

COMPARING SOUTH ASIAN TRANSPORT INFRASTRUCTURE WITH PAKISTAN'S TRANSPORTATION SYSTEMS: A SYSTEMATIC LITERATURE REVIEW

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Abstract

Economic growth is associated with the excellent execution of global supply chains. To maintain efficient, competitive, and sustainable supply chains, well-planned and advanced transportation infrastructure is essential. This study aims to provide a comprehensive analysis of Pakistan's transportation system within the global context, with a special focus on the South Asian perspective, and to generate insights and recommendations for enhancing the country's transport infrastructure and connectivity. A comprehensive review of relevant literature was conducted to gain insights into the global transport infrastructure and its impact on economic growth, climate resilience, technological innovation, energy consumption, and customer preferences and compare it with South Asian countries with a special focus on Pakistan. Based on the research findings, conclusions were drawn regarding the strengths, weaknesses, opportunities, and threats of Pakistan's transportation system compared to the South Asian infrastructure. The major challenges include climate resilience, urban development trends, and technological innovation that influence transportation evolution differently across nations. Opportunities like strategic initiatives CPEC-like projects, acquisition of investment, and technological adoption are the way forward for Pakistan. Practitioners and policymakers can use these insights to enhance the resilience of transportation systems, such as improving drainage systems, incorporating green infrastructure, and implementing sustainable transportation practices.

Keywords: South Asia; global; transportation; logistics; sustainability.

1. INTRODUCTION

Economic Growth and Development of nations are potentially associated with transportation infrastructure, particularly in the context of the Belt and Road Initiative (BRI) countries (De Soyres et al., 2020; Wang et al., 2020a). Well-developed railway and road networks can significantly contribute to economic growth by facilitating trade, reducing transportation costs, and promoting connectivity. Chirisa et al. (2023) delve into the challenges of climate resilience in transportation infrastructure and highlighted that world grapples with climate change, designing and maintaining resilient transportation systems becomes crucial for minimizing environmental impacts and ensuring the sustainability of global transportation networks. Similarly, Butt et al. (2021) explore the application of advanced technologies, such as convolutional neural networks, for intelligent transportation systems and provide evidence that these technologies not only improve safety and efficiency but also contribute to innovation and the development of intelligent urban mobility solutions.

On the other hand, the relationship between road and transport infrastructure development, perceived benefits, and community support for tourism indicated that a well-connected transportation system can boost tourism

and local economies (Kanwal et al., 2020). Besides, Kashif et al. (2020) explore the potential of utilizing untapped renewable energy sources in the transportation sector and found that incorporating renewable energy into transport systems contributes to sustainability and reduced environmental impact. The development of global economic corridors like the China-Pakistan Economic Corridor (CPEC), have significant implications for international trade, connectivity, and infrastructure (McCartney, 2022; Ruihua, 2022). Additionally, Hanif et al. (2020) analyzes the correlation between modern logistics and developing economies using the VAR model and found that efficient logistics and supply chains are essential for global trade and industrial development. Lastly, Zhao et al. (2022) assess the impact of the China-Pakistan Economic Corridor on connectivity in Pakistan, highlighting the role of planned transport network infrastructure in the economic development of emerging economies.

The dynamic linkages between transport, logistics, foreign direct investment, and economic growth in developing countries has highlighted the significance of the interconnectedness of these factors (Saidi et al., 2020). Similarly, Liu et al. (2020) discussed the management and business implications of global health crises, emphasizing the need for adaptability in the face of challenges like COVID-19. Keeping the importance of innovation and sustainability in transportation, Shah et al. (2021) emphasizes the importance of green transportation strategies and innovative technologies for promoting sustainability in South Asian transportation systems. However, the interconnectedness between logistics and international Trade was elaborated by Halaszovich and Kinra (2020) investigated the impact of distance, transportation systems, and logistics performance on FDI and international trade patterns and highlighted the crucial role of transportation in global value chains. Similarly, Waris et al. (2022) evaluates customers' preferences in adoption of drone food delivery services, reflecting the evolving technological landscape and its impact on transportation and service industries.

In association to the economic and environmental consciousness, the studies have also found the traveler preferences for BRT and LRT systems and found mixed findings based on factors such as travel time, comfort, reliability, safety, and accessibility. Different segments of the population had differing priorities when it came to these factors. The research highlighted that factor like age, gender, income, and occupation influenced traveler preferences. These findings underscore the importance of understanding the diverse needs and preferences of different segments of the population (Wang et al., 2020b). Travelers perceived benefits such as reduced travel time, improved comfort, and decreased congestion as major advantages of both BRT and LRT systems. Concerns regarding issues like ticket pricing, overcrowding, and perceived safety issues were identified as challenges that needed to be addressed to encourage higher adoption of these transit systems. Travelers showed an awareness of environmental benefits associated with BRT and LRT systems, such as reduced emissions and congestion. The research by Kepaptsoglou et al. (2020) contributes to the ongoing efforts to improve public transportation infrastructure in Pakistan's urban centers. By understanding traveler preferences and factors influencing adoption, policymakers can make informed decisions that enhance the overall effectiveness, accessibility, and attractiveness of BRT and LRT systems.

The global, South Asian, and Pakistani transport systems exhibit varying characteristics and challenges. On a global scale, transport systems are diverse, with developed countries often having extensive and efficient infrastructure, including advanced public transportation options and sustainability initiatives. In South Asian nations like Pakistan, transport systems face challenges related to rapid urbanization, inadequate infrastructure, and environmental concerns. For instance, in Pakistan, the transportation sector contributes to air pollution, as highlighted by Shirwani et al. (2020) in their study on controlling vehicular emissions using hydrogen-based solutions. This contrasts with global efforts towards sustainable transportation. Comparatively, urban development trends in South Asian cities like Karachi and Beijing, studied by Mangi et al. (2020), reveal varying approaches to managing transportation needs. While Beijing's advanced infrastructure accommodates its rapid urban growth, Karachi faces challenges in integrating transportation networks effectively. Pakistan, specifically Lahore, as studied by Shirwani et al. (2020), is working towards innovative energy solutions to address emissions, but overall, it reflects the need for comprehensive and sustainable transportation planning to align with global goals and ensure efficient mobility, reduced emissions, and improved urban living standards.

The discussed research and literature provide a comprehensive insight into the global, South Asian, and Pakistani transport systems. The studies highlight the significance of efficient transport infrastructure for economic growth. Climate resilience and sustainability challenges faced by transportation infrastructures are

recognized and the innovative solutions for controlling vehicular emissions using hydrogen-based solutions were witnessed rarely. Comparative analysis of urban development trends in Beijing and Karachi, underscores varying approaches to transportation management. These studies showed that there needs an extensive concentration on transportation infrastructure, adoption of innovative and technologically advanced solutions to address the sustainable dimensions in this region.

Hence, it is evident that there exists a gap in literature from transportation, logistics and supply chain operations execution in the South Asian Nations and especially in Pakistan. Addressing gaps in research, while there is substantial literature on various aspects of transport systems, there seems to be a potential gap in research focusing on the integration of sustainable transportation solutions within the larger context of economic growth and environmental conservation. Our study aims to address this gap by examining the interplay between sustainable transportation, economic development, and environmental impact, with a specific focus on Pakistan, considering factors such as the China-Pakistan Economic Corridor, technological innovation, and policy frameworks, as identified by the references mentioned. Based on this research gap, we formulated following research questions and research objectives to fill this gap and provides substantial solutions to policy makers, practitioners and academicians to foster their concentration towards the potential role of transportation and logistics in the development of economy.

2. RESEARCH QUESTIONS

The main research questions addressed in this article are:

RQ1: What are the key differences between global transport infrastructure and Pakistan's transportation system particularly in South Asian region?

RQ2: Analysis of the evolution of Pakistan's transportation system over time in comparison to other Asian countries?

RQ3: What are the main challenges and opportunities facing Pakistan's transportation system in terms of global competitiveness?

RQ4: How can Pakistan's transportation system be improved to better serve the needs of the country's citizens and businesses?

RQ5: What lessons can be learned from other countries in South Asia that have successfully developed their transportation systems?

Based on these research questions following research objectives were formulated:

- To analyze the current state of Pakistan's transportation system and compare it to other countries in South Asian Nations.
- To identify key drivers of change in global transport infrastructure and how they impact Pakistan's transportation system.
- To determine the main challenges and opportunities facing Pakistan's transportation system in terms of global competitiveness.
- To recommend strategies for improving Pakistan's transportation system based on insights from other countries in Asia.

Section 3 of the paper presents the methodology and inclusion/exclusion criteria. Section 4 addresses the mechanism and impact of transportation in the supply chain. The last section of the paper presents the conclusions, implications and future research directions.

3. RESEARCH METHODOLOGY

3.1. Initial Selection criteria of selected articles

The research aims to investigate the impact of transportation infrastructure on economic growth in developing countries, with a focus on the Belt and Road Initiative (BRI) countries. The study has drawn insights from existing literature on transportation infrastructure, economic growth, and the specific case of the China-Pakistan Economic Corridor (CPEC). The goal is to provide comparison of the relationship between transportation infrastructure development and economic growth in the context of developing nations. The research adopted a systematic literature review. The study obtained 40 articles published between 2019- 2023. The data collection involved searching and selecting relevant articles from Google Scholar using specific keywords *Global transport infrastructure, Transport infrastructure in Asia, Pakistan transportation system*, employ econometric models, statistical analyses, and content analysis to explore the relationships and patterns identified in the literature. Articles related to transportation infrastructure, economic indicators, foreign direct investment, trade, and logistics performance will be collected.

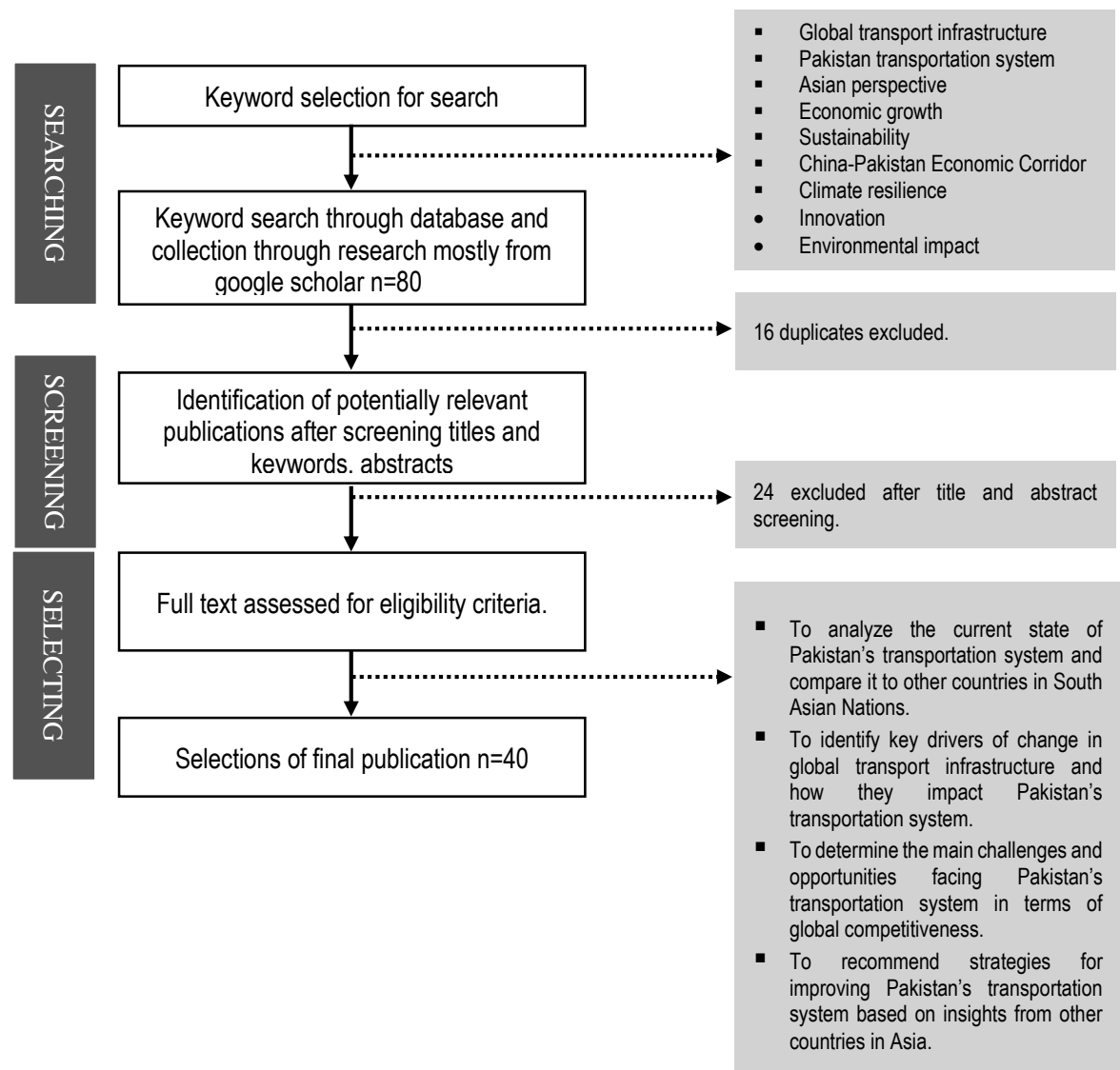


FIGURE 1- SELECTION CRITERIA

3.2. Content Screening and Complementary Research

The research has drawn articles related to infrastructure development, economic growth, and transportation economics. The conceptual framework will integrate insights from the literature to explain the complex relationships between transportation infrastructure, economic development, environmental sustainability, and technology adoption. The study focused on the China-Pakistan Economic Corridor (CPEC) as a prominent case within the Belt and Road Initiative.

The study relies on existing data, which may have limitations in terms of availability and accuracy. The research's generalizability to other developing countries may be influenced by variations in economic conditions and policy contexts. As the study is based on secondary data, ethical considerations primarily involve proper citation and adherence to academic integrity standards. Through this criterion, we successfully obtained 40 articles for final review.

4. DISCUSSIONS

4.1. RQ1 Differences between Pakistan's transportation system and global transport infrastructure, particularly in South Asia

The transportation systems in Pakistan and the global context, particularly within South Asia, exhibit notable differences as highlighted by various studies. Pakistan's transport infrastructure faces challenges such as inadequate road and railway networks, impacting economic growth and connectivity. The China-Pakistan Economic Corridor (CPEC) aims to address some of these issues, focusing on improving connectivity and trade.

In comparison, global transport infrastructure research, such as that by Wang et al. (2020) and De Soyres et al. (2020), emphasizes the significance of transport networks for economic growth, especially within the Belt and Road Initiative countries. The development of sustainable and resilient transportation systems is also of growing concern due to climate change, as discussed by Chirisa et al. (2023). Additionally, the majority of countries transportation infrastructure in South Asian Nations is well supported and planned such as Malaysia, Indonesia, Singapore and Thailand etc.

TABLE 1 – RELEVANT PAPERS FOR RQ1

Author	Challenges Suggested in Respective Article	Impact/Finding
Wang et al. (2020)	Limited connectivity between different transport modes Inadequate investment in infrastructure Insufficient technological advancements	Improved transport infrastructure positively impacts economic growth
De Soyres et al. (2020)	Financing challenges for large-scale infrastructure projects Complex coordination among participating countries Ensuring long-term economic sustainability of projects	Shared transport infrastructure can lead to improved trade and economic integration among participating countries
Chirisa et al. (2023)	Climate change impacts on infrastructure durability and performance Lack of adequate adaptation strategies	Building climate-resilient transportation infrastructure is essential to mitigate climate change risks and ensure long-term sustainability
Shirwani et al. (2020)	High vehicular emissions and air pollution in urban areas Lack of clean and sustainable energy solutions for the transportation sector	The use of innovative energy solutions, such as hydrogen, can contribute to reducing vehicular emissions and improving air quality in Pakistan

Vehicular emissions pose a challenge in Pakistan, prompting innovative solutions like hydrogen-based energy approaches however, developed countries of South Asian region has adopted some of renewable and sustainable energy resources to achieve sustainable development (Shirwani et al., 2020). Urban development

trends and their impact on transport are evident in studies like Mangi et al. (2020). A comparison of these varying transport systems underlines the need for integrated policies, technological innovation, and sustainable practices, as demonstrated by various references. However, despite the existing research, there remains a gap in comprehensive studies that explore the holistic effects of these differences on the economic, environmental, and social dimensions, particularly from an Asian perspective.

Our discussion provided an in-depth analysis of the key disparities between Pakistan's transportation system and South Asian transport infrastructure, focusing on their implications for economic growth, sustainability, and resilience. Through this analysis, we highlighted to insights that can inform policy decisions and strategies for enhancing transportation systems in both Pakistan and the broader Asian context, aligning them with South Asian Nations to address the sustainable development goals.

4.2. RQ2 Evolution of Pakistan's transportation system over time in comparison to other Asian countries?

The evolution of Pakistan's transportation system over time in comparison to other South Asian countries is a complex and dynamic process influenced by various factors such as infrastructure development, community support, renewable energy potential, economic partnerships, and connectivity initiatives. The following discussion draws insights from the provided references to shed light on the evolution of Pakistan's transportation system.

The evolution of Pakistan's transportation system compared to other South Asian countries is a complex process influenced by a range of factors. The transportation infrastructure of Pakistan has evolved after the independence and remarkably established during the decade of 60s leaving other neighboring countries far behind. After that a sluggish, continuous but unplanned development trajectory was witnessed however, the prominent development was recorded due to CPEC. Studies like McCartney (2022) emphasize the transformative impact of the China-Pakistan Economic Corridor (CPEC), which aims to modernize Pakistan's transportation infrastructure through massive investments in road, rail, and port networks. The CPEC is a significant step towards enhancing regional connectivity and trade. In contrast, other South Asian countries have also been advancing their transportation systems through various initiatives.

TABLE 2 - – RELEVANT PAPERS FOR RQ2

Author	Challenges Suggested in Respective Article	Impact/Finding
Liu et al. (2020)	Management challenges and implications of the COVID-19 pandemic Business opportunities arising from the crisis	The COVID-19 pandemic presents both challenges and opportunities for management and businesses, requiring adaptive strategies and seizing new opportunities
De Soyres et al. (2020)	Financing challenges for large-scale infrastructure projects Complex coordination among participating countries Ensuring long-term economic sustainability of projects	Shared transport infrastructure can lead to improved trade and economic integration among participating countries
Mc Cartney (2022)	Political and security challenges Socio-economic disparities between regions Environmental concerns	The China-Pakistan Economic Corridor (CPEC) has the potential to bring economic benefits but also faces various challenges and concerns
Zheng et al. (2022)	Insufficient technological innovation in the energy sector Weak institutional quality affecting energy consumption patterns	Technological innovation and improved institutional quality can lead to more efficient and sustainable energy consumption in different sectors in Pakistan

For instance, research by Wang et al. (2020) and De Soyres et al. (2020) highlights the importance of transport infrastructure within the Belt and Road Initiative (BRI) countries, including Pakistan, for economic growth. These initiatives, including BRI and CPEC, reflect efforts to improve connectivity and trade in the region. However, challenges such as climate resilience (Chirisa et al., 2023), urban development trends (Mangi et al., 2020), and technological innovation (Zheng et al., 2022) influence transportation evolution differently across nations.

Additionally, the global COVID-19 pandemic has prompted adaptation in transport and logistics systems (Liu et al., 2020), with varying implications for different countries. Thus, the evolution of Pakistan's transportation system in comparison to other Asian countries is characterized by a mix of regional development initiatives, policy approaches, urbanization dynamics, technological advancements, and responses to global challenges.

4.3. RQ3 Challenges and Opportunities facing Pakistan's transportation system in terms of global competitiveness

The challenges and opportunities facing Pakistan's transportation system in terms of global competitiveness are influenced by various factors such as infrastructure development, economic partnerships, trade policies, environmental concerns, technological innovation, and institutional quality. The following discussion draws insights from the provided references to examine the main challenges and opportunities confronting Pakistan's transportation system.

Challenges are infrastructure quality, while initiatives like the China-Pakistan Economic Corridor (CPEC) are improving infrastructure, there remain challenges in terms of overall quality, maintenance, and modernization (McCartney, 2022). The establishment of this project despite economic growth poses challenges of environmental degradation and other climate issues depleting the greener belt of Pakistan. Another climate resilience is when climate change poses a significant threat to transportation infrastructure. These climate changes and environmental issues arises due to use of non-renewable energy resources, poor transportation modes and inadequate technology. Chirisa et al. (2023) highlight the challenges surrounding climate resilience in the face of extreme weather events and melting of glaciers and un predicted weathers that leads to erosion of land and deforestation.

Rapid technological innovations and keeping up with rapidly evolving transportation technologies, such as intelligent transportation systems, remains a challenge (Butt et al., 2021). According to them, selection, acquiring, adoption and diffusion of these technologies in transportation infrastructure in Pakistani context is in adequate. Poorly integrated energy efficiency in the transportation sector contributes to environmental issues, including vehicular emissions and energy consumption. Innovations in clean energy solutions are essential to address these challenges (Shirwani et al., 2020). Urban development rapid urbanization places strain on transportation networks, leading to congestion and inefficiencies (Mangi et al., 2020). Logistics and trade are ensuring smooth logistics and trade flows is crucial for global competitiveness. Ensuring efficient trade corridors, as demonstrated by CPEC and BRI projects, is vital (Wang et al., 2020).

Opportunities like Strategic Initiatives in which Projects like CPEC and BRI offer opportunities for enhanced regional connectivity, trade expansion, and economic growth (McCartney, 2022; Wang et al., 2020). Capacity and utilization of clean energy is the focus on energy efficiency and sustainable transportation solutions presents opportunities for innovative approaches like hydrogen-based energy solutions (Shirwani et al., 2020), RFID (N. R. Khan et al., 2017) and blockchain (M. R. Khan et al., 2023). Technological Adoption is Leveraging technological advancements, including artificial intelligence and data analytics, can lead to more efficient transportation systems (Butt et al., 2021).

Besides the environmental and technological adoption opportunities, implementing effective urban planning strategies can lead to improved transportation networks, reduced congestion, and enhanced connectivity (Erhardt et al., 2019; Mangi et al., 2020). Trade facilitation is an efficient transportation networks are crucial for trade facilitation, and initiatives like CPEC and BRI can open up opportunities for Pakistan to become a key transit and trade hub (Wang et al., 2020). Logistics optimization were improved logistics performance, as highlighted by Halaszovich and Kinra (2020), can enhance foreign direct investment and international trade patterns.

TABLE 3 – RELEVANT PAPERS FOR RQ3

Author	Challenges Suggested in Respective Article	Impact/Finding
Chirisa et al. (2023)	Climate change impacts on infrastructure durability and performance Lack of adequate adaptation strategies	Building climate-resilient transportation infrastructure is essential to mitigate climate change risks and ensure long-term sustainability
Butt et al. (2021)	Poor visibility and adverse weather conditions affecting vehicle classification accuracy	Convolutional neural network models can enhance vehicle classification accuracy in adverse conditions for intelligent transportation systems
McCartney (2022)	Political and security challenges Socio-economic disparities between regions Environmental concerns	The China-Pakistan Economic Corridor (CPEC) has the potential to bring economic benefits but also faces various challenges and concerns
Mangi et al. (2020)	Differences in urban development approaches and policies Varied levels of infrastructure provision and planning	Comparative analysis highlights the disparities and challenges in urban development between Beijing and Karachi metropolitan areas

4.4. How can Pakistan's transportation system be improved to better serve the needs of the country's citizens and businesses?

To improve Pakistan's transportation system and better serve the needs of citizens and businesses, several strategies and approaches can be considered. Drawing insights from the provided references, here are some potential ways to enhance the transportation system: Investment in Infrastructure is to prioritize investment in modern and efficient transportation infrastructure, including roads, railways, and ports (Wang et al., 2020). Develop and expand the transportation network to ensure connectivity across regions and support trade (Zhao et al., 2022).

Sustainability and Climate Resilience is the key process to integrate climate-resilient design and construction practices into transportation infrastructure to mitigate the impact of extreme weather events (Chirisa et al., 2023). Promote the use of renewable energy sources for transportation to reduce environmental impact and dependency on fossil fuels (Kashif et al., 2020). Technology Adoption is embraces emerging technologies like intelligent transportation systems, vehicle-to-infrastructure communication, and data analytics for better traffic management and efficiency. Implement advanced vehicle classification systems and traffic management solutions to enhance transportation safety and efficiency (Butt et al., 2021).

Urban Planning and Development have to implement effective urban planning strategies to address congestion, traffic flow, and the needs of growing metropolitan areas (Mangi et al., 2020). Prioritize public transportation systems and integrated multi-modal transportation networks (Kepaptsoglou et al., 2020). Logistics and trade enhancement is to optimize logistics operations and improve supply chain efficiency to facilitate trade and investment (Hanif et al., 2020). Leverage initiatives like the China-Pakistan Economic Corridor (CPEC) to enhance regional connectivity and trade (McCartney, 2022).

Regulatory and Policy Reforms will be establish clear and supportive regulatory frameworks to encourage private sector involvement in transportation infrastructure development (Wang et al., 2020). Develop and implement policies that encourage the adoption of sustainable transportation solutions and promote energy efficiency (Shirwani et al., 2020). Community Engagement and Satisfaction also involve local communities in the planning and development of transportation projects to ensure their needs are met (Kanwal et al., 2020). Focus on improving overall community satisfaction with transportation services through better connectivity and accessibility (Kanwal et al., 2020). Capacity Building and Training will invest in human capital development by providing training and education for transportation professionals and engineers (Wang et al., 2020). Foster a skilled workforce capable of managing and maintaining modern transportation infrastructure.

Collaboration and Partnerships with international partners and organizations to gain access to expertise, best practices, and financial resources for transportation projects (De Soyres et al., 2020). Foster public-private

partnerships to leverage private sector expertise and funding for transportation development. Innovation and Research support in transportation technology, materials, and design to drive continuous improvement (Butt et al., 2021). Encourage universities and research institutions to contribute to transportation-related research and development.

TABLE 4 – RELEVANT PAPERS FOR RQ4

Author	Challenges Suggested in Respective Article	Impact/Finding
Kanwal et al. (2020)	Insufficient transport infrastructure to support tourism activities Lack of community involvement and satisfaction in infrastructure development	The development of transport infrastructure can positively influence community support for tourism by providing improved access and enhancing community satisfaction
Butt et al. (2021)	Poor visibility and adverse weather conditions affecting vehicle classification accuracy	Convolutional neural network models can enhance vehicle classification accuracy in adverse conditions for intelligent transportation systems
Kashif et al. (2020)	Limited awareness and knowledge about the potential of crop residues as a renewable energy source Lack of infrastructure and technologies for residue collection and utilization	Exploring and utilizing crop residues as a renewable energy source can contribute to sustainable development in Pakistan
Zhao et al. (2022)	Inadequate connectivity between different regions Challenges in implementing and completing infrastructure projects	The China-Pakistan Economic Corridor (CPEC) has the potential to improve connectivity within Pakistan but requires effective planning and execution

4.5. RQ5 Lessons learnt from South Asian Nations that successfully developed their transportation systems

Developing a successful transportation system requires learning from the experiences of other countries in South Asia that have achieved notable progress in this area. The following research discussion draws on the provided references to identify key lessons that can be learned from these countries. Many successful South Asian countries have developed integrated multi-modal transport systems that combine various modes of transportation like buses, trains, and subways to provide seamless connectivity (Kepaptsoglou et al., 2020). Pakistan can focus on developing integrated transportation networks to improve efficiency and convenience for passengers. Countries that have improved their transportation systems have made substantial investments in infrastructure development, such as roads, railways, and ports (Wang et al., 2020). Pakistan should prioritize investment in modern and well-maintained infrastructure to support economic growth and connectivity.

Some South Asian countries have successfully implemented public private partnerships (PPPs) to attract private sector involvement in transportation projects, leveraging expertise and funding (Hanif et al., 2020). Pakistan can explore PPPs models to accelerate the development of transportation infrastructure. Green transportation strategies, including the adoption of renewable energy sources and energy-efficient technologies, have been employed to reduce environmental impact (Shah et al., 2021). Pakistan can prioritize sustainable transportation solutions to mitigate environmental concerns and reduce reliance on fossil fuels.

Additionally, South Asian countries that have efficiently managed urbanization have incorporated transportation planning into urban development strategies to address congestion and support population growth (Mangi et al., 2020). Pakistan can integrate transportation planning with urban development to create efficient and livable cities. Successful transportation systems require a skilled workforce to design, manage, and maintain infrastructure. Many countries have invested in training and education (Wang et al., 2020). Pakistan should prioritize capacity building to ensure a competent workforce to manage transportation projects effectively.

Technological innovations, such as intelligent transportation systems and data analytics, have been integrated into transportation management to improve efficiency and safety (Butt et al., 2021). Pakistan can leverage technological advancements to enhance transportation operations and safety. Countries that have successfully transformed their transportation systems have often followed consistent policies and long-term planning to ensure sustained development (Halaszovich & Kinra, 2020). Moreover, Pakistan can benefit from a stable policy framework and long-term vision for transportation development. Involving local communities in transportation planning and decision-making has helped ensure that projects meet the needs of citizens and gain public support. Pakistan can engage communities to gain insights and build support for transportation projects (Kanwal et al., 2020).

TABLE 5 -- RELEVANT PAPERS FOR RQ5

Author	Challenges Suggested in Respective Article	Impact/Finding
Hanif et al. (2020)	Limited infrastructure and logistical capabilities Inefficient supply chain management	Developing a robust logistics industry is essential for the economic development of Pakistan
Kepaptsoglou et al. (2020)	Preferences for Bus Rapid Transit (BRT) and Light Rail Transit (LRT) systems in developing countries Factors influencing traveler preferences	Understanding traveler preferences can inform the planning and development of effective public transportation systems in developing countries
Godil et al. (2021)	Environmental impacts of transportation services Urbanization and its effects on the environment Role of financial development in environmental mitigation	Transportation services, urbanization, and financial development play significant roles in environmental mitigation efforts in Pakistan
Yadav et al. (2020)	Limited awareness and understanding of lean manufacturing principles Lack of resources and capabilities for implementing lean practices	The development and adoption of a lean manufacturing framework can enhance operational efficiency and competitiveness in manufacturing companies in developing economies

5. CONCLUSIONS

The key differences between Pakistan's transportation system and global transport infrastructure, particularly in South Asia, can be identified through various research studies. These differences include variances in the scale and quality of infrastructure, level of connectivity, integration with global networks, climate resilience approaches, adoption of advanced technologies, and intelligent transportation systems. Understanding these differences is crucial for assessing Pakistan's position in the regional and global transportation landscape.

Over time, Pakistan's transportation system has evolved through factors such as infrastructure development, community support, renewable energy potential, economic partnerships, and connectivity initiatives. Improvements in transportation infrastructure to support the tourism sector, tap into renewable energy sources, and developments under the China-Pakistan Economic Corridor (CPEC) have contributed to its evolution. The growth of industries such as logistics has also influenced the evolution of the transportation system. Pakistan's transportation system faces both challenges and opportunities in terms of global competitiveness. Challenges include project implementation, governance, security concerns, regional disparities, and environmental impacts. Addressing these challenges, leveraging trade policies and opportunities, adopting innovative energy solutions, and improving technological capabilities and institutional governance can enhance Pakistan's global competitiveness in the transportation sector.

To better serve the needs of citizens and businesses, Pakistan's transportation system can be improved through customer-centric approaches, lean practices, sustainable solutions, and comprehensive studies on traveler preferences. Incorporating customer satisfaction, convenience, and preferences, along with lean principles, sustainable practices, and innovative technologies, can lead to an improved transportation system that meets the needs of both citizens and businesses. Learning from other countries in South Asia that have successfully developed their transportation systems provides valuable lessons for Pakistan. These lessons

include the importance of integrating transportation and logistics networks, robust crisis management strategies, integrated and multimodal transport systems, efficient logistics capabilities, and embracing innovation and emerging technologies.

5.1. Practical Implications and Future Research Directions

The studies on railway and road infrastructure in the Belt and Road Initiative (BRI) countries provide insights into the potential impact of transport infrastructure on economic growth. The findings suggest that improving transport infrastructure can contribute to economic development and regional integration. Policymakers and governments involved in the BRI can use these findings to prioritize investments in transportation infrastructure to maximize economic benefits (Wang et al., 2020; De Soyres et al., 2020).

The challenges surrounding climate resilience in transportation infrastructures highlight the need for incorporating climate change adaptation strategies into infrastructure planning and design. Practitioners and policymakers can use these insights to enhance the resilience of transportation systems, such as improving drainage systems, incorporating green infrastructure, and implementing sustainable transportation practices (Chirisa et al., 2023).

The application of convolutional neural network (CNN) based vehicle classification in adverse aluminous conditions for intelligent transportation systems has practical implications for improving road safety and traffic management. This technology can be integrated into intelligent transportation systems to enhance real-time monitoring, traffic control, and incident detection, leading to improved efficiency and safety on the roads (Butt et al., 2021).

The comparative analysis of urban development trends in Beijing and Karachi metropolitan areas provides valuable lessons for sustainable urban planning and development. Policymakers can learn from successful practices and policies implemented in Beijing to address urban challenges, such as land use planning, transportation systems, and environmental management, and apply them to the urban development of Karachi (Mangi et al., 2020).

The study on road and transport infrastructure development and community support for tourism emphasizes the importance of perceived benefits and community satisfaction. Governments and tourism authorities can focus on enhancing the perceived benefits of infrastructure development, such as improved accessibility, reduced travel time, and enhanced tourism experiences, to garner support and engagement from local communities (Kanwal et al., 2020).

5.2. Future Research Directions:

Future research should investigate the long-term economic impacts of transport infrastructure development within the Belt and Road Initiative. This can involve assessing the spillover effects of infrastructure investments on various sectors, analyzing the sustainability and cost-effectiveness of projects, and exploring the social and environmental consequences of infrastructure development (De Soyres et al., 2020; Wang et al., 2020b). Further research is needed to explore innovative strategies and technologies for enhancing climate resilience in transportation infrastructures. This can involve studying the effectiveness of green infrastructure, sustainable drainage systems, and climate-responsive design in mitigating the impacts of climate change on transportation networks (Chirisa et al., 2023). Future studies can focus on refining and optimizing convolutional neural network (CNN) models for vehicle classification in adverse aluminous conditions. This can involve improving the accuracy and robustness of the models, expanding the dataset for training and validation, and exploring the applicability of CNNs in other transportation-related tasks, such as traffic flow prediction and anomaly detection (Butt et al., 2021). Comparative analysis of urban development trends should be extended to other metropolitan areas in developing countries to gain a broader understanding of urbanization challenges and opportunities. Future research can explore the factors influencing urban development trajectories, the effectiveness of urban planning strategies, and the role of governance and policy frameworks in shaping sustainable urban development (Mangi et al., 2020).

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