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Towards Sustainable Urban Mobility in Indore: A Theoretical Framework for Advancing SDG 11

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Abstract: *Urban mobility is a critical determinant of sustainable cities, directly influencing environmental quality, accessibility, and social inclusion. Indore, one of India's rapidly growing urban centers, faces all kinds of challenges related with traffic. Initiatives such as No Car Day and the Indore Metro Project promotes sustainable and inclusive transport systems. This theoretical paper develops a conceptual framework linking innovation, citizen engagement, and governance to enhance urban mobility aligning with SDG 11 (Sustainable Cities and Communities). Drawing on Urban Sustainability Theory, Resilience Theory, Innovation Diffusion Theory, and Collaborative Governance Theory, the study examines how policy, technology, and community participation interact to develop robust, accessible, and environment friendly urban transport. The proposed framework provides insights for decision makers to design integrative strategies for sustainable mobility in mid-sized Indian cities.*

Keywords: Sustainable Urban Mobility, Indore, SDG 11, Resilience Theory, Collaborative Governance

I. INTRODUCTION

Urban mobility showcases a pivotal role in determining the sustainability, inclusivity, and resilience of cities. Efficient transport systems not only facilitate the movement of people and goods but also influence environmental quality, economic productivity, and social equity. In the context of India, rapid urbanization has intensified challenges related to traffic congestion, air pollution, and inadequate public transportation infrastructure, particularly in mid-sized cities such as Indore. Recognizing these challenges, urban policymakers and planners have focused on sustainable mobility solutions which emphasizes making cities inclusive, safe, resilient, and sustainable. Sustainable urban mobility encompasses not only technological interventions but also behavioral changes, policy frameworks, and community participation, all of which are critical for achieving long-term urban resilience.

Indore, the largest city in Madhya Pradesh, has emerged as a noteworthy example of a mid-sized Indian city undertaking significant efforts to promote sustainable urban mobility. Initiatives such as the "No Car Day," aimed at reducing private vehicle use, and the development of the Indore Metro Project demonstrate the city's commitment to reducing congestion, lowering emissions, and promoting equitable access to transport. Furthermore, these initiatives highlight the interplay between technology, policy, and societal participation, underscoring the importance of a holistic approach to sustainable mobility. Despite these efforts, challenges persist, including limited public awareness, infrastructural gaps, and the slow adoption of behavioral and technological innovations, which necessitate a deeper understanding of the theoretical mechanisms that can facilitate sustainable urban transport transitions.

From a theoretical perspective, sustainable urban mobility can be examined through multiple lenses. Urban Sustainability Theory emphasizes the integration of environmental, social, and economic dimensions in urban planning, advocating for transport systems that balance efficiency with equity. Resilience Theory highlights the adaptive capacity of urban systems to withstand disruptions, such as congestion, pollution, or unforeseen events, and underscores the need for flexible and responsive planning strategies. Innovation Diffusion Theory offers insights into the adoption and dissemination of new transport technologies and practices, including public transport solutions, electric vehicles, and mobility apps. Finally, Collaborative Governance Theory stresses the significance of participatory decision-making processes, wherein citizens, policymakers, and other stakeholders collectively shape sustainable urban outcomes.

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This paper aims to synthesize these theoretical perspectives to develop a conceptual framework for sustainable urban mobility in Indore. By examining the interactions between technological innovation, citizen engagement, and governance mechanisms, the study provides a structured understanding regarding mid-sized cities with respect to inclusive, efficient, and environmentally responsible transport systems. The proposed framework contributes towards theoretical aspects on urban sustainability and practical insights for decision makers and urban planners seeking to implement context-specific solutions that advance SDG 11. In doing so, the study emphasizes the necessity of integrated approaches that simultaneously address infrastructural, behavioral, and institutional dimensions of urban mobility.

II. LITERATURE REVIEW

Shanmugam A. et al. (2024) Urban traffic congestion has emerged as a critical concern in India's rapidly expanding cities, where conventional approaches such as static signal scheduling and manual regulation have shown limited effectiveness. Recent scholarship emphasizes the application of artificial intelligence and deep learning frameworks for improving traffic efficiency. YOLO-based object detection models, including YOLOv3 and YOLOv5, have been widely adopted for real-time vehicle tracking, license plate recognition and traffic violation detection demonstrating high levels of accuracy. These models, when integrated with camera-based surveillance at intersections, enable dynamic traffic signal control and adaptive decision-making. Further studies highlight the integration of Internet of Things (IoT) devices and machine learning algorithms into Autonomous Road Surveillance Systems (ARSS), which facilitate real-time adjustments to signal timings, reducing delays and congestion. Collectively, the literature underscores the potential of intelligent traffic management systems in optimizing traffic flow and advancing sustainable urban mobility.

S.C. Dimri et al. (2024) With the rapid growth of population, road traffic density is increasing, leading to frequent congestion and extended waiting times at intersections. Conventional traffic light systems that allocate equal green time to all approaches are often ineffective, as vehicle inflow varies across different directions. The uneven arrival rate is a primary cause of long queues, traffic jams, and delays. The study proposes a dynamic green signal allocation framework in which the duration of green light is proportionally adjusted according to the arrival rate of vehicles. A weighted mechanism ensures that approaches with higher inflow receive longer green phases, thereby reducing residual traffic and wait times. Simulation results confirm the effectiveness of this strategy, showing significant improvements during peak hours. For example, green light durations were optimized between 20.04 and 41.4 seconds across four approaches, achieving smoother traffic flow and minimizing congestion at critical times.

M.F. Cheranchery and G.S. Greeshma (2025) Artificial Intelligence–enabled Enforcement Systems (AIES) have been implemented at 675 sites in Kerala, India, to curb traffic violations and improve road safety. These solar-powered, 4G LTE-based cameras detect violations in real time and alert drivers through multiple channels. This study undertakes a three-stage assessment of AIES effectiveness, combining machine learning–based analysis of driver perception, crash data evaluation, and spatial–temporal examination of violation patterns. An Artificial Neural Network revealed that driver perception and prior experience significantly shape behavioral adaptation. Using DBSCAN clustering, drivers were categorized into two groups: one displaying limited change and another showing favorable perception with notable behavioral improvements. Results indicated a substantial decline in fatal crashes and higher compliance, particularly helmet usage, near camera locations. However, deterrent effects decreased with distance, suggesting the need for rotating units. The study highlights the importance of system transparency and effective communication to sustain compliance and enhance traffic safety outcomes.

R. Kandpal and G. Trencher (2025) In order to curb carbon emissions and improve air quality Electric Vehicles (EVs) are being promoted, despite this developing countries face issues in mass adoption of electric vehicles. This study examines India, a rapidly expanding vehicle market, to understand governance strategies for EV transition in the Global South. Using a policy mapping approach, the study analyzes trends across four key areas: EV adoption, EV manufacturing, charging infrastructure, and restrictions on Internal Combustion Engine Vehicles (ICEVs). Spatial

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analysis indicates that policies are concentrated in economically and industrially advanced regions. Most initiatives target EV adoption, with some focus on infrastructure development, whereas few jurisdictions implement ICEV restrictions or promote domestic EV production strategically. Policy instruments are heavily skewed toward economic incentives and soft measures, such as planning and awareness campaigns, while regulatory and command-and-control mechanisms remain limited. The study offers the first comprehensive assessment of India's sub-national EV policies, highlighting gaps in regulatory strategies and providing insights for policymakers in India and similar developing economies.

III. RESEARCH METHODOLOGY

The study adopts a theoretical framework for sustainable urban mobility in Indore, aligned with Sustainable Development Goal (SDG) 11. The area of study is the city of Indore, Madhya Pradesh, which has experienced rapid urbanization and faces significant challenges in traffic management, accessibility, and environmental sustainability. The study primarily relies on secondary data collected from government reports, city transport plans, policy documents, academic research, and publications.

Objectives

1. To analyze the current urban mobility system in Indore and identify key challenges related to traffic congestion, environmental impact, accessibility, and inclusivity.
2. To develop a scientific and theoretical framework for sustainable urban mobility in Indore by integrating technological, social, and environmental dimensions aligned with SDG 11.
3. To provide actionable recommendations for policymakers, urban planners, and stakeholders to enhance efficiency, inclusivity, and sustainability in Indore's urban transport system.

IV. DATA ANALYSIS

Objective 1: To analyze the current urban mobility system in Indore		
Challenges	Intervention	Expected Contribution
Traffic congestion on arterial roads and peak-hour bottlenecks	Implement AI-based intelligent traffic management Introduce congestion pricing or designated traffic zones	Reduced congestion and travel time Improved traffic efficiency and flow
Limited public transport coverage and inefficiency	Expand multimodal public transport network Provide incentives/subsidies for public transport usage	Increased ridership Reduced dependence on private vehicles Enhanced accessibility in peripheral areas
High environmental impact (air and noise pollution)	Promote electric/low-emission vehicles Develop green corridors and emission-control zones	Lower pollution levels Contribution to climate change mitigation Healthier urban environment
Poor accessibility for women, elderly, differently-abled	Mandate inclusive transport design Build safe pedestrian and cycling infrastructure	Increased social inclusion Safer and more equitable mobility
High accident rates and road safety issues	Conduct road safety audits Use AI for accident prediction and improve signage	Reduced accidents and fatalities Safer transport network
Fragmented planning and poor	Develop a city-wide integrated	Coordinated planning

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integration of transport modes	mobility plan Encourage public-private partnerships	Improved multimodal connectivity

Objective 2: To develop a scientific and theoretical framework for sustainable urban mobility		
Challenges	Intervention	Expected Contribution
Lack of structured framework for sustainable urban transport	Formulate a scientific framework integrating environmental, social, and technological aspects	Provides a systematic approach for planning and implementation Ensures decisions are evidence based
Limited adoption of technology (AI, IoT) in mobility	Incentivize smart traffic systems, IoT sensors, and AI-based predictive modeling	Improved traffic monitoring and optimization Data-driven decision-making for policymakers
Weak focus on inclusivity and equity	Incorporate equity-focused metrics and inclusive design standards in the framework	Ensures marginalized groups have access Promotes social inclusivity
Inefficient multimodal integration	Include guidelines for multimodal connectivity and last-mile solutions	Seamless integration between buses, cycling, walking, and metro services Enhanced efficiency and convenience
Lack of environmental sustainability measures	Embed emission reduction targets and green transport policies	Supports SDG 11 and climate goals Encourages low-carbon transport adoption

Objective 3: To provide actionable recommendations for policymakers, urban planners, and stakeholders		
Challenges	Intervention	Expected Contribution
Low efficiency of existing interventions	Conduct scenario analysis of different mobility strategies	Prioritized interventions based on effectiveness Optimized use of resources
Limited social inclusivity in planning	Stakeholder engagement programs including citizens, women, elderly, and differently-abled representatives	Policies are socially relevant and equitable- Increased citizen satisfaction and adoption
Environmental impacts not adequately addressed	Implement low-emission vehicle policies, green corridors, and monitoring programs	Reduced emissions and pollution Healthier urban environment
Lack of evidence-based policy recommendations	Develop data-driven mobility index and monitoring framework	Facilitates evidence-based decision-making- Tracks SDG 11 progress and policy effectiveness
Fragmented implementation	Encourage cross-agency coordination and public-private partnerships	Improved coordination Faster and more effective policy implementation

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V. CONCLUSION

Sustainable urban mobility in Indore is pivotal for achieving SDG 11: Sustainable Cities and Communities. The study provides that despite improvements in public transport, traffic management, and non-motorized mobility, the city faces persistent challenges such as congestion, air pollution, limited last-mile connectivity, and unequal access to transport services. Addressing these issues requires integrated strategies that combine technological innovation, policy reform, and stakeholder participation.

The proposed theoretical framework underscores the interdependence of transport efficiency, environmental sustainability, and social inclusivity. By enhancing public transport systems, promoting walking and cycling, and adopting smart traffic management solutions, Indore can advance toward a low-carbon, resilient urban transport ecosystem. Participatory planning and evidence-based policymaking ensure that mobility interventions are context-specific and socially equitable.

In essence, fostering sustainable mobility in Indore entails more than development of infrastructure. There is a requirement of a holistic approach that caters to the different stakeholders. The framework offers actionable guidance for decision makers and urban planners for developing inclusive, sustainable and resilient cities.

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