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# Beyond Traditional Traffic Solutions: Exploring the Feasibility and Impact of E-Micromobility Adoption on the AMU Campus, Aligarh

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**Abstract -** *Short-distance mobility problems have gotten worse due to rapid urbanisation and an increasing reliance on private motorised vehicles, particularly on big, crowded, and regulated university campuses. Congestion, parking pressure, safety issues, and ineffective use of internal circulation routes for quick and frequent journeys are common in these settings. In this regard, e-mobility choices like e-bikes and e-scooters are becoming more widely acknowledged as viable, low emission, and compact options for short-distance transport. By looking at a few national and international case studies, this paper investigates the viability and possible effects of implementing e-micromobility within institutional precincts. It focusses on important aspects such user acceptability, governance procedures, infrastructure needs, operational models, implementation methods, and safety management. The study finds crucial success factors, obstacles, and context-specific limitations by examining how various organisations have planned, controlled, and integrated e-micromobility into their internal transportation systems. Building on this comparative analysis, the study suggests a methodology for evaluating and implementing e-micromobility in comparable institutional contexts. The framework is meant to assist planners, campus administrators, and legislators in methodically evaluating demand, creating suitable infrastructure and rules, and coordinating e-micromobility projects with more general sustainability, accessibility, and climate objectives. The study's ultimate goal is to facilitate the shift from traditional, motorised short-trip patterns to safer, more effective, and cleaner campus mobility solutions.*

***Key Words*: *E-micro mobility, Campus-scale mobility, Sustainable campus, Mobility performance, Last-mile connectivity.***

## 1. INTRODUCTION

The use of e-bikes, e-scooters, e-cars and e-buses as greener substitutes for traditional fuel-powered vehicles in urban transportation networks is known as "e-mobility." The desire to reduce greenhouse gas emissions, lessen air pollution, and increase urban energy efficiency is a major driving force for this shift E-micro-mobility is a subset of this larger category that focusses on small, light electric cars intended for short-distance travel, usually in urban or campus settings. These include e-bikes, e-scooters, and other small devices that are ideal for short urban trips, internal campus circulation, and first- and last-mile connection. In order to supplement public transportation and lessen reliance on private motorised cars, e-micro-mobility systems seek to provide flexible, low-emission, and space-efficient travel choices.

### 1.1 Current Indian Government Initiatives for E-Mobility

- National Electric Mobility Mission Plan (NEMMP): Launched in 2012 to promote hybrid and electric vehicles in the country.
- Faster Adoption and Manufacturing of hybrid and Electric vehicles (FAME): Phase 1: 2015-2019; Phase 2: 2019-2022
- PM Electric Drive Revolution in Innovative Vehicle Enhancement (PM E-DRIVE)
- Scheme Electric Mobility Promotion Scheme 2024 (EMPS 2024): By Ministry of Heavy Industries

## 2. Research Design

### 2.1 Aim

The aim of this research is to develop a framework for integrating e-micro mobility in the AMU campus Aligarh.

### 2.2 Objectives

1. To study the role and significance of e-micro-mobility in the urban context and to analysis the various policies, schemes, and regulatory frameworks undertaken in India for its promotion.

2. To study the spatial characteristics, circulation patterns, and campus movement behaviour in institutional environments to understand the potential for integrating e-micro mobility.

3. To examine and compare cases of E-micro mobility strategies being used worldwide

### 2.3 Need of Study:

Even at locations like campuses where they are frequently overkill, motorised cars nevertheless handle the majority of short journeys, resulting in needless traffic, safety hazards, and pollution. Although e-micromobility is promoted as a green solution, we don't completely understand how it works outside of brief testing. The majority of studies ignore the

whole picture, including the requirements for infrastructure, how people actually use it, and the regulations that make it function, particularly on institutional grounds. Planners are left in the dark, which leads to uneven or unsuccessful rollouts. To identify the true obstacles and factors that contribute to their success, a realistic, side-by-side examination of actual college programs is required.

### 2.4 Methodology

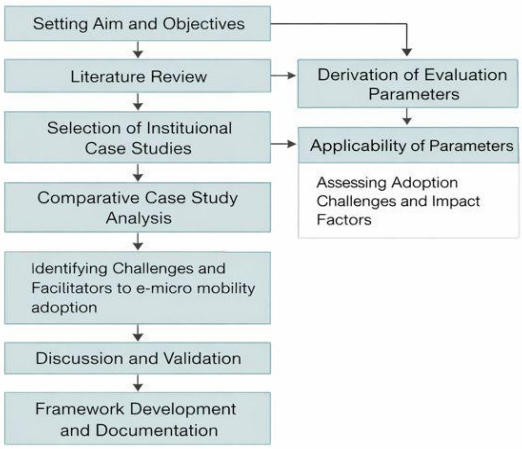


**Fig -1**: Methodology

## 3 Literature Study

**Table -1**: Literature Study

| S. No. | Title / Author(s) | Year | Summary of Study | Key Takeaway | Key Factors |
|---|---|---|---|---|---|
| 1 | S.R. & R.J. – Review on Electric Mobility | 2024 | Reviews global EV and e-mobility development | Micro-mobility still lacks focused policy support despite EV growth. | Sustainability, Policy direction |
| 2 | Javed & Nia – E-Mobility in India | 2023 | Discusses India's mobility challenges | Infrastructure and regulatory gaps are the main barriers to micro-mobility adoption. | Infrastructure gaps, Regulation |
| 3 | Ignacio et al. – Urban Micromobility Planning | 2022 | Proposes planning criteria | Well, -planned micro-mobility lanes improve safety and accessibility. | Urban design, Safety |
| 4 | Bozzi & Aguilera – Shared E-Scooters | 2021 | Reviews global usage and impacts | Sustainability benefits exist but regulatory clarity is weak. | Sustainability, Urban policy |
| 5 | Panagakos et al. – Solutions Across Continents | 2023 | Compares global user needs | User acceptance and governance quality drive adoption success. | User behavior, Governance |
| 6 | Lech & Nikonczuk – Route Optimization | 2022 | Develops routing models | Smart route planning is crucial for efficient micro-mobility operations. | Technology, Routing |
| 7 | Sengül & Mostofi – Effects on Sustainability | 2021 | Meta-analysis of 100+ studies | Micro-mobility significantly reduces emissions and improves transport efficiency. | Emission reduction |
| 8 | Public Health Scoping Review | 2023 | Social and accessibility outcomes | Micro-mobility improves accessibility and inclusion in urban areas. | Accessibility, Inclusion |
| 9 | Szakonyi – Mobility in Győr | 2024 | Medium city case | Micro-mobility replaces short car trips and supports green mobility. | Adoption behavior |
| 10 | ETRR – User Preferences Study | 2025 | Mode choice analysis | Affordability and safety strongly influence micro-mobility adoption. | Cost, Safety |
| 11 | Caltrans – Geofencing for E-Scooters | 2020 | Study on geo-controlled zones | Geofencing improves traffic discipline and safe fleet operation. | Monitoring, Safety |
| 12 | Moran – Regulation of Shared Mobility | 2021 | Governance structure review | Flexible governance frameworks enhance micro-mobility integration. | Regulation, Land-use |
| 13 | Patel – Integration Case (Ahmedabad) | 2019 | Urban transport integration | Micro-mobility must connect to mass transit for effective implementation. | Integration, Connectivity |
| 14 | PwC & GERMI – EV Roadmap | 2020 | Scaling EV ecosystem strategy | Policy continuity and phased expansion are essential for scalability. | Policy, Infrastructure |
| 15 | Swamy et al. – Electrification Study | 2022 | Barriers across Indian cities | Cost and charging infrastructure are the primary challenges. | Cost barriers |
| 16 | B.PAC & Uber – Bengaluru Mobility | 2020 | Sustainable city transport strategies | City-level stakeholder coordination is necessary for successful micro-mobility. | Shared mobility, Coordination |
| 17 | Harsha et al. – Transport Reforms (Bengaluru) | 2020 | Public transport improvement | Micro-mobility works best as a feeder to public transit. | Efficiency, Public transport |
| 18 | ITDP – Bhubaneswar Spotlight | 2023 | Integrated public transport review | Micro-mobility enhances last-mile access and urban inclusivity. | Inclusivity, Urban equity |
| 19 | Behavioural Research – Geofencing | 2023 | Tracking movement patterns | Data-driven monitoring improves operational reliability. | Technology, Data systems |
| 20 | Ghosh – COVID Impact (Bangalore) | 2021 | Pandemic mobility changes | Shift from shared transit to micro-mobility shows user resilience and adaptation. | Behavioural shift |

## 4 Case Studies

### 4.1 IIT Madras

One of the first sizable institutional settings in India to use e-micromobility on a wide scale is the campus of IIT Madras. It creates significant internal transit between dispersed academic buildings, dorms and research centres, which formerly relied mostly on individual two-wheelers and unofficial motorised transportation. It is around 620 acres in size. This pattern disrupted the campus's environmentally delicate ecosystem, caused traffic jams, and raised safety concerns.

The institute responded by implementing a structured e-micromobility system based on on-campus charging stations, shared e-bikes, and electric shuttle services. With GPS monitoring, speed limitations, and geofenced regions to safeguard sensitive locations, access is controlled via a mobile application. In order to promote walking, cycling, and e-mobility, the campus gradually introduced priority corridors for low-speed cars and limited traditional motorised access in specific areas. In addition to improving circumstances for bicycles and walkers, these actions have decreased the need for private two-wheelers and helped to lessen local pollution and noise. All things considered, the IIT Madras experience shows how technology-based monitoring tools, robust institutional control, and a gradual roll-out may make micromobility feasible and significant in big campus settings.

### 4.2 National University of Singapore (NUS)

An excellent global example of how e-micromobility may be included into a sizable, technologically advanced campus is the National University of Singapore (NUS). The institution is around 370 acres in size, and there is a lot of daily traffic between the teaching areas, residence halls, hospitals, and public transportation hubs. The campus's earlier reliance on diesel shuttle buses and other motorised vehicles resulted in traffic jams, increased operational expenses, and negative environmental effects.

In response, NUS implemented a multi-layered e-micromobility strategy that includes shared e-bikes, electric shuttle buses, and autonomous electric vehicle trials. A digital mobility platform that provides real-time vehicle positions, route planning, and service updates connects a network of approved bike lanes and controlled traffic zones. In addition to providing financing and clear laws, close cooperation with national transportation authorities has assisted in coordinating campus activities with citywide transportation strategies. Smoother internal circulation, safer walking and cycling environments and discernible decreases in local pollutants and fuel use are among the reported results. The NUS example demonstrates how e-mobility can be made scalable and dependable in intricate institutional settings through well-coordinated policies,

consistent infrastructure investment, and robust digital governance.

## 5. Comparative Analysis

| PARAMETER | IIT MADRAS (INDIA) | NUS – NATIONAL UNIVERSITY OF SINGAPORE (INTERNATIONAL) |
|---|---|---|
| Scale of Study | 2.5 sq. km (eco-sensitive forest campus) | 1.5 sq. km (urban-tech campus) |
| Issues | • Long walking distances (1–2 km)<br>• Wildlife-vehicle conflict (deer, blackbuck, monkeys)<br>• Shuttle timing mismatch<br>• Peak-hour congestion<br>• Limited parking space | • Long campus travel due to hilly terrain<br>• Overcrowded diesel shuttles<br>• Mixed pedestrian–vehicle zones<br>• Emission reduction targets<br>• Limited last-mile connectivity |
| Key Features | • Shared e-bikes (Yulu)<br>• 22 docking stations<br>• 11 charging hubs (solar-powered)<br>• Geofencing & speed limits (15 km/h)<br>• Mobile app + IoT tracking<br>• Micro mobility lanes (3.2 km) | • Shared e-bikes (SG Bike)<br>• 30+ docking stations<br>• Autonomous EV shuttles (NAVYA)<br>• Full EV shuttle bus fleet<br>• 14 charging hubs (8 solar-enabled)<br>• 4.5 km cycling lanes<br>• NUS NextBus App (real-time mobility) |
| Authorities Involved | • IITM Administration<br>• IITM Research Park<br>• Yulu Mobility (PPP operator) | • NUS Office of Campus Sustainability<br>• Singapore Land Transport Authority (LTA)<br>• SG Bike + ComfortDelGro + ST Engineering |
| Environmental Impact | • $CO_2$ reduction: **18–22 tons/year**<br>• Noise reduction: **58–62%**<br>• Zero wildlife disturbance | • $CO_2$ reduction: **30–35 tons/year**<br>• Noise reduction: **55–60%**<br>• Lower diesel dependence |
| Strategies | • Geofencing in wildlife zones<br>• Battery-swap operations<br>• Solar charging hubs<br>• Speed limit enforcement<br>• Demand-based redistribution | • Autonomous shuttle trials<br>• EV bus electrification<br>• Cycling network expansion<br>• Real-time mobility app ecosystem<br>• Last-mile integration with MRT stations |
| Stage of Completion | Phase-2 complete (2023); Phase-3 expansion in progress (2025 target) | Fully operational (2019–2022); Autonomous shuttle trials still expanding |
| Project Benefits | • 50–60% reduction in travel time<br>• 30–40% congestion reduction<br>• Lower shuttle dependency (-25%)<br>• Better punctuality & lower fatigue<br>• 92% positive user feedback | • 45–55% reduction in travel time<br>• 30–40% drop in shuttle load<br>• Higher safety for cyclists/pedestrians<br>• Campus-wide emission reduction<br>• 90% positive user satisfaction |

**Table -2**: Comparative Analysis

## 6. Feasibility Analysis

| PARAMETER | IIT MADRAS (INDIA) | NUS (SINGAPORE) |
|---|---|---|
| Population Density / Stats | YES | YES |
| Transportation Equity Goals | YES | YES |
| Environmental Considerations | YES | YES |
| Public Transport Integration | NO (limited internal bus integration) | YES (linked to MRT & bus network) |
| Infrastructure Development | YES (docks, lanes, chargers) | YES (cycling network, EV buses) |
| Community Engagement | YES (student surveys, feedback) | YES (user studies & pilots) |
| Alignment with Transport Plans | YES (campus mobility plan) | YES (aligned with Singapore Green Plan 2030) |
| Economic Consideration | YES (PPP lowers cost) | YES (government & PPP support) |
| Traffic Congestion | YES (congestion reduction achieved) | YES (shuttle load reduction achieved) |

**Table -3**: Feasibility Analysis

## 7. Way Forward

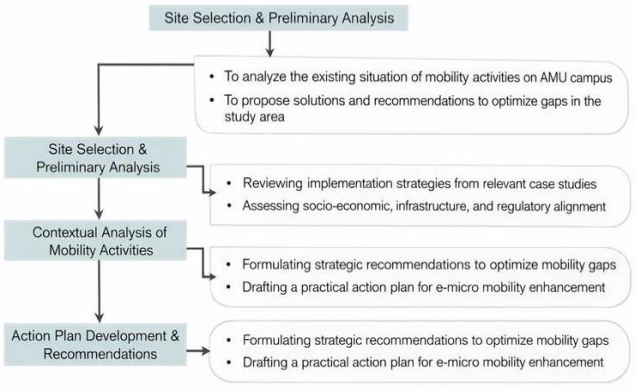


**Fig -2**: Way Forward

In order to match feasibility characteristics from case studies with the site's context and find opportunities, this research is expected to proceed with site selection and a first site investigation.

## 8. Conclusion

In conclusion, the case studies of National University of Singapore and IIT Madras expands and solidifies the broader global lessons that are coming from places like Bengaluru, Paris, Brisbane, and San Francisco. The IITM and NUS examples indicate how comparable ideas may be operationalized inside big, semi-controlled institutional campuses, whereas global urban situations illustrate how micromobility can be governed at a city scale. Collectively, these experiences demonstrate that e-micromobility works best when it is backed by transparent governance frameworks, context-specific laws, and specially designed low-speed infrastructure that protects pedestrians and users alike.

Stakeholder cooperation, data-driven operations, and flexible regulatory frameworks that can address safety concerns, public space challenges, and changing demand are common success elements that appear in all situations. Campus-level policies like speed limits, wildlife-sensitive zones, and digital mobility platforms at IITM and NUS are paralleled by city-level efforts like geofencing in Paris or coordinated operator management in Brisbane. These similarities highlight the importance of factors like trip length appropriateness, pedestrian intensity, environmental sensitivity, and infrastructure preparedness when figuring out where e-micromobility, particularly geo-fenced operations, may be deployed in a practical and responsible manner.

The feasibility study for institutional settings builds on these findings by identifying a set of assessment metrics that can help determine whether and how to geofence certain sites for the deployment of e-mobility. These include user acceptability, safety records, operational effectiveness, integration with current public transportation, and the ability of campus authorities to keep an eye on and enforce regulations. The paper presents e-micromobility as a scalable, flexible instrument for providing cleaner, safer, and more egalitarian short-distance mobility in both institutional and urban settings by coordinating campus-scale frameworks with the more general lessons from global urban experience.

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