Circular Economy Integration in Urban Transport Planning: A Case Study of Kochi, India

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Abstract — Rapid urbanisation and rising transport-sector emissions have intensified the search for sustainable urban mobility solutions. The Circular Economy (CE) offers a regenerative alternative to linear transport planning by promoting resource efficiency, material reuse, electrification, and multimodal integration. This paper examines how CE principles can be embedded in urban transport planning, with Kochi, Kerala, as the primary case study. Drawing on a systematic literature review, analysis of national and state policies, three international case studies (Amsterdam, Norway's GoGreen Project, and Zurich), and a primary user survey across three mobility zones in Kochi (Vyttila, Kakkanad, and Fort Kochi), the study evaluates the extent of CE integration in existing transport infrastructure. Findings indicate that CE-aligned strategies such as multimodal integration, electric mobility adoption, shared transport systems, and waterway-based commuting are already demonstrating measurable positive outcomes in Kochi's mobility landscape. However, significant gaps persist in material recovery systems, non-motorised transport (NMT) infrastructure, last-mile connectivity, and circular procurement. The paper proposes targeted recommendations for strengthening CE-integrated transport planning in medium-sized Indian cities, contributing to the broader discourse on sustainable urban mobility in the Global South.

Keywords: Circular Economy, Urban Transport Planning, Sustainable Mobility, Multimodal Integration, Electric Mobility, Resource Efficiency, Kochi

I. Introduction

Rapid urbanisation and expanding mobility demands are placing unprecedented pressure on urban transport systems worldwide. Transportation networks, while essential for economic growth and social interaction, are among the most energy- and resource-intensive components of urban infrastructure. Globally, the transport sector contributes approximately 20-25% of total CO_2 emissions, with road transport alone accounting for nearly three-quarters of this share [1]. In developing countries such as India, urban mobility challenges are further compounded by rising private vehicle ownership, inadequate public infrastructure, and limited institutional capacity for sustainable planning.

The Circular Economy (CE) presents a compelling alternative to the prevailing linear "take–make–dispose" model. CE promotes closed-loop systems that emphasise resource efficiency, asset durability, material reuse, and lifecycle-based planning [2]. Applied to urban transport, CE principles can transform how mobility systems are designed, operated, and renewed. CE-based strategies including multimodal integration, shared mobility, electric vehicle (EV) adoption, recycled material use in infrastructure, and waterway-based logistics offer pathways toward significant reductions in emissions, resource consumption, and long-term infrastructure costs [3].

Despite growing international interest in CE, its integration into urban transport policy and planning remains limited, particularly in Indian cities. Challenges include governance fragmentation, weak lifecycle assessment standards, and procurement systems that prioritise cost over sustainability [4]. This study addresses this gap by examining how CE principles can be systematically integrated into urban transport planning, using Kochi, Kerala as a representative case of a mid-sized Indian city with emerging multimodal infrastructure.

Kochi is uniquely positioned for this analysis. The city hosts the Kochi Metro Rail, the Kochi Water Metro (India's first integrated water-based mass transit system), electric feeder bus services, and a growing EV-charging network. Its designation under the Smart Cities Mission further underscores its institutional readiness for CE-aligned mobility planning. Three distinct mobility zones-Vyttila, Kakkanad, and Fort Kochi, were selected for site-level analysis.

II. Background

A. *The Circular Economy in Transport*

The Circular Economy is a regenerative economic model that replaces linear consumption with systems designed to keep materials and infrastructure in productive use for as long as possible [2]. CE strategies in transport encompass: (i) reuse and recycling of construction and demolition waste; (ii) adoption of Reclaimed Asphalt Pavement (RAP) and recycled aggregates; (iii) electrification of vehicle fleets powered by renewable energy; (iv) multimodal integration to maximise asset utilisation; and (v) shared mobility models that reduce per-capita resource demand [5].

The CE "10Rs" framework operationalises these strategies across three tiers: design-phase strategies (Refuse, Rethink, Reduce); use-phase strategies (Reuse, Repair, Refurbish, Remanufacture, Repurpose); and end-of-life strategies (Recycle, Recover). Applied to transport infrastructure, these tiers support systems that minimise virgin material extraction, reduce embodied carbon, and extend infrastructure lifespans [6].

B. *Circular Economy Principles in Urban Mobility*

Literature identifies four intersecting dimensions of CE in urban transport planning. First, material circularity in road construction involves the use of RAP, plastic-modified bitumen, and recycled steel, reducing dependence on virgin resources and lowering embodied carbon in pavements [7]. Second, electrification and renewable energy integration reduces operational emissions and supports energy loop closure through renewable-powered charging infrastructure

[3]. Third, multimodal integration enhances system-level resource efficiency by increasing passenger throughput per unit of infrastructure investment [8]. Fourth, shared and low-carbon mobility reduces total vehicle production demand, parking land use, and infrastructure wear, maximising asset utilisation consistent with CE goals [9].

III. RESEARCH QUESTIONS

This study addresses two primary research questions: (i) How can Circular Economy principles be integrated into urban transport planning to enhance efficiency, sustainability, and resilience of infrastructure systems? (ii) What CE-aligned strategies and policy interventions are most applicable to mid-sized Indian cities?

IV. AIM AND OBJECTIVES

The aim of the study is to assess how the integration of CE principles in urban transport planning enhances the efficiency, sustainability, and resilience of transport infrastructure systems.

The main objectives are to: (i) examine CE principles for enhancing resource efficiency in urban transport; (ii) review national and state-level policies for CE integration opportunities; (iii) identify enabling factors and barriers for CE adoption; and (iv) evaluate CE-aligned practices in Kochi's mobility zones and derive recommendations.

V. LITERATURE REVIEW

A. *Material Circularity and Road Infrastructure*

Morseletto [2] demonstrates that current CE targets are predominantly focused on recycling and recovery, while broader strategies such as repair, reuse, and reduction remain underutilised in transport policy. Pasetto et al. [7] show that Recycled Asphalt Shingles (RAS) can replace up to 20% of asphalt binder in pavement construction, reducing virgin material demand and landfill disposal while supporting closed material loops.

Piñones et al. [10] developed the CIROAD evaluation model, finding that road infrastructure projects achieved circularity scores of only 21–28%, indicating significant scope for improvement through design-for-environment strategies. Bherwani et al. [11] identified construction and transport as the highest contributors to carbon and material footprints in Indian cities, underscoring the urgency of CE interventions. Serrano et al. [6] confirmed that CE strategies can substantially reduce emissions in developing countries by redirecting material flows from primary extraction to secondary use.

B. *Multimodal Integration and Shared Mobility*

Zhou et al. [8] applied an activity-based transport model to the Rotterdam–The Hague region and found that combined strategies involving Mobility-as-a-Service (MaaS), parking restrictions, and mobility hubs reduced private car use and improved multimodal balance. Lower vehicle-kilometres travelled deferred infrastructure expansion and reduced per-capita material demand, supporting system-level circularity.

Salles et al. [12] confirmed through Amsterdam's case that CE urban strategies foster economic growth, social equity, and environmental protection, while also noting persistent barriers in stakeholder coordination. La Cagnina et al. [3] demonstrated that carbon-footprint metrics applied to intermodal freight systems reveal pathways toward decarbonisation through modal shift. Eelager et al. [13] established that CE contributes to sustainable development by reducing waste and conserving resources when integrated into infrastructure planning at early design stages.

C. *Inference from Literature*

The literature consistently establishes that shifting from infrastructure expansion to optimisation of existing systems yields measurable savings in costs, materials, and emissions. Effective CE integration in transport requires monitoring of resource consumption, material recovery, and lifecycle emissions. Institutional alignment and circular procurement mechanisms are essential to operationalise CE within municipal governance frameworks.

VI. INTERNATIONAL CASE STUDIES

Three international cases were selected to illustrate CE application in transport planning across different scales and geographies: Amsterdam (system-level CE mobility strategy), Norway's GoGreen Project (construction-phase material circularity), and Zurich (shared mobility and modal integration).

A. *Amsterdam: Circular Strategy and Zero-Emission Mobility*

Amsterdam's Circular Strategy 2020–2025 targets a 50% reduction in new material use by 2030 and full circularity by 2050 [14]. Key transport measures include: (i) Zero-Emission Zones (ZEZ) covering areas within the A10 ring road, limiting access to EVs and low-emission vehicles from 2025, with projected reductions of 97% NOx, 44% PM2.5, and 95% CO_2 by 2028; (ii) a cycling network exceeding 500 km, with 56% of residents commuting by bicycle; (iii) 12,197 public EV charging stations ranking the city first in Europe; and (iv) waterborne logistics using electric barges to replace truck-based freight, reducing road wear and emissions. Circular procurement policies target 50% circular procurement by 2025 and 100% by 2030.

B. *Norway GoGreen Project: Circular Road Construction*

The GoGreen project, part of the Betna–Hestnes highway reconstruction in Norway, demonstrated near-complete material circularity in road demolition and reconstruction [15]. Unlike typical projects with material recovery rates below 40%, GoGreen achieved 100% sorting of demolition waste through on-site planning and logistics. Materials recovered included metals (remelted for reinforcing steel), timber (converted to boards and chips), plastics and tyres (recycled into rubber granulate), and reclaimed asphalt (reintegrated into new pavement layers). The net global warming potential benefit was −88.9 tonnes of CO_2-equivalents, demonstrating that lifecycle-based construction significantly reduces embodied carbon and virgin material extraction.

C. Zurich: Integrated Multimodal Transport

Zurich's transport model achieves 65% public transport use among daily commuters, with private car use at only 17% [16]. The city's Mobility Cooperative operates one of the world's largest car-sharing networks, with each shared vehicle replacing approximately 18 private cars and freeing approximately 8,000 parking spaces for green or pedestrian use. Active mobility redesign raised cycling's modal share from 5% to 13% and walking to 33%, saving approximately 11,000 tonnes CO_2 annually. Electrified mobility supported by renewable energy closes the energy loop, aligning with CE principles of resource optimisation.

D. Comparative Inference

Across the three case studies, common CE enablers in transport include clear policy frameworks with measurable circularity targets; circular procurement requirements embedded in public contracts; infrastructure designed for durability and material recovery; multimodal integration that maximises asset utilisation; and electrification supported by renewable energy. These factors inform the assessment and recommendations for Kochi's transport system.

VII. POLICY FRAMEWORKS FOR CE-ALIGNED TRANSPORT

A. National-Level Policies

The National Urban Transport Policy (NUTP, 2014) prioritises public transport, NMT, multimodal integration, and demand management—consistent with CE principles of efficient resource use over road expansion. The FAME I and FAME II schemes incentivise electric bus adoption, EV charging infrastructure, and battery recycling. The Smart Cities Mission promotes walkable cities and transit-oriented development (TOD). The Vehicle Scrappage Policy (2021) recognises end-of-life vehicles as secondary material sources, promoting regulated recycling of steel, aluminium, rubber, and copper.

B. State-Level Policies

The Kerala Electric Vehicle Policy (2019) targets one million EVs by 2025, promotes shared electric mobility, public charging stations, and battery second-life applications. The Kerala State Climate Change Action Plan (SAPCC 2.0, 2023–2030) encourages modal shift to public transport and NMT, supports electric mobility across passenger and freight movement, and promotes integrated urban transport planning. Together, these frameworks provide a supportive institutional environment for CE integration, though implementation gaps remain in circular procurement and material recovery.

VIII. STUDY AREA: KOCHI CITY

A. Overview

Kochi, a major port city and commercial hub of Kerala, represents a rapidly urbanising metropolitan region characterised by diverse mobility contexts-coastal heritage areas, IT corridors, and dense urban cores. The city hosts the Kochi Metro Rail, the Kochi Water Metro (India's first integrated water-based mass transit system), electric feeder buses, and a growing EV-charging network. Kochi's designation under the Smart Cities Mission makes it an exemplary setting for evaluating CE integration in Indian urban transport. Three zones were selected based on their distinct mobility functions and CE assessment potential.

B. Zone 1: Vyttila Mobility Zone

Vyttila serves as Kochi's primary multimodal interchange, integrating metro, buses, feeder services, and the Water Metro. The Mobility Hub handles approximately 68,000 daily passengers, making it the city's busiest transport node [17]. Its multimodal design reduces dependence on private vehicles, lowers resource use per trip, and exemplifies CE strategies of asset utilisation and modal shift. Vyttila demonstrates how existing infrastructure can be optimised rather than expanded, aligning with CE principles of system circularity.

C. Zone 2: Kakkanad Zone

Kakkanad is Kochi's major IT-industrial corridor, encompassing Infopark, the Kakkanad CBD, and Smart City, with high daily commuter flows. Electric feeder buses connecting the Kakkanad Water Metro terminal to Infopark represent a significant CE intervention by shifting commuters from fossil-fuel private vehicles to electric public transport. Kochi has over 150 public EV charging stations, with high-density clusters along the Kakkanad IT corridor [18]. Ernakulam district recorded higher EV registrations than diesel vehicle registrations by 2024 [19].

D. Zone 3: Fort Kochi

Fort Kochi is a heritage-tourism waterfront district characterised by narrow historic streets, significant pedestrian activity, and strong reliance on ferry-based mobility. The Kochi Water Metro connects Fort Kochi to the mainland via the High Court–Fort Kochi route, reducing travel time from over one hour by road to 19 minutes [20]. The electric ferry fleet closes the energy loop by avoiding fossil fuel dependence, and pedestrian-oriented planning reduces material demand from motorised infrastructure.

IX. METHODOLOGY

The study adopted a qualitative and descriptive mixed-methods approach comprising four parallel tracks. First, a systematic literature review synthesised findings on CE strategies in transport from peer-reviewed journals (2020–2025). Second, a policy analysis reviewed national and state-level transport frameworks to identify CE integration opportunities. Third, comparative case studies of Amsterdam, Norway, and Zurich established international benchmarks. Fourth, primary data were collected through a structured survey administered across the three study zones capturing mobility behaviour, mode preferences, user perceptions of efficiency, affordability, environmental quality, and barriers to public transport adoption. Secondary data included KMRL ridership reports, district EV registration statistics, Water Metro project documents, and Smart City proposals.

X. RESULTS AND ANALYSIS

A. Primary Survey Findings: Mobility Behaviour

Survey responses across the three zones reveal distinct mobility patterns reflecting differing CE performance levels.

Kakkanad displays a relatively higher dependence on private vehicles, attributable to weak last-mile connectivity between the Water Metro terminal and dispersed employment nodes within the IT corridor. Vyttila shows a balanced modal mix with significant metro and public bus usage, reflecting the CE benefit of multimodal hub design in reducing private vehicle reliance. Fort Kochi demonstrates the highest NMT and public transport dependence, consistent with its pedestrian-oriented street fabric and ferry connectivity, indicating progress toward a low-carbon, resource-minimising mobility transition.

B. *Transport Efficiency and Affordability Perceptions*

The metro and Water Metro were consistently rated as the most efficient transport options across all three zones. EVs and feeder services received moderate efficiency ratings. Metro and Water Metro fares were perceived as accessible by respondents in all zones. Kakkanad respondents reported the highest acceptance of EVs and feeder services as affordable options, suggesting greater receptivity to new low-carbon mobility in employment corridors. Fort Kochi respondents reported mixed affordability perceptions for EVs and feeder services due to limited local availability, highlighting an infrastructure gap requiring attention.

C. *Environmental Quality and Circular Behaviour Perceptions*

Metro, EVs, and Water Metro were rated highest across all zones for their contribution to environmental quality improvement, particularly through the reduction of air and noise pollution. Respondents broadly recognised that shared and electric transport modes reduce energy use and resource consumption, demonstrating awareness of CE values in mobility. The use of renewable energy in transport and improved multimodal integration were identified as key factors in lowering fossil fuel dependence, providing a social foundation for CE integration in Kochi's transport planning.

D. *Barriers to Public Transport Adoption*

The primary barriers to shifting from private vehicles to public transport across all zones were preference for convenience and flexibility, inadequate last-mile access, lack of comfort, and safety and hygiene concerns. Kakkanad exhibited the highest private vehicle dependence driven by poor pedestrian connectivity between the Water Metro terminal and workplace destinations. These findings establish that CE effectiveness in Kochi's transport system is constrained by insufficient feeder connectivity, NMT provisions, and walkability rather than lack of modal infrastructure.

XI. Indicators of CE performance in Kochi

Several measurable indicators reflect the CE performance of Kochi's evolving mobility system. The Kochi Water Metro reached approximately 9,000 daily riders in its first operational month [19], demonstrating modal shift from road to electric waterway transport. Metro ridership on the Vyttila–Kakkanad-Infopark route increased by approximately 10% following the introduction of electric feeder buses [21]. The Water Metro reduces Fort Kochi–mainland travel time from over 60 minutes by road to 19 minutes, encouraging commuters to shift to cleaner transit [20]. Water Metro project documents estimate lifecycle CO_2 reductions of approximately 44,000 tonnes annually once fully operational [20]. EV registrations in Ernakulam district increased from 0.1% of total vehicles in 2019 to approximately 6.7% in 2022, with diesel registrations surpassed by EVs in 2024 [19]. Fort Kochi's pedestrian and ferry-based mobility patterns minimise new road construction, reducing associated material extraction consistent with CE regenerative mobility principles.

XII. Recommendations

A. *Strengthen Multimodal Integration and Last-Mile Connectivity*

Kochi's CE outcomes are constrained by weak last-mile connectivity, particularly in Kakkanad. Targeted interventions include: expanding electric feeder bus coverage across high-demand commuter corridors; establishing Multimodal Mobility Hubs with unified ticketing, real-time transit information, cycle parking, and EV charging at key nodes; and deploying first/last-mile solutions such as e-rickshaw stands, shared bicycles, and dedicated pedestrian routes within 500 m of all major metro and Water Metro stations.

B. *Implement Circular Procurement and Material Recovery*

Circular procurement mechanisms should be embedded in Kochi's public works contracting for transport infrastructure. Road maintenance projects should mandate the use of Reclaimed Asphalt Pavement (RAP), recycled aggregates, and plastic-modified bitumen as standard materials, modelled on Amsterdam's Circular Procurement Tool and Norway's GoGreen material loop approach. Local material recovery centres for construction and demolition waste should be established in coordination with public works departments.

C. *Enhance Renewable Energy Integration in Electric Mobility*

EV charging infrastructure should be expanded at all major transit nodes, integrated with rooftop solar installations at metro stations and Water Metro terminals to enable renewable-powered energy loops. Incentive structures for EV adoption including subsidised charging tariffs for public transport fleet operators should be introduced consistent with the Kerala EV Policy (2019). Battery second-life programmes should be developed in partnership with EV manufacturers to close the material loop for spent transit batteries.

D. *Expand NMT Infrastructure and Walkability*

Complete Streets design principles should be applied along major transit corridors, incorporating minimum 1.5 m footpaths, protected cycle lanes, shaded pedestrian zones, and safe crossings. Fort Kochi's planned 800 m NMT zone should be expanded across the heritage district, and Kakkanad's Water Metro terminal should be connected to Infopark via a dedicated pedestrian-priority walkway to address the zone's persistent private vehicle dependence.

E. Develop Institutional Frameworks for CE in Transport

A dedicated CE in Transport task force should be established under KMRL and the Kochi Smart City Mission to coordinate circular procurement, lifecycle assessments, and material recovery across transport projects. Public awareness programmes on CE benefits in mobility, including shared transport, EV adoption, and material recycling, should be integrated into city-level sustainability communication strategies.

XIII. Discussion

The findings from Kochi present a pattern consistent with CE challenges documented in rapidly urbanising cities globally. Kochi's multimodal transport backbone-Metro, Water Metro, and electric feeder buses-provides a strong foundation for CE-aligned mobility that many Indian cities lack. The city's performance on indicators of shared transport adoption, EV penetration, and travel time efficiency demonstrates that CE principles are producing measurable outcomes even in the absence of an explicit CE policy framework for transport.

However, the study reveals that CE effectiveness is constrained by operational and spatial gaps rather than structural infrastructure deficits. The Kakkanad zone's persistent private vehicle dependence despite the Water Metro's presence illustrates that modal infrastructure alone is insufficient; feeder connectivity, walkability, and integrated ticketing are essential complements. This aligns with international evidence from Amsterdam and Zurich, where CE gains were achieved through system-level optimisation rather than infrastructure expansion.

Comparing Kochi with the international cases, the city's trajectory most resembles Amsterdam's early-stage CE integration: significant multimodal assets are in place, but circular procurement, material recovery systems, and comprehensive NMT networks remain underdeveloped. The GoGreen project's success also signals an underexploited opportunity for Indian cities: road reconstruction projects can achieve near-complete material circularity through on-site sorting and planning. Study limitations include the qualitative nature of the primary survey and the absence of quantified material flow and lifecycle carbon accounting data.

XIV. Conclusions

This study demonstrates that integrating Circular Economy principles into urban transport planning offers a viable pathway toward sustainable, resource-efficient, and resilient mobility systems. The analysis of Kochi's transport network confirms that CE-aligned practices are already producing measurable reductions in emissions, private vehicle dependency, and resource consumption. International case studies from Amsterdam, Zurich, and Norway establish that CE integration in transport requires coordinated action across policy, procurement, infrastructure design, and user behaviour.

Kochi's strengths in multimodal infrastructure and growing EV adoption provide a strong foundation, but gaps in material recovery, last-mile connectivity, and NMT infrastructure must be addressed to achieve systemic circularity. The study contributes to the evidence base on CE in urban transport in the Global South and offers a replicable analytical framework for other mid-sized Indian cities with emerging metro or multimodal systems. Applying CE principles in transport planning can enable Indian cities to simultaneously meet climate commitments, reduce infrastructure costs, and transition to more equitable and liveable mobility systems.

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References

[1] International Energy Agency, "Transport," IEA, Paris, 2023. https://www.iea.org/energy-system/transport
[2] P. Morseletto, "Targets for a circular economy," Resources, Conservation and Recycling, vol. 153, 2020.
[3] L. La Cagnina, D. Di Giacomo Marotta, F. Mertoli, A. Matarazzo, and M. Di Martino, "The carbon footprint applied to the transport sector as an instrument of transition to the circular economy," Procedia Environmental Science, Engineering and Management, pp. 95–104, 2020.
[4] R. Rajayya et al., "Circular economy integration in urban transport: barriers and policy frameworks," Sustainable Transport Policy Review, 2025.
[5] A. Salles, C. Cervantes, and L. Bragança, "Assessing the impacts of urban circular economy practices on economic growth, environmental sustainability, and social benefits," in Coordinating Engineering for Sustainability and Resilience, pp. 482–490, 2024.
[6] T. Serrano, S. Aparcana, F. Bakhtiari, and A. Laurent, "Contribution of circular economy strategies to climate change mitigation: generic assessment methodology with focus on developing countries," Resources, Conservation and Recycling, vol. 25, no. 6, 2021.
[7] M. Pasetto, S. Haider, and E. Pasquini, "Circular economy for transport infrastructure: an overview of the sustainable use of recycled asphalt shingles in asphalt mixtures," Applied Sciences, vol. 14, no. 22, 2024.
[8] H. Zhou, J. L. Dorsman, M. Mandjes, and M. Snelder, "Sustainable mobility strategies and their impact: a case study using a multimodal activity-based model," Case Studies on Transport Policy, vol. 11, 2023.
[9] I. D. Gurusinghe et al., "Practical considerations of circular economy strategies in the residential sector in Australia using the ReSOLVE Framework," Building and Environment, vol. 282, 2025.
[10] P. Piñones, I. Derpich, and R. Venegas, "Circular economy 4.0 evaluation model for urban road infrastructure projects (CIROAD)," Sustainability, vol. 15, no. 4, 2023.
[11] H. Bherwani, M. Nair, A. Niwalkar, R. Balachandran, and A. Kumar, "Application of circular economy framework for reducing the impacts of climate change: a case study from India," Energy Nexus, vol. 5, 2022.

[12] A. Salles et al., 2024. See [5].
[13] M. P. Eelager, M. Madar, N. P. Dalbanjan et al., "Pathways to a sustainable future: exploring the synergy between sustainability and circular economy," Sustainable Futures, p. 101208, 2025.
[14] Gemeente Amsterdam, "Circular Economy Policy," City of Amsterdam, 2020–2023. [Online]. Available: https://www.amsterdam.nl/en/policy/sustainability/circular-economy/
[15] K. Vetnes, "GoGreen project: circular economy in road construction, Norway," Norwegian Road Authority Report, 2025.
[16] ZVV, "Annual Report on Public Transport Performance, Zurich," Zurich Transport Network, 2022.
[17] Kochi Metro Rail Ltd. (KMRL), "Ridership and Mobility Hub Data," KMRL Official Reports, 2024.
[18] Solarmaster, "Kochi EV charging infrastructure report," 2025.
[19] The Times of India, "Registrations: EVs zoom past diesel vehicles in district," July 4, 2023.
[20] Kochi Water Metro Project, "Environmental and Operational Impact Assessment," Kochi Metro Rail Ltd., 2025.
[21] The Hindu, "Metro ridership rises with feeder bus integration in Kochi," 2025.

