move towards a cleaner, more efficient future for all (Reis et al., 2024)<sup>36</sup>.

Pakistan's carbon emissions have shown a significant upward trend, with total emissions projected to reach 1,603 million tons by 2030, reflecting a 123% increase over the past two decades, from approximately 720 million tons in 2000 to the projected figure for 2030 (Sardar and Liaqat, 2022)<sup>37</sup>. In 2020, emissions

were approximately 184 million tons, resulting in a per capita emission rate of 0.81 metric tons (Sardar and Liaqat, 2022)<sup>37</sup>. The transportation sector notably contributes to these emissions, accounting for about 38% of total greenhouse gas emissions in Pakistan (Government of Pakistan, 2021)<sup>38</sup>. To address this issue, the government has set an ambitious target to transition 30% of vehicles to electric by 2030 as part of its national climate strategy (Sardar and Liaqat, 2022)<sup>37</sup>.

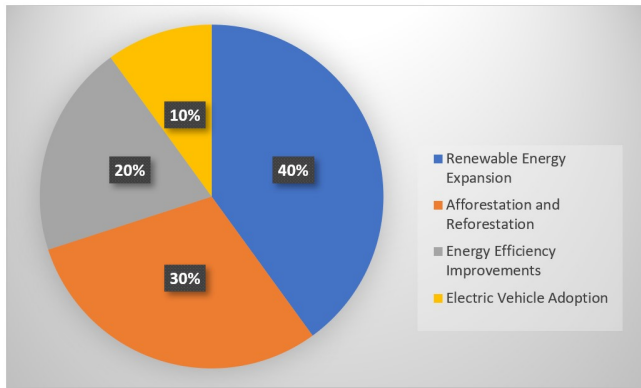
Additionally, urban mobility improvements are being pursued to reduce vehicle numbers and associated emissions. For example, the Lahore Bus Rapid Transit system aims to decrease traffic congestion and promote public transport usage, which could significantly lower per capita emissions in urban areas (Farooq et al., 2021)<sup>39</sup>. The government's commitment to improving urban mobility scores and reducing reliance on fossil fuels is crucial for aligning with SDG 13. Furthermore, the National Adaptation Plan emphasizes enhancing local communities' resilience to climate impacts while promoting sustainable infrastructure and technology (Relief Web, 2024)<sup>40</sup>. By focusing on these quantifiable indicators and aligning national policies with international climate commitments, Pakistan can work towards a more sustainable future.

In conclusion, an international call to action, the Sustainable Development Goals (SDGs) address the most pressing concerns facing our planet today. These 17 interrelated goals were adopted by all UN Member States in 2015, and these goals could assist achieve a sustainable world by 2030. These goals emphasise the need for collaboration between different sectors and nations and focus on eradicating poverty, ensuring access to excellent education, combating climate change, and advancing sustainable urban development. The SDGs recognise the interconnection of social, economic, and environmental sustainability, call on governments, businesses, and civil society to work together to create a more equitable and resilient world. Aligning with the SDGs will bring about revolutionary change that will benefit both the present and the future, ensuring that no one is left behind.

## Limitations and Research Gaps

Bridging the knowledge gaps in Pakistan's sustainable urban transport systems holds the key to designing transformative policies and strategies that address pressing environmental challenges. This section outlines the shortcomings of existing studies and suggests areas for future research to address these issues. Batool et al. (2020)<sup>10</sup> has concentrated on evaluating the benefits of Lahore's Bus Rapid Transit (BRT) system. Her study focuses on aspects such as travel time savings, reductions in the number of vehicles, vehicle cost savings, and environmental emission reductions annually (Batool et al., 2020)<sup>10</sup>.

However, Batool's study has not addressed the associated costs. The long-range energy policy alternatives planning sys-



**Fig. 1** Estimated contributions to the total CO<sub>2</sub> emissions (Metric Tons) reduction by initiative type in Pakistan by 2030 compared to the baseline year 2018 (Data from Government of Pakistan, 2021)<sup>38</sup>.

tem (LEAP) analysis employed in Shahid et al. (2022)<sup>13</sup> research faces data limitations due to the lack of publicly available, detailed datasets on transport vehicles. Additionally, this research was conducted prior to the implementation of the electric vehicle policy in the country (Shahid et al., 2022)<sup>13</sup>.

These factors should be considered when discussing the limitations and research gaps in this study. In research of Khan et al. (2023)<sup>4</sup>, the inadequate infrastructure in Pakistan significantly hampers the implementation of carbon-neutral transportation, which is crucial for promoting sustainable travel. Many urban areas lack dedicated cycling lanes, pedestrian-friendly pathways, and efficient public transportation systems limits the adoption of eco-friendly alternatives (Khan et al., 2023)<sup>4</sup>. Additionally, financial constraints pose a major challenge for both the government and individuals (Khan et al., 2023)<sup>4</sup>.

The high initial costs associated with electric vehicles and the necessary infrastructure can deter investment, with limited financial resources potentially obstructing the widespread adoption of green technologies and infrastructure development (Khan et al., 2023)<sup>4</sup>. Furthermore, the lack of public awareness and educational initiatives about the environmental impacts of transportation choices also impedes progress (Khan et al., 2023)<sup>4</sup>. Widespread public misconceptions about the benefits of sustainable transportation and the hidden costs of excessive carbon emissions have stymied Pakistan's progress toward eco-friendly mobility solutions (Khan et al., 2023)<sup>4</sup>.

The general recommendations for improving sustainable development in Pakistan are that the government of Pakistan should develop legislation and rules regarding sustainable transportation practices to ensure better implementation of sustainable transportation strategies (Kamran, Farhan and Shah, 2019)<sup>9</sup>. All stakeholders, specifically transportation sector should arrange sustainable development awareness campaigns, workshops and training programs for public awareness to encourage them to adopt sustainable practices (Kamran, Farhan and Shah,

2019)<sup>9</sup>.

Pakistan faces barriers to EV adoption, including unreliable electricity, lack of skilled labour, and limited public awareness, necessitating targeted training and awareness campaigns (United Nations Development Programme, 2021)<sup>27</sup>. These challenges hinder the adoption of electric vehicles (EVs) and sustainable transport solutions, necessitating targeted awareness campaigns and vocational training programs to address these issues effectively.

Pakistan's readiness for advanced transportation technologies is assessed through a Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis. A SWOT analysis is a strategic planning framework used to identify and analyse an organization's Strengths, Weaknesses, Opportunities, and Threats (SWOT). Strengths include government initiatives for electric vehicles, while weaknesses highlight inadequate infrastructure and low public awareness (Farooq et al., 2021; Masood et al., 2024).

Opportunities involve leveraging international partnerships, and threats encompass potential carbon emissions from insufficient policy enforcement (Farooq et al., 2021; Masood et al., 2024)<sup>39,41</sup>. Collaborations with countries such as China, which has extensive experience in smart city technologies, could facilitate knowledge transfer and investment. For example, the China-Pakistan Economic Corridor (CPEC) has already led to infrastructure developments that can be built upon for smart city initiatives (Masood et al., 2024)<sup>41</sup>.

However, weaknesses such as inadequate infrastructure, low public awareness, and a disintegrated governance model hinder progress. For instance, while Lahore shows better readiness for smart city transformation due to its existing infrastructure, cities like Multan lag behind in essential components like surveillance and e-governance (Agha, 2016)<sup>42</sup>. Current projects like the Lahore Bus Rapid Transit and Islamabad Metro Bus demonstrate progress but reveal execution challenges (Farooq et al., 2021; Masood et al., 2024)<sup>39,41</sup>. Addressing data gaps and enhancing community involvement are crucial for sustainable transport goals in Pakistan (Farooq et al., 2021; Masood et al., 2024)<sup>39,41</sup>.

A significant drawback to all of these studies is the overall dearth of current, trustworthy data on vehicle usage patterns, public behaviour, and transportation emissions. These factors make thorough and comprehensive sustainability assessments difficult. Furthermore, the lack of long-term studies monitoring effects makes gauging the success and unintended consequences of sustainable transport regulations challenging. The various urban contexts found in Pakistan must also be considered in research, as transportation problems in large cities such as Karachi and Lahore differ from those encountered in smaller towns or rural regions.

In conclusion, there are significant gaps in the current study on sustainable transportation in Pakistan. The difficulty to obtain current and dependable data on vehicle usage patterns, public behaviour, and transportation emissions makes it difficult to

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carry out thorough and precise sustainability studies. Measuring the efficacy and unintended consequences of sustainable transport policies is difficult due to the lack of long-term research that monitor the policies' effects over time. Furthermore, the studies need to include Pakistan's heterogeneous urban landscapes. This is because the transportation problems encountered by megacities such as Karachi and Lahore could be very different from those encountered in smaller towns or rural regions. To create transportation systems that are both efficient and flexible, we must bridge these gaps through enhanced data gathering, extended impact analyses, and context-specific research.

## Conclusion

While the transport sector powers Pakistan's economy, contributing significantly to GDP and employment, it simultaneously exacerbates environmental degradation, posing a complex challenge for sustainable growth. However, transport industry also plays a major role in carbon emissions, which worsen climate change and environmental degradation. This duality highlights the urgent need for a balanced approach that promotes economic growth while mitigating environmental impacts. The transition to sustainable mobility is essential, driven by heavy fossil fuel dependence, outdated infrastructure, and rapid urbanization.

Recent reviews of Pakistan's transport policies indicate a shift towards sustainability, with initiatives like the National Transport Policy of 2009 and the Electric Vehicle Policy of 2020 promoting greener alternatives. Major projects, such as the Karachi Green Line and the Lahore Bus Rapid Transit (BRT) system, exemplify efforts to enhance public transportation infrastructure. Despite these advancements, challenges such as inadequate funding, poor infrastructure, and low public awareness remain significant barriers to progress.

Europe's innovative approaches to sustainable transportation, emphasizing public education, green infrastructure, and multi-modal planning, offer a valuable blueprint for addressing Pakistan's transport challenges. European countries have adopted diverse strategies tailored to their contexts, emphasizing public education, green infrastructure, and multimodal planning. These strategies highlight the importance of integrating new technologies, improving vehicle efficiency, and fostering public engagement in the transition to sustainable transport. A similar multifaceted approach could help Pakistan develop a more sustainable transport system.

The environmental impact of transportation extends beyond carbon emissions. For instance, environmental impact also includes noise pollution, air quality deterioration, and traffic congestion. All of these factors adversely affect public health and urban environments. Addressing these negative externalities requires comprehensive legislation and infrastructure improvements.

Key limitations in Pakistan's transport sector include outdated infrastructure, financial constraints, and insufficient public awareness. To overcome these challenges, public awareness campaigns promoting sustainable mobility benefits are essential. Additionally, the government should prioritize financial incentives for electric vehicle adoption and green infrastructure development.

Aligning Pakistan's transport policies with international sustainability goals, such as the Sustainable Development Goals (SDGs), is critical. By addressing identified research gaps and implementing best practices from other countries, Pakistan can enhance its efforts towards a sustainable transport industry. This includes developing and enforcing regulations that support environmentally friendly transportation methods and encouraging collaboration among stakeholders.

Moving forward, government bodies need to implement and enforce robust policies, the private sector should invest in green technologies and infrastructure, and civil society must advocate for sustainable practices. Coordinated action from all stakeholders is essential to drive this transformation and secure a sustainable future for Pakistan's transport sector. Policymakers, stakeholders, and researchers can utilize these recommendations to collaboratively advance the transport industry, ensuring alignment with global sustainability goals. Continued research and innovation must be prioritized to facilitate ongoing improvements, embracing new technologies and strategies to enhance the effectiveness of sustainable transportation while meeting the evolving needs of future generations.

A staged strategy is necessary for Pakistan's transport sector to achieve sustainability. Short-term priorities include implementing public awareness campaigns, changing legislation, and making initial investments in EV infrastructure. Creating green infrastructure, tightening emissions controls, and encouraging public-private collaborations are some of the medium-term objectives. The main objectives of long-term initiatives should be to modernise and extend public transportation networks, maintain public participation, and conform to global environmental norms. This methodical approach will deal with current issues and open the door for long-term advancements in the industry.

In conclusion, achieving sustainability in Pakistan's transport sector requires a comprehensive strategy that encompasses legislative reforms, technological advancements, and public engagement. The transition to sustainable transport system is vital for balancing environmental protection with economic growth. By adopting global best practices and addressing regional challenges, Pakistan can make significant progress toward a cleaner, more efficient, and sustainable transportation future.

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