

A Review of Public Road Transport in India: Challenges, Innovations and Policy Recommendations

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Abstract—Efficient and reliable public road transportation systems are essential for ensuring accessible and sustainable mobility for the vast population of India. With a rapidly growing population and increasing urbanization, India faces significant challenges in providing affordable, safe, and efficient road transportation services. This paper aims to analyze the key challenges and explore opportunities for improvement in the public road transportation sector in India. As the paper begins, it emphasizes the importance of public road transportation for both urban and rural populations. In addition to facilitating economic growth, it provides essential services. Despite this, India's public road transportation system faces several challenges. Furthermore, the lack of reliable and standardized public transportation is a major concern. Private buses and unregulated informal transport operators dominate the road transportation sector, leading to issues of overcrowding, irregular schedules, and inadequate passenger comfort and safety measures. To address these challenges and improve public road transportation in India, the paper explores potential opportunities and solutions. It highlights the need for increased investment in road infrastructure development, including the expansion of road networks, improved road design, and enhanced traffic management systems. Additionally, the integration of technology, such as intelligent transportation systems and real-time information systems, can optimize operations and enhance the overall passenger experience.

Index Terms— public road transport, India, challenges, innovations, policy recommendations.

I. INTRODUCTION

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Public road transport plays a pivotal role in facilitating mobility and connectivity in India, serving as the primary mode of transportation for a vast majority of the population. With a rapidly growing population, urbanization, and increasing demand for transportation services, the public road transport sector in India faces a multitude of challenges. Road transportation is a vital component of India's transportation system, providing mobility and accessibility to millions. Despite this, the sector faces many challenges that impede its efficiency and effectiveness.

The Indian road transportation system faces numerous challenges that impact its functionality and quality of service. Public road transport is hindered by insufficient infrastructure, including road networks, terminals, and

depots. Increasing urbanization and increased population growth have resulted in insufficient road capacity, which increases travel time and reduces efficiency. Furthermore, road maintenance and road quality need to be addressed in order to ensure safe and comfortable travel for passengers.

The objective of this review is to provide policy recommendations to enhance the performance and sustainability of the Indian public road transportation sector, examine the key challenges that it faces, explore innovative solutions, and explore technological advances.

II. LITERATURE SURVEY

There has been an overwhelming situation with public transportation in particular. There are many problems with bus and train services, such as overcrowding, unreliability, slowness, inconvenience, and un-coordination. [1] As a result of the rapid growth of the largest cities in India and the low incomes associated with them, a lack of adequate transport infrastructure, rampant suburban sprawl, sharply increasing ownership and use of motor vehicles, deteriorating bus services, a wide range of different modes of transportation sharing the same roads, and inadequate and uncoordinated transport planning, India's transportation crisis has been exacerbated.[2] Economic growth, structural transformation, and urbanization are all dependent on investments in transport infrastructure. [3] The country's public transport system needs to be improved to increase user satisfaction, both for the purpose of maintaining existing users and attracting new ones. In the future, these improvements will reduce the use of private cars in the city and make it more sustainable.[4]

Through various sustainable transport policies, India has taken steps to reduce the problems related to transportation, such as congestion, pollution, and accidents.[5] A discussion was intended to be initiated in this article regarding traffic engineering and planning, and the need for local urban road research and resurfacing, as if we had immediately connected all the principles requiring pavement elements in terms of road lifespan, most people would not have read it to the end.[6] According to the author, he presents a method to map bus travel times with stream travel times based on gradient boosting and support vector machines. In contrast to linear regression and artificial neural networks, the proposed methods were found to efficiently map bus travel times with stream travel times.[7]

Using a mathematical model to predict bus delays and represent bus behavior is discussed in this paper. It was found that there were significant differences in results for bus lines operating in different cities, which had very different road and traffic structures, and characteristics of public transportation.[8] In a public transportation network, selecting the best timetable for vehicles can be a complex task, since the needs and satisfaction of passengers should be taken into account as well as transportation companies' needs. An approach for timetabling PTs is presented in this paper that incorporates the passenger waiting time (PWT) at stations as well as the vehicle occupancy ratio (VOR). PWT is minimized and VOR is maximized in the solution. His solution is based on a multi objective particle swarm optimization (MOPSO) algorithm due to the large search space of the problem.[9]

Dynamic navigation, infrastructure planning, congestion control, and accident detection include the use of travel time information as input or auxiliary data. Recent research has focused on data-driven Travel Time Prediction (TTP). The development and selection of the most appropriate prediction algorithm is one of the most challenging aspects of TTP. Three different TTP methods are compared in this paper (ensemble tree-based learning, deep neural networks, and hybrid models) and ten different prediction algorithms in general. XAI (Explainable Artificial Intelligence) techniques (SHAP and LIME) were also applied to get a better understanding and interpretation of the models.[10]

Modern megalopolises, which have several millions of inhabitants, face colossal challenges in terms of urban mobility as a result of their increasing number and complexity. Utilizing the resources available efficiently is essential for meeting the ever-increasing mobility demand without further aggravating traffic congestion. Using flexibility and integration dimensions, the author of this article analyzed the literature. He summarizes the most relevant solutions and approaches for each of the application areas identified.[11]

In this paper, data-driven optimization is applied to the well-known berth allocation problem. Aspiring to give conflict-free vessel assignments at a terminal by taking into account uncertain arrival times, such as crosswinds and sea currents, robust berth scheduling aims to derive conflict-free terminal berth assignments. We evaluate the prediction quality of each Machine Learning method. Based on the various AIS-based forecasts, dynamic time buffers (DTBs) are calculated and used in the berth scheduling model, whose length is determined by the forecast reliability estimate, which significantly improves the robustness of the resulting schedules. An extensive numerical study proves this.[12]

III. CHALLENGES IN PUBLIC ROAD TRANSPORT

A. Sustainable Mobility

Several countries have introduced physical distancing to curb the spread of the COVID-19 virus in recent years, resulting in a dramatic drop in public transportation use. Fear that passengers might become infected has led to future research questions regarding the sustainability and efficiency of transportation options in many major cities throughout the world.[13]

B. Infrastructure and Road Conditions

There are significant challenges for public road transport in India due to the inadequate and poorly maintained road infrastructure. Traffic congestion and increased travel times are caused by insufficient road capacity, poor road quality, and poor maintenance.

C. Energy for sustainable

A significant source of air pollution is the transport industry, since old and poorly maintained cars emit high levels of pollutants. As a result, severe health risks and environmental challenges arise.

D. Overcrowding and Congestion

There is often overcrowding and congestion in Indian public transport services, particularly in urban areas.[14] It is difficult to maintain schedules when buses and trains are overcrowded.

E. Reliability and Punctuality

Public road transport in India is notorious for its lack of reliability and punctuality. [15] The lack of consistency in schedules and delays negatively impacts passengers' trust in public transportation.

F. Safety and Security:

Public road transport is prone to safety and security issues, such as road traffic accidents, thefts, and harassment. [16]

G. Transport Externalities

Particularly in urban areas, transport externalities are a major concern. Policy makers have developed long-term strategies to reduce transport externalities due to the citizens' sensitivity to environmental issues. [17].

IV. INNOVATIONS IN PUBLIC ROAD TRANSPORT

A. Social implications

It is widely acknowledged that public transportation that provides a high level of networked service improves the quality of life. Affluent societies are less likely to endorse public transportation unless certain measurable demands are not met. Several parts of the world have endorsed public transportation as a way to promote a sustainable environment, which is energy efficient, low-emission and green.[18]

B. Innovative Vehicles

A number of innovations have taken place in the vehicles markets that are disruptive: engine technologies, autonomous vehicles, and novel delivery methods have dominated the automotive industry in the past century. Technology innovations such as electric, hybrid and fuel cell electric vehicles (FCEVs) reduce externalities.[17]

C. Mobility as a Service (MaaS)

Providing seamless travel experiences through digital platforms, MaaS integrates various modes of transport and could transform public road transport in India.[19]

D. Intelligent Transportation Systems (ITS)

Implementing ITS technologies, including real-time monitoring systems, smart traffic management, and passenger information systems, can enhance the efficiency and reliability of public road transport services.

V. POLICY RECOMMENDATIONS IN PUBLIC ROAD TRANSPORT

A. Infrastructure Development

Investing in road infrastructure should include road and bridge construction and maintenance, as well as bus terminals.

B. Reducing black carbon emissions

Particulate matter is composed of black carbon, a product of incomplete diesel combustion. Cardiopulmonary disease and lung cancer are caused by particulate matter emissions; black carbon is a significant climate force.[20]

C. Regulatory Framework

For the public road transportation system to be safe, secure, and of high standard, robust regulations are needed, including vehicle maintenance, driver training, and passenger protection.

D. Promotion of Sustainable Practices

By promoting electric vehicle adoption, promoting carpooling and ridesharing, and incentivizing sustainable transport modes, we can reduce carbon emissions and congestion.

VI. CONCLUSION AND FUTURE DIRECTIONS

Public road transport in India faces numerous challenges that hinder its efficiency, safety, and sustainability. This review paper has examined the key challenges, innovative solutions, and policy recommendations for the sector.

The challenges identified include inadequate infrastructure and road conditions, overcrowding and congestion, reliability and punctuality issues, emission and environmental concerns, and safety and security issues. These challenges collectively impact the quality and effectiveness of public road transport services in India.

To address these challenges, several innovative solutions have emerged. The adoption of electric mobility, including electric vehicles (EVs), has the potential to reduce emissions and improve air quality. Intelligent Transportation Systems (ITS) offer advanced technologies for real-time monitoring, traffic management, and passenger information, enhancing the efficiency and reliability of public transport. Additionally, Mobility as a Service (MaaS) platforms integrating various modes of transport provide seamless travel experiences.

Policy recommendations are crucial for the sustainable development of public road transport in India. Infrastructure development should be a priority, including investments in road construction, maintenance, and improvement of bus terminals. A robust regulatory framework is essential to ensure safety, security, and quality standards for vehicles, drivers, and passengers. Promoting sustainable practices such as encouraging the adoption of electric vehicles, incentivizing carpooling and ride-sharing, and integrating sustainable transport modes into the system can lead to significant improvements.

To achieve a comprehensive transformation of public road transport in India, collaboration among policymakers, transport authorities, urban planners, and stakeholders is crucial. Implementing the identified policy recommendations and embracing innovative solutions will enhance the efficiency, reliability, safety, and sustainability of the public road transport system.

It is important to recognize that the challenges faced by public road transport are complex and multifaceted. Therefore, continuous research, monitoring, and evaluation of policies and interventions are necessary to address emerging issues and adapt to changing needs.

By addressing the challenges, implementing innovative solutions, and adopting appropriate policies, India can achieve a more efficient, sustainable, and inclusive public road transport system that enhances connectivity, promotes economic growth, and improves the overall quality of life for its citizens.

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