



POLICY ADVICE PAPER: **SHARED ELECTRIC TWO-WHEELER SERVICES IN HANOI**



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ABOUT

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TITLE

Policy Advice Paper: Shared Electric Two-Wheeler Services In Hanoi

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CONTENTS

1. BACKGROUND	08
2. CURRENT STATE OF URBAN TRANSPORT IN HANOI	10
2.1. Urban Mobility Characteristic in Hanoi	10
Modal Share	10
Vehicle Fleets	10
Public Transport	11
Accessibility	12
Air Pollution and GHG Emission	12
2.2. Current State of E-mobility in Hanoi	13
Electric Vehicles	13
Local Start-Ups	14
Charging Infrastructure	14
Bike and Electric Mopeds Sharing in Hanoi	15
2.3. Urban public transport management institution in Hanoi	15
3. ASSESSING SHARED ELECTRIC TWO-WHEELERS PILOT PROJECT IN HANOI	16
3.1. Project Overview	16
Vehicle fleet	18
Infrastructure	18
Application Development	18
Operation System	18
Data collection - Operating Record/ Results	18
3.2. Policies and Administration Procedures	19
Rationale of the Pilot Activity	19
Preparation Phase	19
Operational Phase	21

3.3. Collaboration among Relevant Stakeholders	21
3.4. Establishment of Infrastructure and Related Facilities	23
Pilot Route	23
Billboards and Information	24
Parking stations	25
Charging Station	26
Vehicles	26
Application and IoT	27
Repair workshop	28
Implementing Agency and Operator	29
Users	30
4. OPPORTUNITIES AND BARRIERS FOR SHARED ELECTRIC TWO-WHEELERS IN HANOI	32
4.1. Opportunities for Shared Electric Two-Wheelers	32
Promotion of E-Mobility in NDC Target	32
National and City Policy	32
Operational Costs of EVs	33
Technologies/ Mobile App	33
User's Willingness to Use	33
Active and Accountable Support from International Organizations	34
Expansion of Public Transport and Shared Two-Wheelers	34
4.2. Barriers for Shared Electric Two-Wheelers	34
Policy and Management	33
Infrastructure and Facilities	36
Environment, Travel Behaviors, and Users' Knowledge	36

5. POLICY RECOMMENDATIONS	37
5.1. Principles of Deploying Shared Electric Two-Wheelers	37
5.2. Specific Policy Recommendation in Developing Shared Electric Two-Wheeler System	38
Infrastructure Development Policies	38
Financial Policies	40
Management and Operation Policies	41
Bidding and Service Licensing	42
Vehicle's Characteristics and Related Equipment	43
Training Policies, Communication, Capacity Building, Scientific Research and International Cooperation	45
6. CONCLUSIONS	45
REFERENCES	46
ANNEXE	48

LIST OF TABLES

Table 1. Urban Public Transport Key Departments in Hanoi

Table 2. Administrative Procedure in Shared Two-Wheelers Pilot Project

Table 3. Stakeholders and Their Roles in Implementing the Pilot Project

LIST OF FIGURES

Figure 1 Modal shared among transport modes in Hanoi, 2020

Figure 2 Private vehicle population in Hanoi

Figure 3 Traffic congestion in Hanoi

Figure 4 Air pollutant emission sources in Hanoi

Figure 5 Number of Days with Good, Moderate, Unhealthy, and Hazardous Air Quality in Hanoi

Figure 6 Electric Motorcycle Fleet in Hanoi

Figure 7 Shared electric two-wheeler services for last-mile connectivity in Hanoi

Figure 8 Main Features of Phase 1 Activity

Figure 9 User statistics

Figure 10. Pilot route

Figure 11. The system of information signs and instructions is located in the area of BRT Van Khe waiting room, in AEON Mall Ha Dong.

Figure 12. Parking lot at the Van Khe BRT station and Aeon Mall Hadong

Figure 13. Direct vehicle charging at the borrow/ return point and Bettergen charger

Figure 14. Screenshot of Pro-Track Vehicle Monitoring and Management Software

Figure 15. V-Share application was used from November 28 to December 13, 2022; Google Forms was used from December 14, 2022 until the end of the pilot.

Figure 16. Control room

Figure 17. Guiding for registering and using the service

LIST OF ABBREVIATIONS

BAU	Business-as-usual
BRT	Bus Rapid Transit
CNG	Compressed Natural Gas
COP	Conference of the Parties
DOT	Department of Transport
EV	Electric vehicle
GHG	Greenhouse gas
HPC	Hanoi People's Committee
HPTC	Hanoi Transport Management Center
IEC	International Electrotechnical Commission
IOT	Internet of Things
ITDP	Institute for Transportation and Development Policy
MOC	Ministry of Construction
MOF	Ministry of Finance
MOIT	Ministry of Industry and Trade
MOT	Ministry of Transport
MRT	Mass Rapid Transit
NDC	Nationally determined contribution
NSCC	National Strategy on Climate Change
QCVN	Vietnam Technical Regulations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UTT	University of Transport Technology
VGGG	Viet Nam Green Growth Strategy

1 BACKGROUND

The Government of Viet Nam fully recognizes the threat of climate change, as well as the significant development benefits associated with the implementation of climate change adaptation and mitigation projects and programs, and the shift towards a green and circular economy. The government continues to promulgate strategic policies and plans to address climate change, including the Green Growth Strategy 2021-2030. In addition, a new Climate Change Strategy 2021-2030 is currently being finalized, which will set the long-term greenhouse gas emission targets up to 2025. This target will influence Vietnam's long-term low greenhouse gas emission development strategy (LTS).

At the United Nations Climate Change Conference (COP26) 2021, Viet Nam Prime Minister made ambitious and highly commendable commitments, including national target of net-zero emissions by 2050. The Prime Minister has recently established a new national steering committee for the implementation of Viet Nam's Commitment at COP26 and approved related climate change strategy and action plans (e.g., the National Climate Change Strategy, the National Green Growth Action Plan, Action plan for green energy transition and reduction of carbon dioxide and methane emissions of transport sector).

Between 2030 and 2050, the mitigation measures of the transport sector focus on modal shift and fuel switches. The main objective of the action plan is to accelerate fuel switches for all transport subsectors and readiness of technology, institutional, capacity and resources for the transition. Starting in 2050, electrification and green energy for all transport vehicles and equipment is mandatory to achieve zero emission targets.

Viet Nam updated its nationally determined contribution (NDC) in 2020, increasing its targets for greenhouse gas (GHG) emissions reduction by 2030. Compared to the business-as-usual (BAU) scenario, the target shifted to 9% and 27% for unconditional and conditional, respectively, depending on receiving adequate foreign financial support. The NDC includes two measures to reduce emissions from the transportation sector:

- Converting fuel use, with an estimated mitigation potential of 9.9 million tCO₂
- Shifting transportation mode, with an estimated mitigation potential of 26.7 million tCO₂

In 2019, GHG emissions from Viet Nam's transport sector reached about 45 million tons CO₂e, and predicted to increase by 6-7% per year on average. The Ministry of Natural Resources and Environment (MONRE) forecasted that GHG emissions from the transport sector will be doubled and reach 87.9 million tCO₂ by 2030, urging for immediate and significant interventions. In addition to considerable GHG emissions, fossil-fueled vehicles also emit substantial amounts of solid matter and fine particles (i.e., PM_{2.5}) that can may cause cancer, severe respiratory issues, and potentially lead to other health problems.

Reducing emissions from the transportation sector faces significant challenges, including the vast number of fossil-fuel vehicles and an inadequate public transportation system. Additionally, the adoption of electric vehicles is hindered

by high upfront costs, technology skepticism, a lack of infrastructure and enabling environment, and limited public-private partnership opportunities. On the other hand, timely opportunities for intervention include increasing public awareness of emissions and air pollution, increasing interest from national and local governments in implementing environmentally friendly transportation systems, and policy interest in fuel economy and energy efficiency in transportation.

For road transport, especially in big cities, shared two-wheelers is one of the most effective solutions that contributes to reducing GHG emissions and toxic gases released into the environment, alleviate traffic congestion, and prevent traffic accident.

The shared two-wheeler service has been a transformative force in urban transportation for the past 58 years (1965-2023), with its most significant breakthroughs occurring in the last two decades. Cities across the globe have successfully integrated this service into their existing public transport systems, making it a comprehensive and sustainable solution that enhances the accessibility of public transport. This model aligns perfectly with the broader goals of promoting health, preserving the environment, and improving urban mobility. China, leading the shared two-wheeler service market globally, recorded more than 400 million users in 2018. Ecobici, a Mexican shared two-wheeler service developed in the form of a public-private partnership, has more than half a million users and made around 83 million trips for the last decade. The growth of the shared two-wheeler service globally indicates that the contributing success factors are influenced by the determination and political will of the government system, constant innovation, alignment with the goals of the government, as well as the interest of the people and businesses in deploying the service.

In Vietnam, the shared two-wheeler model emerged around 2014 in Hanoi, deployed by Urban Greenery Environment Joint Stock Company. A decade later, numbers of other projects have been implemented, such as in Hue City (joint implementation between GIZ, Hue City People's Committee and Vietsoftpro Joint Stock Company), Ho Chi Minh City, Da Nang, Hai Phong, Vung Tau, and Quy Nhon (TNGo project implemented by Tri Nam Group), as well as in Hung Yen and Ha Long city (MBI Sharing service in Ecopark urban area by Lemonc Vietnam Co., Ltd.).

The growth of this service in Vietnam ignites the interest of the government to incorporate shared two-wheeler service as a solution in decarbonizing transport. However, due to the lack of appropriate policies, the implementation of this service is still limited to the pilot phase or motor vehicle rental form, discouraging people and businesses to utilize and invest in this service.

Shared electric two-wheeler initiative has been piloted in Hanoi by the SOLUTIONSplus project, a project which aims to enable transformational change towards sustainable urban mobility through innovative and integrated electric mobility solutions. The project provides 50 e-mopeds to support last-mile connectivity from Van Khe BRT station to Aeon Mall Ha Dong in Hanoi. The sharing system was pilot tested and periodically assessed to identify improvement potentials and provide inputs for policy development and institutionalization recommendations.

This policy advice paper explores and provides recommendations for sustainability, policy development, institutionalization to scale up the piloted shared electric two-wheelers. It includes relevant policies, regulations and technical standards,

resource utilization, price strategy and incentive scheme to engage service providers, stakeholder involvement and collaboration, and business models proposals.

2 CURRENT STATE OF URBAN TRANSPORT IN HANOI

2.1 Urban Mobility Characteristic in Hanoi

Vietnam is a developing country with rapid urbanization process. Urbanization rate of Viet Nam has been increasing rapidly, from 20% of population in 2000 to 41% in 2022. The urbanization rate is expected to reach 45% by 2025 and over 50% by 2030¹. This significant growth rate is followed by increased urban travel demand, expanding the fossil-fuel consumption and GHG emissions in the transport sector.

In 2022, Hanoi's population is around 8.4 million people with an average population density of 2,398 people/km². As the public transport services cannot meet the demand of the user, the traffic in Hanoi is mainly carried out by private vehicles. The bus network is reportedly only meets about 17.8% of demand.

Modal Share

Hanoi's modal share is currently dominated by private passenger vehicles, particularly motorcycles (refer to Figure 1). In contrast, public transport has a low share in Hanoi. For example, the share of public buses was only 8.7% in 2020. Shifting from private to public transport requires long-term strategies, significant economic resources, and appropriate policies and mechanisms to collaborate with the private sector. Other measures to improve transportation include developing a traffic management plan, providing adequate park and ride options, and enhancing the accessibility of public transportation.

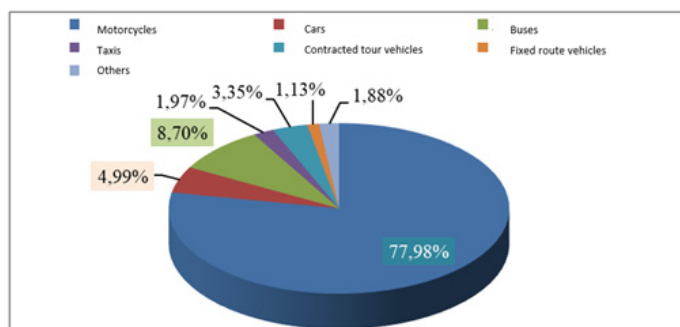


Figure 1 Modal shared among transport modes in Hanoi, 2020

Vehicle Fleets

Private vehicles comprises the large share of vehicle fleets in Hanoi and continue to increase rapidly. The total vehicle population registered in Hanoi in 2020 was at 7,160,052 vehicles, comprising 6,122,936 gasoline motorcycles (86%), 167,211 electric motorcycles (2%) and 869,905 cars (12%). However, these numbers do not account for a significant population of vehicles that are registered in other provinces but operate in Hanoi.

For 15 years, the private vehicle population in Hanoi has grown immensely, starting from two million vehicles in 2015 and reaching almost 7 million in 2020. Between 2015-2019, the average growth rate of vehicles in Hanoi is about 4 to 5% per year and spiked to 8% in 2020 (Figure 2). However, in 2021, Hanoi's bus fleet consisted of only 1,966 vehicles. The fleet was predominantly diesel-powered, making up 89% of the total. In contrast, CNG and electric buses accounted for just 11% of the fleet.

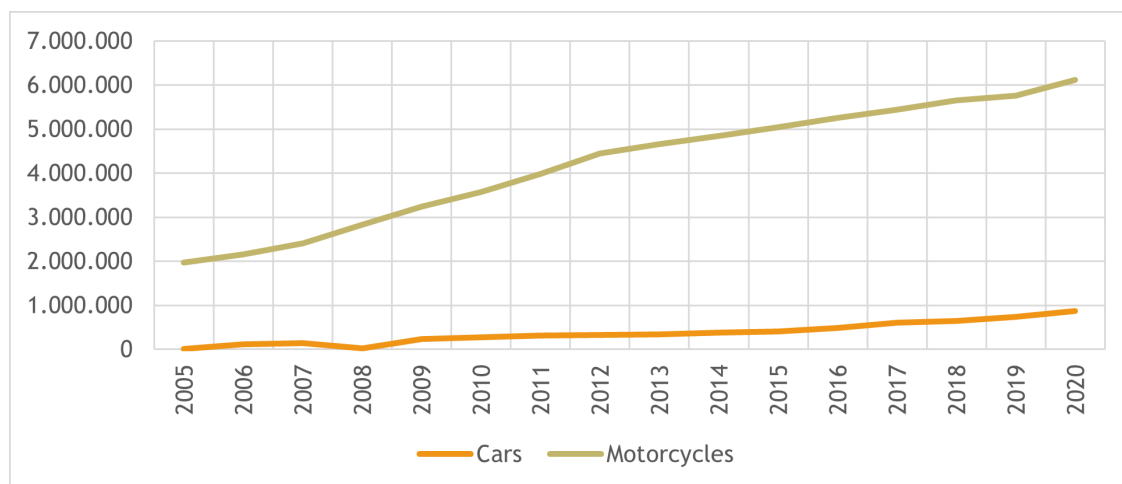


Figure 2 Private vehicle population in Hanoi

Public Transport

Private vehicles comprises the large share of vehicle fleets in Hanoi and continue to increase rapidly. The total vehicle population registered in Hanoi in 2020 was at 7,160,052 vehicles, comprising 6,122,936 gasoline motorcycles (86%), 167,211 electric motorcycles (2%) and 869,905 cars (12%). However, these numbers do not account for a significant population of vehicles that are registered in other provinces but operate in Hanoi.

The rapid increase in private vehicles in Vietnam is primarily attributed to the underdevelopment of public transportation, resulting in traffic congestion in major cities such as Hanoi. Currently, public transport options in Hanoi are the buses (e.g., city buses, mini buses), rail-based Mass Rapid Transit (MRT), and Bus Rapid Transit (BRT). However, both MRT and BRT networks are still limited, each only operating one line with 12 km and 8.5 km length, respectively. To date, bus transport under the management of Hanoi Department of Transport (DOT) comprises of 112 bus lines, of which 92 lines are receiving subsidized funding.² The government's current financial and technical resources to develop new public transport models (e.g., BRT, MRT) are quite limited, making it heavily dependent on foreign resources.

In 2019, Hanoi People's Committee established the plans to develop the public transport network, reduce the number of private vehicles, and encourage the use of public transport and bicycles. The city aimed to expand the bus network by adding 45 new routes by 2020, some of which were planned to incorporate priority lanes for buses. The city also planned to develop park-and-ride facilities near major public transport stations to encourage multimodal journeys.

The Hanoi People's Committee also issued a Decision "approving the Hanoi Urban Economic Development project to 2025 with a Vision to 2030," assigning the Hanoi

² Results from consultation meeting with DOT and TRAMOC by TA 9055 team, 2018

DOT as the main coordinator for zoning restriction for motorcycle and introducing bike and e-bike sharing systems in order to improve last-mile connectivity to the mass transit systems.

Accessibility

To ensure the accessibility of Hanoi's buses, MRT, and BRT, robust connections between transport modes as well as park-and-ride facilities need to be provided. Currently, access to MRT and BRT stops depends on the bus feeder system. In addition, the lack of park-and-ride facilities also discourage people from using the MRT and BRT.

In addressing commuters' unfamiliarity with the public transport system, TRANSERCO, a Hanoi Transport Corporation, launched Timbuyt in 2017, an application for bus trip planning in Hanoi. Timbuyt provides route information, tracks the numbers of vehicles moving towards the chosen location, and estimates the time to reach the bus terminal. To enable these features, the buses are equipped with GPS devices.

Cities with limited space allocated for transportation-related development struggle to build effective public transportation system, impacting the quality of transport services. In Hanoi, the land area designated for urban transport uses is only around 6.7% of the total land area. In comparison, this proportion ranges from 20-25% in cities like Paris, London, and New York, and is still higher in neighboring Asian cities such as Bangkok, Jakarta, and Taipei, where it ranges from 10-15%.³



Figure 3 Traffic congestion in Hanoi

Air Pollution and GHG Emission

GHG emissions from the transport sector have increased at a faster rate compared to any other energy end-use sector. In 2019, GHG emissions from the transport sector were estimated at 45 million tCO₂, and predicted to increase 6-7% annually, reaching 90 million tCO₂ by 2030. These emissions account for 39% of the total GHG emissions from energy consumption. Road transport is the largest GHG emission source within the transport sector, contributing about 80% of total GHG emissions.⁴ In Hanoi, the road transport sector is also a major source of air pollution, contributing more than 20% of PM_{2.5} emissions (Figure 4)⁵. In addition, the annual average PM_{2.5} concentrations in every district in Hanoi exceeded the national standard, with the number of days with good air quality accounting for only 42.2% of the total days in 2021 (Figure 5)⁶.

3 D.Thi Phin and E. Dotson. 2013. Urban Transport Institutions and Governance and Integrated Land Use and Transport. Ha Noi. <http://www.unhabitat.org/grhs/2013>

4 Updated Vietnam's NDC report, 2022

5 WorldBank, 2021. Ô nhiễm không khí hà nội: Thực trạng và gợi ý chính sách

6 USAID, 2021, Status of PM_{2.5} and Its Impact on Public Health in Vietnam 2021 report

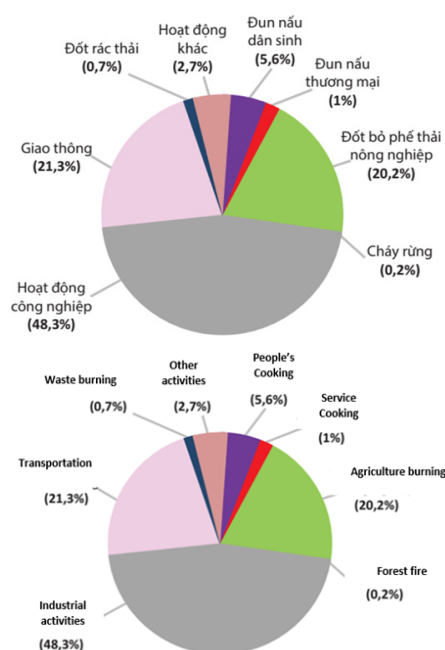


Figure 4 Air pollutant emission sources in Hanoi

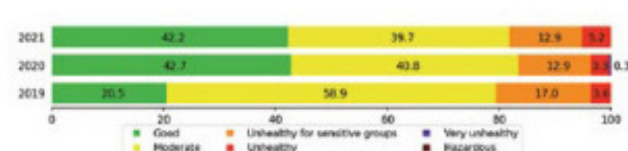


Figure 5 Number of Days with Good, Moderate, Unhealthy, and Hazardous Air Quality in Hanoi

2.2. Current State of E-mobility in Hanoi

Electric Vehicles

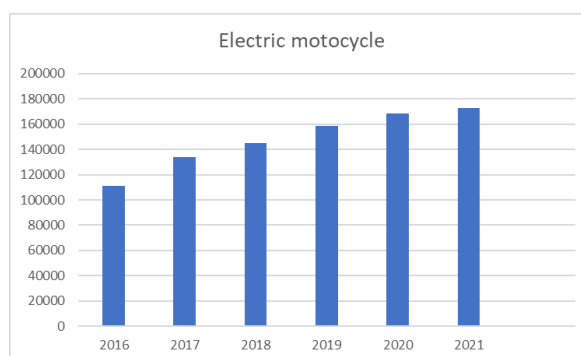


Figure 6 Electric Motorcycle Fleet in Hanoi

Since 2016, the number of e-motorcycles in Hanoi has been growing (Figure 6). As of November 2022, Hanoi has 182,917 registered e-motorcycles. The city's bus fleets are also gradually transitioning to e-buses, contributing to the implementation of the Green Energy Transition Roadmap. According to the Hanoi Department of Transport, 277 vehicles, or 13.6% of the fleet, use clean fuel. Of these, 138 buses are electric and 139 buses are powered by CNG.

Hanoi has established specific targets for its energy transition. According to Decision No. 876/QĐ-TTg, all new investment and replacement buses must be electric or use green energy starting from 2025. By 2050, all buses must be electrified or use green energy. Between 2025 and 2030, all newly invested or replacement buses must use green energy. Additionally, the market share of public transport in Hanoi must reach 45-50%. By 2030, at least 50% of vehicles must use electricity or green energy.

Local Start-Ups

To keep up with the shift towards electric vehicles in the transportation sector, many Vietnamese companies are researching and developing their own electric vehicles. This enables them to stay up to date with the latest technologies and meet the needs of Vietnamese consumers.

VinFast

Founded in 2017, VinFast is a subsidiary of Vingroup focusing on automotive industry, charging stations, and electric moped manufacturing at its factory in Cat Hai, Hai Phong. In 2018, VinFast launched its first electric moped model, VinFast Klara, available in both lithium battery and lead-acid battery versions. Currently, VinFast offers 8 models of electric mopeds catering to the diverse needs of Vietnamese users. In addition, VinFast has installed public fast-charging stations in 63 provinces and cities nationwide. These charging stations are established in various public spaces, including commercial and entertainment centers, bus stations, tourist areas, and residential areas.

Selex Motor

Founded in 2018, Selex Motors is a Hanoi-based start-up that develops the world's first and most optimal e-mobility ecosystem for urban transport using electric two-wheelers from scratch. The solution comprises 4 key elements: a novel electric moped that is highly optimal for both passenger and cargo transport, a highly compatible battery pack, an automatic battery swapping station, and an IoT management platform. This unique ecosystem helps users save 30-40% operational costs, reducing charging time from 3-8 hours to less than 2 minutes, and improving load capacity by 50%. Selex Motors focuses on applying its solution to the fast-growing segments of last-mile delivery in Vietnam, with plans to expand throughout Southeast Asia. It is estimated that replacing each gasoline motorcycle with a Selex e-mopeds reduces the CO₂e footprint by four tons per year. Officially launched in November 2022 as the first and only provider of battery-swapping service in Vietnam, Selex aims to have at least 200 swap points, powering 3,000 electric mopeds in 2023. Selex Motors receives funding from regional venture capitals, including Asian Development Bank Ventures.

Dat Bike

In September 2019, Dat Bike launched its first product line and participated in fundraising from investors to enter the acceleration phase. Dat Bike prioritizes three criteria in producing electric vehicles: speed, travel distance, and charging time. Vehicles manufactured by Dat Bike aim to improve technology to enhance performance and user experience. Weaver 200 and Weaver++ electric vehicles feature a maximum speed of 90km/h, a maximum travel distance of 200km, and a charging time of 2 to 3 hours. Electric bikes have become a popular means of delivery since 2020. The company aims for 30% of their goods in major cities to be delivered by electric vehicles by the end of 2028.

Charging Infrastructure

Currently, technical standards for charging infrastructure in Viet Nam are still under development by various stakeholders. The stakeholders include the Ministry of Transport (MoT), Ministry of Industry and Trade (MoIT), Ministry of Construction (MoC), Ministry of Finance (MOF), local authorities, and private companies and service providers.

VinFast is the largest provider of charging stations for both electric cars and mopeds. It is reported that about 150,000 charging points are available at 2,000 locations

nationwide, adhering to SO-15118 and IEC 61 technical standards. However, the charging infrastructure provided by VinFast can only be utilized by VinFast vehicles. An application has also been developed to allow users to find the nearest charging station. These charging stations are strategically located in areas such as parking spaces, residential buildings, commercial centers, stopover stations, and fuel filling stations.

Selex Motors provides battery-swapping services, primarily for their electric mopeds, which are specialized for delivery services. According to Selex Motors, this battery-swapping system is compatible with vehicles from different brands, offering greater flexibility for users.

Bike and Electric Mopeds Sharing in Hanoi

Since 2014, Hanoi has been a trailblazer in establishing the bike-sharing model in four different locations. A decade later, several businesses are still developing shared e-bikes and e-mopeds model into a sustainable and comprehensive solution that connects public transport in Hanoi.

Tri Nam Group

Tri Nam Group is a company that develops information and communication technology solutions and online services with the aim of providing high-quality products and services to Vietnam and its citizens. Since 2021, Tri Nam Group has proposed and deployed a bike-share service in cities such as Ho Chi Minh City, Da Nang, Hai Phong, Quy Nhon, and Vung Tau. Many users and tourists use Tri Nam's services through the TNGo application. In Hanoi, Tri Nam has proposed implementing a shared electric bicycle and motorcycles pilot program in six inner-city districts, comprising 94 stations and 1,000 vehicles, of which 50% are electric power-assisted bicycles.

MBI Motors

MBI Motors is fully funded by MBI Technology Group from South Korea. The MBI electric car-sharing service was first launched in the Ecopark urban area, Hung Yen, in cooperation with UNDP. The service then expanded in Vinhomes Ocean Park in Hanoi, as well as other localities such as Quang Ninh, Phu Quoc, and Nha Trang. Vehicles used by the MBI sharing system have a maximum speed of about 25 km/h, and users can easily search for, borrow and return vehicles through the application. The service model provided by MBI is often concentrated in internal areas rather than connecting with the public transport network. The models deployed in Hanoi also faced several challenges, notably due to the lack of specific policies and regulation in Hanoi. The services are being piloted in the form of "motor vehicle rental."

2.3. Urban public transport management institution in Hanoi

The governance structure of Hanoi city is similar to other urban areas in the country. The Hanoi People's Committee (HPC) is responsible for delivering infrastructure and services across various sectors or departments of the city government. The city has several specialized agencies which support the city government in performing specific functions. The city also has a number of State-Owned Enterprises, which report directly to the HPC, including those responsible for bus supply services and the development of the urban rail system. The key departments involved in urban public transport within Hanoi are listed in Table 1, encompassing both infrastructure construction and service operation.

HANOI DOT	Responsible for ongoing governmental management functions, enterprises, as well as project management. In terms of public transport management, the DOT currently oversees the operation of public buses with the assistance of TRAMOC.
TRAMOC	An administrative service in charge of developing the bus network. Its major responsibilities include managing public transport by bus, developing strategies, overseeing the route network, and preparing and implementing bus public transport development policies in Hanoi (e.g., BRT lane, and the management of infrastructure and other service providers).
TRANSERCO	State-owned enterprise which reports directly to the HPC. Its main business is to provide public transport services by bus and inter-city transport services.
HANOI RAILWAY ONE MEMBER LIMITED LIABILITY COMPANY	Established by HPC under Decision 6266/QĐ-UBND of HPC in 2014 to carry out operation of public transport by urban railway systems. Its main duties include passenger transport, infrastructure maintenance, and repair and maintenance of (industrial) vehicles.

Table 1. Urban Public Transport Key Departments in Hanoi

Infrastructure development and the operation of traffic system in Hanoi also require the involvement of other stakeholders, such as the Department of Construction, the Department of Environment and Natural Resources, the Department of Finance, the Department of Investment and Planning, and other city functional divisions.

3 ASSESSING SHARED ELECTRIC TWO-WHEELERS PILOT PROJECT IN HANOI

Shared two-wheeler programs are becoming increasingly common in cities globally. They offer numerous advantages, including reducing traffic congestion, improving air quality, and encouraging people to exercise. Shared two-wheelers programs also make it easier for people to get around without owning a car, thereby reducing greenhouse gas emissions and make cities more livable.

Key measures for the development of a successful shared two-wheeler system include:

- Political will to support active transportation
- Commitment to investing in infrastructure
- Integration with the city transport development plan
- Compatible with the city's density, topography, and weather

3.1. Project Overview

The demonstration activity in Hanoi aims to develop shared electric two-wheeler services for last-mile connectivity of public transportation and enhance the accessibility of the Hanoi BRT. By providing a link between a BRT station and a commercial center, the project seeks to achieve three main objectives:

- Integrating shared e-two-wheelers with public transport (e.g., buses, BRT).
- Increasing public transport use while minimizing private vehicle use.
- Reducing GHG emissions and improving air quality.

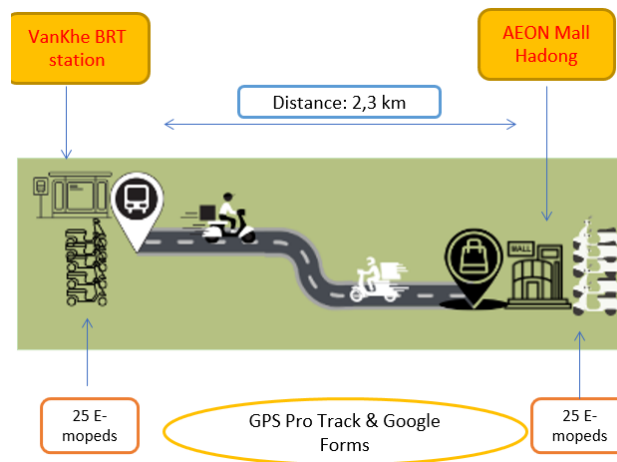


Figure 7. Shared electric two-wheeler services for last-mile connectivity in Hanoi

The main components of the demonstration activity include:

- Shared electric two-wheeler system
- User application and interface
- Back-end system

The demonstration was conducted in several phases. During the first phase, a designated route was established between the Van Khe BRT station and a shopping mall (Aeon Mall), a distance of 2.3 km, to test the sharing system using 50 shared e-mopeds (see Figure 7.). Periodic assessments were conducted to identify the strengths and weaknesses of the pilot. Following these evaluations, the improved sharing system is planned to be replicated in other locations across the city, potentially connecting metro terminals with residential areas.

In implementing this activity, Hanoi University of Transport Technology (Hanoi UTT), as a SOLUTIONSplus country partner, oversees concept note preparation, selection of location and route, completion of all administrative requirements, and management of on-site activities during the demonstration period.

The project is supported by both international and local partners. Under the SOLUTIONSplus project, the international partners include UNEP, UN-Habitat, Clean Air Asia, Wuppertal Institute, and TNO Research Institute. Local partners include the Hanoi Department of Transport, Hanoi Public Transport Management Center, Hanoi Transport Corporation, QIQ Joint Stock Company, and AEON Commercial Center. QIQ provides software infrastructure such as app and IoT development for vehicle monitoring systems and users.

The main features of the phase 1 are illustrated in Figure 8.



Figure 8. Main Features of Phase 1 Activity

Vehicle fleet

The electric two-wheeler fleet consists of 50 Ludo e-mopeds, each equipped with a battery specification of 22Ah, 50.4V, and 55 kWh, respectively. The vehicle fleet is funded by the SOLUTIONSplus project.

Infrastructure

The physical infrastructure provided consists mainly of parking areas and charging stations. Specifically, two parking areas have been established: one adjacent to the Van Khe BRT station and another within the Ha Dong AEON Mall. A charging station installed in the Ha Dong AEON Mall parking lot can accommodate the simultaneous charging of up to 50 vehicles.

Application Development

Initially, the pilot program utilized Pro-Track software connected to IoT devices to manage and monitor vehicles. The V-Share mobile application was also employed to manage and register users, allowing them to borrow and return vehicles automatically. This application also recorded user information, utilization time, vehicle status (e.g., stop, move, position, distance traveled, travel time, vehicle history), vehicle locking/unlocking warnings, and sent reminders when the vehicle moved out of range. In addition, operators could track vehicle locations in real-time with this application.

However, QiQ Company, contracted under SOLUTIONSplus project, was unable to deliver the V-Share software before the deployment of the pilot. As a result, during the pilot period, the team utilized Google Forms and UTT's IoT as an alternative. This alternative enabled users to register for an account, borrow and return vehicles, as well as supported the operating, monitoring process, and stored user information.

Operation System

The operation of this system is not fully automated and requires at least one staff member to manage and monitor it remotely and another staff member to support and guide users directly at the borrowing and returning points. This is due to the absence of a fully functioning application.

Data collection - Operating Record/ Results

The operation of this system is not fully automated and requires at least one staff member to manage and monitor it remotely and another staff member to support and guide users directly at the borrowing and returning points. This is due to the absence of a fully functioning application.

The demonstration activity started on December 5, 2022. While the number of users was below expectations, there was an increase in service usage. On average, the demonstration recorded 3-5 new registered users and 10-12 trips on weekdays. During weekends and holidays, these numbers increased to 5-10 new registered users and 15-20 trips. The statistics on users and trips are illustrated in Figure 9.

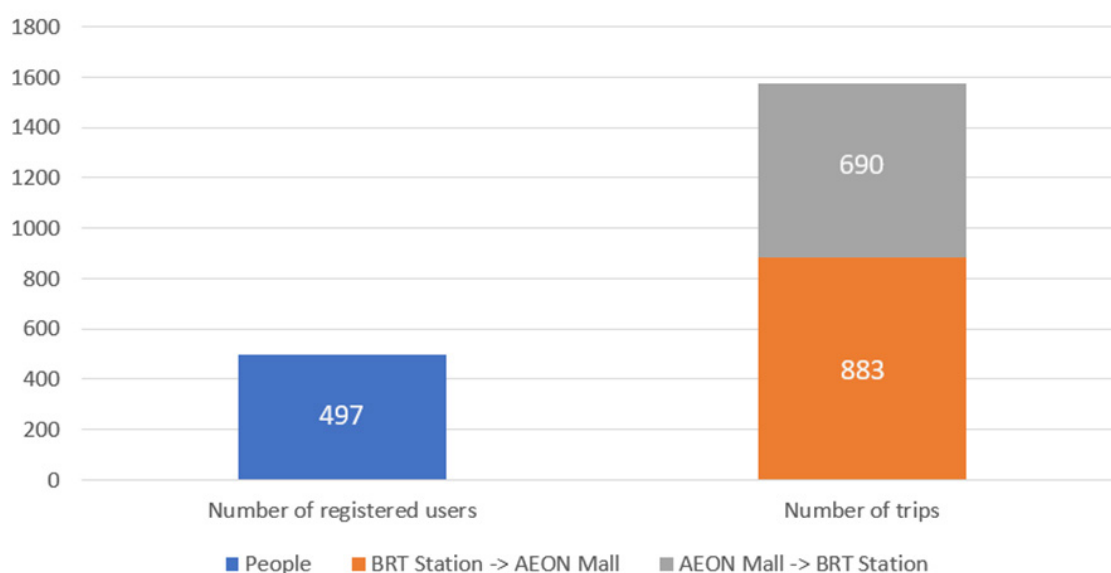


Figure 9. User statistics

3.2. Policies and Administration Procedures

Rationale of the Pilot Activity

Development activities in Hanoi should align with the city's policies. The plan to improve access to the mass public transport system by promoting shared two-wheelers is included in the city's Plan No. 201/KH-UBND of Hanoi People's Committee, dated October 16, 2020, on the development of public passenger transport vehicles in the city from 2021 to 2030.

The major constraints in piloting and upscaling the two-wheeler sharing system lies in the absence of supportive policies, technical guidance for setting up and operating a sharing system, as well as a lack of standards for shared vehicles and related facilities. The introduction of electric vehicle sharing system requires even more advanced policies and technical guidance, not only for the vehicles but also for related facilities such as power supply, charging stations, parking areas, and safety requirements. Setting up a shared two-wheeler system typically needs to be built on the city's public transport targets, commitment, and political support. The shared two-wheeler system should contribute to sustainable transport development, reducing congestion and pollution while improving mobility options.

Preparation Phase

The shared two-wheeler business model in Viet Nam has not yet been legalized at all levels of management. Consequently, the vehicle sharing system operates as a self-driving vehicle rental service, resulting in several disadvantages as it become ineligible for several incentives related to public service provision, such as tax breaks, and fee reductions. The situation is also more complex for electric vehicle sharing systems, which require additional measures such as investments in physical infrastructure,

power supply, and safety measures, including fire prevention requirements. Approval from the authorities is required for all pilot activities, with proposed ideas needing to align with the authorities' development plans and strategies. The implementing agencies also need to have responsibilities or be authorized by government agencies to manage the type of piloted activities. For instance, the shared two-wheeler pilot proposal had to be submitted and approved by local government before the implementation process begins. As the implementing partner of SOLUTIONSplus in Viet Nam, Hanoi UTT is responsible for completing all administrative requirements and managing demonstration activities in Hanoi. This process involved two stages: the license application stages and the project operation stage. The administrative procedure is summarized in Table 2.

STEPS	PROCESS	RESPONSIBILITY
STEP 1	Preparation of demonstration proposal for EV-sharing for last-mile connectivity between BRT Van Khe Station and Aeon Mall Ha Dong.	Metropolitan Public Transportation Company (EPMTQ)- Public company in charge of operating two public transport corridors: trolebús and ecovía.
STEP 2	Submission of proposal to Hanoi Department of Transport (DoT).	
STEP 3	Seeking comments from relevant authorities on demonstration proposal.	DoT conducts consultation with other city departments and agencies on several aspects, such as compliance with national and city policies, technical feasibility, management option, and safety requirements.
STEP 4	Updating and revising the demonstration proposal based on comments and suggestions from local authorities.	DoT works with implementing partner to consider and address comments and suggestions from other related departments.
STEP 5	Submission of final demonstration proposal to Hanoi People's Committee (HPC) by DoT.	HPC conducts internal review to issue a decision to approve the project preparation agreements.
STEP 6	HPC issues a decision, approves the demonstration proposal, and agrees to prepare the detailed demonstration implementation plan.	HPC conducts internal review to issue a decision to approve the project preparation agreements.
STEP 7	Preparation of the demonstration implementation plans following guidance from Hanoi DoT	Prepare the full implementation plans based on legal instruction in the approval letter.
STEP 8	Internal reviews and comments from the city's relevant authorities.	Conduct internal evaluation and assessment of submitted implementation plan and consulted with other concerned agencies, if needed.
STEP 9	Submission of the demonstration implementation plan to HPC for approval.	Final review and approval of the implementation plan.
STEP 10	HPC issues written approval for demo implementation.	Implementation of the demonstration activities in the sites.

Table 2. Administrative Procedure in the SOLUTIONSplus Shared Two-Wheelers Pilot Project

The lack of technical regulations, policies and urban plans for shared two-wheeler systems in Hanoi creates a bureaucratic hurdle. A number of local government agencies need to be involved in reviewing and approving proposals, making the process quite time-consuming. Moreover, pilot activities that require public infrastructure development must be located in public open spaces. This necessitates additional licensing and approvals, including land use permissions, sidewalk usage, power connections, safety requirements, and vehicle registration.

Operational Phase

The operation of the vehicles needs to comply with the Road Traffic Law and regulations from related institutions, such as the police (e.g., traffic safety, security), tax department (e.g., license tax, value added tax, corporate income tax, personal income tax), and various fees (e.g., electricity consumption fee, sidewalk rental). The management system needs also to follow the guidance from several related departments such as the Department of Transport, Department of Financing, and Department of Construction.

The shared two-wheeler project at BRT Van Khe - Aeon mall Ha Dong is an initial pilot of free two-wheeler sharing in Hanoi with a semi-automatic management system. This system allows for real-time monitoring and tracking of the vehicle's journey and automatic registration. However, the process of borrowing and returning vehicles still needs the involvement of computer operator, a booking app, and an automatic payment system.

Globally, the current concept of shared two-wheelers has evolved into the fourth generation of 'smart' shared two-wheeler networks. Technological advancements have increased transparency and accountability through identification devices, allowing for real-time monitoring of station capacity and vehicle users. This system enables effective monitoring of operational management, reducing operating costs and ensuring user responsibility.

3.3. Collaboration among Relevant Stakeholders

The stakeholders in this pilot project include authorities at all levels, related businesses (e.g., transportation service providers, vehicle suppliers), project implementing agencies, and users. During the implementation of the pilot project, stakeholders and their role are outlined in Table 3.

STAKEHOLDERS	ROLE
HANOI PEOPLE'S COMMITTEE	Approves the project and formulating the decision to allow project implementation.
HANOI DEPARTMENT OF TRANSPORT (DOT)	Serves as traffic policy advisory agency for Hanoi. DoT reviews and evaluates relevant management and technical issues, and consults with other agencies.
HANOI PUBLIC TRANSPORT MANAGEMENT CENTER (HPTC)	Coordinates and guides relevant steps to manage public passenger transport in the city.
CITY POLICE	Assesses traffic safety for the pilot route and issues licensing plate number for the vehicles.
HANOI ELECTRICITY	Provides connection for charging stations.

DISTRICT-LEVEL AUTHORITIES AND WARD-LEVEL AUTHORITIES	Arranging land funds and grants permission for sidewalk utilization.
DEPARTMENT OF CONSTRUCTION	Issues construction license for parking lot`s roof (if necessary)
DEPARTMENT OF FINANCE (DOF)	Appraises price/ fee norms for the project. At this stage of the project, involvement of DoF was unnecessary since the pilot was currently free of charge.
HANOI TAX DEPARTMENT	Applies tax exemption and reduction policies and infrastructure rental exemption for public shared two-wheeler parking.
PUBLIC PASSENGER TRANSPORT ENTERPRISES	Supports in advertising and communicating the two-wheeler-sharing services.
OTHER SERVICE PROVIDERS	Provides specialized services such as software development and management and online payment service providers.
SERVICE USERS	Use the services and comply with the requirements and operating rules of the system.
AEON MALL HA DONG SHOPPING CENTER	Supports the establishment of borrowing/ returning points and charging stations. Supports communication and advertising activities of the service.
HANOI TRANSPORT CORPORATION	Manages activities at BRT stations and supports advertisement and communication activities about the pilot program.
GREEN MOBILITY VIETNAM	Implements operational activities.

Table 3. Stakeholders and Their Roles in Implementing the Pilot Project

During the development of the concept note for the SOLUTIONSplus pilot project in Hanoi, the DoT was identified as the implementing agency, with the UTT serving as the research and consulting partner. However, due to certain objective reasons, the DoT proposed that the UTT also serve as the implementation partner for the SOLUTIONSplus project in Hanoi. As a result, UTT now serves as both the implementing agency and operator. To implement the pilot project as described above, UTT had to complete ten steps to gain approval (see Table 2) and deploy the necessary infrastructure, procure vehicles and equipment, and establish the operating system.

Based on international experience, the government entity responsible for planning, implementing, and operating the shared two-wheeler system should ideally be the implementing agency. This agency should be located within the authority that has control over the roadbeds and sidewalks, which includes the authority to build out the stations.

In the pilot project in Hanoi, HPTC played an important role in getting the project approved and operational. Additionally, Hanoi DoT assigned HPTC to coordinate and support the UTT during the project operation stage.

In addition to UTT's efforts in proposing and operating the pilot project, the invaluable support and coordination of stakeholders have significantly contributed to its success. However, the lack of a specific policy for the shared two-wheeler model resulted in a cumbersome and unappealing licensing and operating process for businesses. Finally, the media and press have a crucial role in the success of the pilot project. In

the early stages of pilot projects and the city-wide shared two-wheeler model, it is important to highlight the positive aspects of this model to attract the attention and support of all stakeholders and road users.

3.4. Establishment of Infrastructure and Related Facilities

The infrastructure and facilities for the project were established based on an analysis of survey results and the current traffic situation in Hanoi, conducted by UTT. As this is a pilot project with limited time and resources, some criteria may not meet global standards for shared electric two-wheelers systems. Two major differences were identified: the system's coverage and the type of two-wheeler selected for the project. These differences provide valuable insights for proposing policies for the shared two-wheeler model in Hanoi.

A shared electric two-wheeler system requires various types of infrastructure and equipment. The basic components of such a system include:

- Vehicle parking infrastructure (with roofs and locking docks if needed)
- Charging points or battery-swapping stations
- Power supply infrastructure
- Control center and hotline
- Surveillance cameras
- Vehicle management system
- Infrastructure and equipment for testing and maintaining vehicles

Pilot Route

The selection of locations for pilot activities has been made with the objective of enhancing the connectivity and accessibility of the city's public transport system by providing alternative options for accessing public transport. In Viet Nam, the lack of park-and-ride facilities and limited accessibility to public transport, combined with the convenience of motorcycles, discourages people from using the public transport system. The location for the pilot project was chosen based on several factors: the BRT route as a mass transit system, the number of passengers entering and exiting at BRT stations, the daily visitors to and from Aeon Mall, the total length of the connected route (2.3 kilometers), the availability of public spaces for parking stations and other facilities, the use of private vehicles on existing road sections, and the small number of intersections. The final selection is the route connecting the BRT station and Aeon Mall, a commercial center.

Based on global experience, effective location planning for bike-sharing systems involves four key factors: minimum coverage area, station density, bikes-per-resident ratio, and parking-per-bike ratio. However, due to limited resources, it was not feasible to meet these factors for the SOLUTIONSplus pilot project in Hanoi. Instead, the selection was guided by practical considerations and a careful assessment of the following:

Minimum System Coverage Area and Station Density

The pilot activity focused on a single line with two stations (Van Khe BRT Station and Aeon Mall Ha Dong). This route effectively fulfills the objectives of last-mile connectivity and serves as a vital link to a commercial center, showcasing high passenger service potential. The project presently comprises only two stations, spaced 2.3 km apart (see Figure 10.). However, this limited number of stations could pose challenges in attracting users since only one route is available, potentially inadequately serving those seeking transportation to or from other locations.



Figure 10. Pilot route

Deployment of e-two-wheelers based on location density and mobility demand

The demand for the pilot service was calculated based on the number of passengers accessing Van Khe station by BRT and Aeon Mall by different means of transport. To introduce and familiarize shared two-wheeler usage in Hanoi, 50 vehicles were deployed on this route. The e-two-wheeler-per-resident ratio and the parking-per e-two-wheeler ratio were calculated based on the number of people entering Aeon Mall Ha Dong daily, particularly those using Aeon Mall's shuttle bus. Arranging 25 e-mopeds at each end of the route was deemed reasonable and met the goal of the pilot project.

Based on the assessments and results, it is evident that implementing the project without meeting the minimum criteria would result in low operating efficiency of the shared electric two-wheeler system. To improve the performance of the pilot system, it is necessary to increase the coverage area of the pilot (including the number of stations) and extend the pilot duration.

Billboards and Information

For a shared electric two-wheeler system with extensive coverage, it is necessary to integrate a navigation function into the mobile application to assist users in traveling conveniently while complying with traffic regulations. For pilot projects with limited coverage, dedicated signs should be added to create maximum convenience for users. During the operation of the pilot program, users were expected to be guided by the mobile application, removing the need for temporary signboards and signs. However, since the app was not available as expected, some users found it difficult to navigate the route. In response, the Center for Public Transport Management of Hanoi City, Hanoi Transport Corporation, and AEON Mall Ha Dong collaborated to provide information boards to introduce the pilot program (see Figure 11.). These boards helped attract users and contributed to an increase in the number of users.

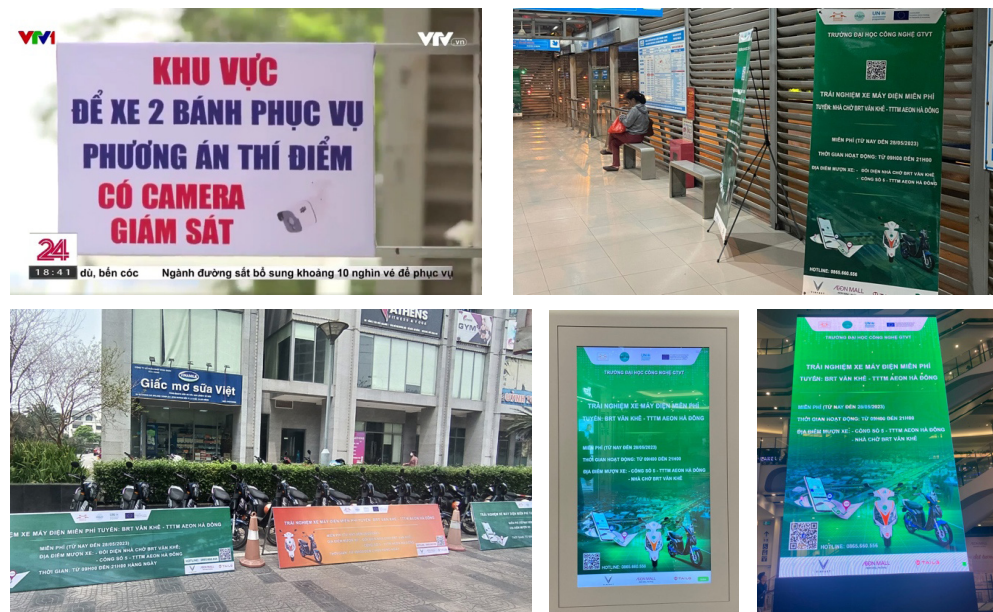


Figure 11. The system of information signs and instructions is located in the area of BRT Van Khe waiting room, in AEON Mall Ha Dong.

Parking stations

The parking stations are only located at the beginning and end of the pilot route: the BRT station and Aeon Mall shopping center. The arrangement these stations mainly considered easy and safe access for users, as well as land use rights and land ownership. There are two typical types of land ownership for the parking stations:

Parking station at Van Khe BRT

The parking station is situated adjacent to the Van Khe BRT and on the sidewalk of To Huu Street. Placing vehicles at this location requires approval from the Ha Dong district authority. Other infrastructure development activities, such as installing roofs and charging points, require permission from management agencies like the Department of Construction and District/Ward People's Committee, Hanoi Department of Electricity.

Parking station at Aeon Mall

This parking station is located in the general parking area of Aeon Mall. Since this area is under the management of the Aeon Mall center, installing the parking station and other infrastructure is relatively straightforward, requiring only agreements with the Aeon Mall management.



Figure 12. Parking lot at the Van Khe BRT station and Aeon Mall Hadong

Charging Station

Currently, Viet Nam does not have specific standards for electric two-wheeler charging stations. Therefore, charging batteries and installing charging poles are considered similarly to charging household appliances and must adhere to the relevant regulations and standards. The applicable standards in this case are:

- TCVN 5699-2-29:2007 (IEC60335-2-29) with specific requirements for battery chargers. With a composition of many equipment components, the current two-wheel electric vehicle charging station can also apply the standards of relays and switches, electronic equipment and Micro relays according to 3 TCVN 12777-1-2 -3:2020 (ISO 7588-1-2-3: 1998).
- TCVN 13078-1:2020 (IEC61851-1) and electromagnetic compatibility requirements according to TCVN 13078-21-1:2020 (IEC 61851-21-1):2017).
- Clause 8.13 of TCVN 12773:2020 (ISO13063: 2012) clearly stipulates the safety requirements for charging input of electrical and storage components with class B voltage.

During the pilot implementation period, there were no available electrical connection points for charging electric vehicles on the street due to the lack of infrastructure in the city's power network master plan. As a result, no charging infrastructure was set up at the BRT station. Battery charging was mainly done at AEON Mall Ha Dong Center to comply with fire protection requirements.

During the implementation process, three methods of battery charging were implemented:

- Direct vehicle charging at AEON Mall Ha Dong Center
- Using the Bettergen mobile charger provided by Batteries AMPS GmbH
- Battery-swapping for vehicles at Van Khe BRT point.



Figure 13. Direct vehicle charging at the borrow/ return point (left image) and Bettergen charger (right image)

Vehicles

According to the 2013 ITDP guidelines, vehicles used for shared two-wheeler systems are typically based on a standardized bicycle with specially designed or proprietary components built solely for the system to enhance durability and security, preventing easy theft and resale. The appearance of the bicycle is a crucial element in the overall branding of a two-wheeler-share system, and the two-wheeler should project a sleek, modern image. The two-wheeler-share fleet can be distinguished from regular two-wheeler in the city using distinctive colors, frame style, molding, and graphics. It is important that the two-wheelers are robust since they will be used much more

frequently daily than normal two-wheeler that are designed for less intensive use. As a result, such two-wheelers typically have an average lifespan of three to five years.

Compared to conventional one, the use of electric two-wheelers in Viet Nam possesses several advantages, notably due to usage habits and inclement weather. In addition, electric two-wheelers facilitate vehicle control and monitoring during operation. However, the cost of investment and maintenance will be one of the main constraints, as it is significantly higher than those of conventional bicycles. Therefore, specific studies to determine the most efficient type of vehicle for the shared two-wheeler system in Hanoi need to be conducted.

For the demonstration project, 50 VinFast Ludo electric mopeds were selected. The choice of electric vehicle for a sharing system offers numerous benefits, including higher speed and applicability for longer distances, aligning with people's preferences. However, electric two-wheelers also present constraints, such as vehicle registration requirements, advanced maintenance, and driving license requirements for certain types of vehicles. The necessity of a driving license tends to limit the number of users, making driver's license-free types of electric two-wheelers more suitable for shared-vehicle systems.

Since there are no dedicated types of vehicles for the shared electric two-wheelers services, VinFast Ludo, a common commercial electric two-wheeler in the market, was selected for the pilot activities. The VinFast Ludo electric motorcycle or mopeds is a suitable choice for Vietnamese people, given its size and design, which are well-suited to the weather, climate, and traffic infrastructure conditions in the pilot area. In addition, this model does not require a driver's license for users. Although Ludo electric mopeds are commercial vehicles, they are not specifically designed for public use. Therefore, using these vehicles for pilot electric vehicle-sharing services requires technical adjustments and the installation of additional equipment. This can lead to potential technical conflicts with the vehicle's electrical and battery systems, as these systems are designed and tightly controlled by the manufacturer.

The pilot implementation process has shown that choosing electric bicycles and mopeds for vehicle-sharing systems brings numerous benefits for users. These include higher speed, greater convenience for long-distance travel, and reduced influence from weather factors. However, the limitations of the chosen vehicle types include vehicle registration requirements, regular maintenance needs, and driver's safety requirements for high-capacity vehicles, such as wearing helmet. Managing the helmet requirement can also become a challenge in operating the sharing system.

Application and IoT

Application and IoT are important tools to ensure smooth and effective operation and management of the vehicle-sharing system. Comprehensive application and IoT software help increase safety and reduce operational costs. These components should be synchronized and compatible with other system parts and must be designed and manufactured by professional manufacturers to ensure safe and stable function.

Between November 28 and December 13, 2022, the pilot project utilized Pro-Track software to manage vehicles and the V-share application to manage users and vehicle borrowing/returns. However, technical difficulties arose during the installation of additional devices into the electric vehicles used for pilot activities. As a result, the Pro-Track system and V-share software remain incomplete.

Between December 14, 2022, and May 28, 2023, the pilot project utilized Google Forms

as an alternative to V-Share application, and vehicle management was handled using the IoT from Viview's Protrack. These were two separate management systems: Google Form took care of user management (e.g., account registration, QR code scanning to confirm vehicle borrow/return, tracking user journey), while the IoT managed vehicle-related tasks (e.g., vehicle tracking, incident notification, turning the vehicle engine on/off).

This management method led to difficulties in tracking the vehicle borrow/return process, requiring more manpower during operations. In addition, other functional limitation arose with the use of Google Forms, such as the inability to automatically lock/unlock vehicles, lack of route display to guide users, inability to signal a warning when the vehicle traveled outside the designated area, and the lack of an automatic payment function.

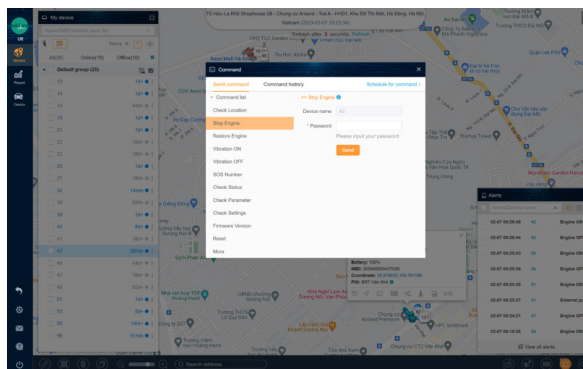


Figure 14. Screenshot of Pro-Track Vehicle Monitoring and Management Software

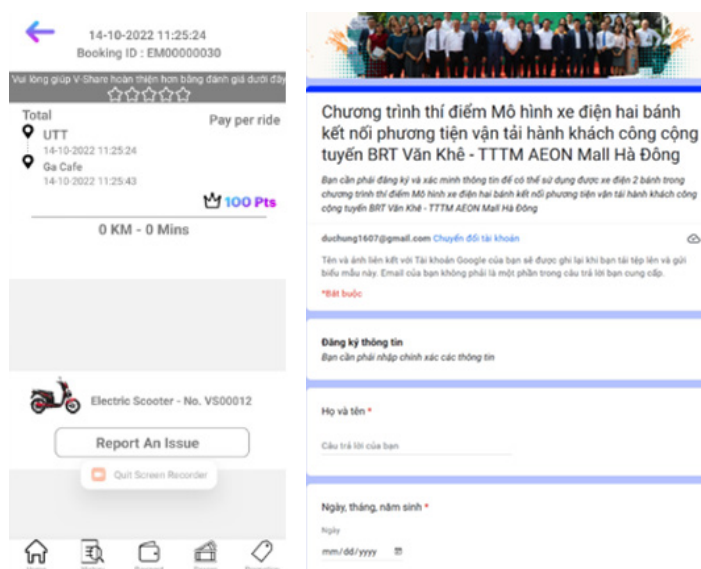


Figure 15. V-Share application was used from November 28 to December 13, 2022 (left photo); Google Forms will be used from December 14, 2022 until the end of the pilot (right image).

Repair workshop

Technical logistics are crucial for the effective operation of the system, including the maintenance and repair of vehicles and equipment to ensure user safety. During the pilot operation, small maintenance and repair activities, such as tire inflation and cleaning, are being carried out at the UTT workshop.

As previously mentioned, failures and incidents primarily pertain to the batteries and electrical systems. Additionally, due to the recent implementation of the new system, the demand for vehicle repairs and maintenance is currently low. However, operating mopeds requires a high level of technical expertise, which will require further evaluation and planning in the future.

Implementing Agency and Operator

According to the 2013 ITDP guidelines, the operator is responsible for the day-to-day operations of the public shared two-wheeler system. This includes managing the maintenance and cleanliness of the fleet of vehicles and stations, as well as redistributing the vehicles. The operator is also responsible for customer service, payment processing, marketing, and brand management of the system, except in special circumstances.

As discussed in the previous section, UTT serves as both the implementing agency and the operator in this pilot project. The characteristics of the pilot system operation can be summarized as follows:

- The system cannot fully reflect the actual needs of a standard operating system because the main components for operating electric bicycle- and moped-sharing have not been established, and some technical infrastructures are still lacking.
- Due to technical barriers, the system is not fully automated yet. Personnel are needed at some stages of the operation.
- The pilot activity is currently free of charge, requiring no financial management process, payment methods, or integration with online payment service providers.
- Supporting infrastructure to address logistical issues was not required. Vehicle redistribution activities were relatively simple during the pilot period.

Due to these characteristics, a private company was hired to operate the system, separating the supervisory role of the regulator. Lesson learnt from this practice includes:

- Investing in and developing a complete system will help the sharing system operate efficiently, safely, and with lower operating costs.
- Selecting a suitable management model. There are three common management models globally:
 - o Government invests, businesses operate
 - o Government and businesses jointly invest and operate
 - o Government plans, manages, supervises; businesses invest and operate.
- The choice of management model depends on several different factors, including investment capital, availability of management institutions and relevant government regulations, ownership of core technology by the private sector, and the availability of infrastructure and space.

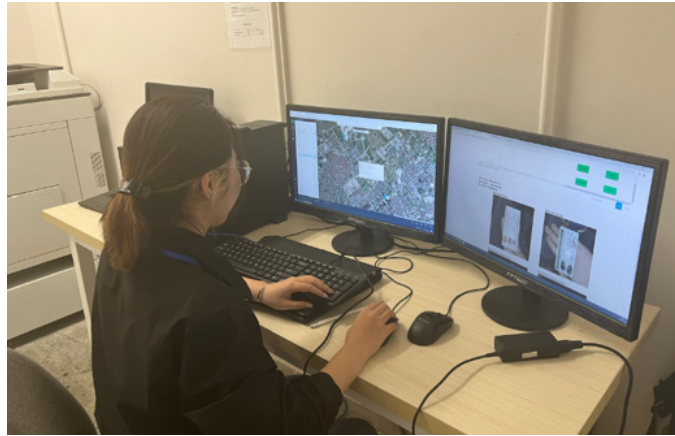


Figure 16. Control room

Users

This project identifies its users as BRT or bus passengers needing last-mile solutions to reach Aeon Mall supermarket area. These passengers alight at Van Khe BRT stop and borrow the electric two-wheelers to travel to Aeon Mall. Given that the pilot two-wheeler sharing system has only recently been implemented, observations indicate a need for additional technical guidance for users. Improved communication strategies should be employed to attract more users to the system. To synthesize lessons learnt from the shared-vehicle operation, user interviews were been conducted.

The initial responses from the users are summarized below:

- Early registration and usability: Most of the users mentioned that the registration process was straightforward and the system was easy to use. They were also satisfied with the staff's service and the quality of the vehicles.
- Novelty and curiosity: Some of the users were excited about this new and innovative type of transport due to its novelty and their curiosity to try the experience. However, a few users were hesitant and not willing to try the vehicles, even after asking numerous questions about the project.
- Preference for personal vehicles: Many people prefer to use their personal vehicles to travel to Aeon Mall, as it allows them more control and flexibility over their entire journey.
- Misuse of vehicles: A few users intentionally or unintentionally went in the wrong direction or used the vehicles for their own purposes and destinations (e.g., picking up their kids, going to a spa, going home). Four cases recorded during the pilot involved users contravening regulations by using vehicles for personal purposes or traveling on the wrong route, lane, or part of the road.
- Inquiries about payment: Many users inquired about the payment process and pricing for this service.
- Interest in service expansion: Some users asked about the possibility of expanding the service to other routes.

Based on the interview results and analysis of the pilot project, the following factors were identified as influencing users to utilize the service:

Habits of using personal vehicles

The use of private vehicles remains common due to the convenience of mopeds and the inadequacy of the public transport system. A proper and reliable public transport system and changing people's habits to shift to public transport usage takes time and requires support and encouragement from the government.

Communication and provision of information

Effective communication and provision of information are crucial to reaching potential users of the sharing system. Communication activities need to be initiated as early as possible, particularly during the initial system establishment phase, and should continue throughout the operational phase.

Potential users' identification

Identifying potential users and those who may have difficulty using the service is crucial to ensure appropriate support and promotion plans.

Usability of the system

Technologies provided by the system such as applications for registration, itinerary management, and payment, need to be designed with an easy-to-understand interface, good connectivity, and user-friendliness.

Local weather

Hanoi's extreme weather—hot summers with rain showers and cold, drizzly winters—along with inadequate transportation infrastructure and public transport, has led Vietnamese people, especially those in Hanoi, to rely on personal vehicles. Changing this habit to favor public transport requires effective, drastic, and long-term solutions.

It is hoped that, in the near future, the two-wheeler sharing model will scale up in Hanoi, promoting the formation of new habits and increasing awareness among road users about the benefits of using public transport.



Figure 17. Guiding for registering and using the service

4 OPPORTUNITIES AND BARRIERS FOR SHARED ELECTRIC TWO-WHEELERS IN HANOI

4.1. Opportunities for Shared Electric Two-Wheelers

Promotion of E-Mobility in NDC Target

- The Paris Agreement on Climate Change was adopted by countries at COP 21 as the first legal document regulating responses to climate change globally. Decision No. 1/CP.21 of the Paris Agreement on Climate Change mandates that all parties review and update their Nationally Determined Contributions (NDCs) at least every five years, aiming to increase their ambition to mitigate greenhouse gas (GHG) emissions.

- Viet Nam updated its NDC in 2022 increasing its targets for GHG emission reduction by 2030 compared to the business-as-usual (BAU) scenario. The targets include a 9% unconditional reduction (equivalent to 83.9 million tonnes of CO₂e) and a 27% conditional reduction, contingent upon sufficient foreign financial support (equivalent to 250.8 million tonnes of CO₂e). During the 2021 United Nations Climate Change Conference (COP26) in Glasgow, Viet Nam Prime Minister made ambitious commitments that include setting the national target of net-zero emissions by 2050.

- Viet Nam's NDC sets out two measures to promote electric and public transport: converting passenger transport from using private vehicles to using public transport (Measure E18) and the usage of electric mopeds (Measure E25).

National and City Policy

- The Viet Nam Green Growth Strategy (VGGS), approved in 2021, sets short, medium, and long-term targets to reduce GHG emissions intensity and promote the use of clean and renewable energy.

- The National Strategy on Climate Change (NSCC) 2050, approved in 2022, aligns with the goal of carbon neutrality by 2050. It acknowledges that reaching net-zero emissions by 2050 is a global development objective, achievable through a strong energy transition, low-emission development, and the transformation of economic growth models.

- Decision No. 888/QĐ-TTg outlines the approved scheme for implementing the results of the 6th Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC). The Decision includes tasks to promote emission reductions in transportation, and mitigate GHG emissions in the production of building materials, urban development, and green construction. The Decision also aims to promote the use of public transportation over private means of transportation in urban areas, with the goal of increasing the market share of public passenger transport. Additionally, it seeks to expand and develop non-motorized traffic.

- Decision No. 876/QĐ-TTg approves the Action Programme on Green Transformation, Carbon and Methane Reduction of the Transport Sector. The programme aims to develop a green transport system to contribute to achieving net-zero emissions in the transport sector by 2050. The action plan consists of two implementation phases.

The first phase, from 2022 to 2030, aims to enhance fuel efficiency and accelerate the switch from conventional fuel to electricity and other green energy sources for subsectors that have the necessary technology, institutional support, and resources to achieve the NDC's commitments and methane reduction objectives. The second phase, from 2030 to 2050, aims to switch all transport vehicles and equipment to electricity and green energy to achieve the zero-emission target.

- The Draft Law on Road Traffic (revised 2020) includes more specific regulations on the transportation of passengers and goods using rudimentary vehicles, mopeds, three-wheeled motorcycles, and similar vehicles (Article 129), as well as regulations on the rental business of self-driving vehicles (Article 135).
- Various city-level policies to encourage the use of public transport:
 - Plan No. 201 mentioned the shared two-wheeler to the public services
 - Resolution No. 07/2019/NQ-HDND dated July 10, 2019, on prioritizing the development of a large volume public passenger transport system
 - Plan No. 201/KH-UBND dated October 16, 2020, of the City People's Committee on the development of public passenger transport vehicles in the city for the period from 2021 to 2030

Operational Costs of EVs

Technologies/ Mobile App

- Advances in science and technology can improve the quality of electric vehicle-sharing services and enhance operator management capacity, provided they are applied appropriately and balance costs and usage.
- The quality and technology of electric two-wheelers are improving while prices are decreasing. Advanced battery technology now allows for fast charging and longer operating distances after charging. VinFast reports that the maximum range of their new generation of electric mopeds is nearly 200km.
- Advanced technology can be used to manage and operate shared vehicle fleets through the app and IoT, resulting in improved efficiency and cost-effectiveness. This will also enhance journey management convenience and simplify the monitoring process.

User's Willingness to Use

- There has been an increase in people's awareness and responsibility in responding to climate change. People are gradually adopting more environmentally friendly behaviors and making choices that are more responsible towards climate change.
- The need for public transportation is increasing due to traffic congestion, traffic safety threats, and air pollution in many urban areas.
- To shift people's travel behavior, service quality of public transportation companies needs to be improved. Regulations for the related public transportation companies also need to be developed and enforced.
- The government and localities are investing in the development of public

passenger transport infrastructure. The system is becoming more modern and is attracting more people to use it.

- Uncertainty and instability regarding fossil fuel supply and prices will encourage people to shift to electric vehicles and public transportation.
- Frequent traffic congestion is pushing more people to opt for public transport.

Active and Accountable Support from International Organizations

- In transitioning to green transportation and working towards the government's commitment to achieving the ambitious target of net-zero emissions by 2050, Viet Nam has received and will continue to receive active and responsible support from international organizations on research and development as well as capacity development.

Expansion of Public Transport and Shared Two-Wheelers

- The bus network in Hanoi now covers all 30 districts and towns, contributing to the development of two-wheeler sharing services.
- Many cities worldwide have popularized shared two-wheelers. This experience will be valuable in shortening the development time of the shared two-wheeler business model in Vietnam.

4.2. Barriers for Shared Electric Two-Wheelers

The shared two-wheelers system has gained considerable popularity worldwide and is increasingly asserting its importance in the traffic landscape of modern cities, contributing to GHG reduction and net-zero emission targets.

However, shared two-wheelers are still in their infancy in Vietnam and have only been implemented as pilot projects. Identifying barriers across various aspects such as planning, implementation, and operation, and conducting comprehensive analyses of key factors including parking/public charging station planning, technology, financial planning, stakeholder participation, and policy support, will pave the way for the realization of shared two-wheeler systems in the future.

Policy and Management

• **Lack of specific implementation guidelines:** While the government's strategies and policies establish clear goals for public transportation, there is a lack of specific instructions and roadmaps for implementing shared electric two-wheelers. This hinders the achievement of these goals. Furthermore, the official concept and definition of shared bicycles, electric mopeds, or shared-vehicle services are absent from the government's management documents. This absence complicates the review, licensing, implementation, and operation processes, as well as the determination of appropriate management models.

• **Complex business registration procedures:** Business registration and related procedures for shared electric vehicles are very complicated and legally unclear. According to Decision No. 27/2018/QĐ-TTg dated July 6, 2018, of the Prime Minister promulgating the System of Vietnam's economic sectors, only "motor vehicle rental" belongs to industry code 7710 and "sports and entertainment equipment rental"

belongs to industry code 7721. Meanwhile, businesses that registers as a vehicle rental are not eligible for several incentives for public service provision activities, such as tax rebate and fees reduction.

- **Missing regulatory instruments:** Currently, road public passenger transport services are regulated under the following types:
 - o Passenger transport by fixed routes
 - o Passenger transport by bus on fixed routes
 - o Passenger transport by bus
 - o Taxi
 - o Contract passenger transport not on fixed routes
 - o Tourist transport by car (Decree No. 10/2020/ND-CP dated January 17, 2020, of the government on car transport business and conditions for car transport business by car)
 - o Motorbike taxis
 - o Technology vehicles (e.g., Grab, Go-jek, Be)

However, service providers for these vehicle types provide both vehicles and drivers for the users. Meanwhile, shared electric two-wheelers only provides vehicles.

- **Involvement of multiple management agencies:** The shared-vehicle system's licensing, implementation, and operation involve multiple management agencies, adding complexity:
 - o Ministry of Construction: manages activities related to infrastructure development and investment
 - o Ministry of Transport: manages passenger transport services
 - o Ministry of Natural Resources and Environment: oversees land use rights, compensation, and site clearance
 - o Ministry of Finance: managing public fund
 - o Ministry of Industry and Trade: manages licensing and connection to the national power grid network
 - o City People's Committee: plans the bicycle stations, motorcycles, electric charging stations on sidewalks, and public spaces in urban areas.
- **Absence of special pricing regulations for electricity:** There are currently no regulations regarding the special pricing of electricity for charging stations. It is important to note that electricity prices for daily life, production, and business are regulated by Circular No. 16/2014/TT-BTC dated May 29, 2014, of the Ministry of Finance. Additionally, there are regulations on the use of electricity as renewable and clean energy.
- **Unclear implementation documentation:** Although Hanoi's Development Plan includes activities to promote the development of public transportation and increase connectivity and accessibility to the public transportation system, the documents guiding implementation have not been clearly defined. This includes policies to promote socialization and encourage investors, financial support policies, and allocation of implementation resources. The lack of detailed planning creates difficulties for private entities that wish to participate in providing shared electric two-wheeler services.
- **Lack of financial support policies:** The lack of financial support policies for shared electric two-wheelers is a significant concern. While there are preferential policies

supporting 50% of bank loan interest rates to invest in CNG buses (Circular No. 02/2016/TT- BTC dated January 6, 2016 of the Ministry of Finance), similar incentives are not available for other sustainable transport options like shared electric two-wheelers.

Infrastructure and Facilities

- **Mixed traffic:** Traffic features in Hanoi is characterized by mixed traffic, making dedicated lane for two-wheelers unavailable.

- **Insufficient infrastructure planning:** The current infrastructure plan has not accommodated shared two-wheeler services. Very few places are eligible to be utilized as parking lots for shared two-wheeler projects. Some sidewalks might be eligible for parking, but not necessarily reasonable as routes.

- **Lack of uniform standards:** Vietnam currently lacks uniform standards for electric vehicle charging station systems. It is important to establish comprehensive standards to ensure the efficient and safe operation of electric vehicle charging stations throughout the country. While there are individual standards for charging station connection points and charging stations themselves, there are no standards for the location or construction techniques of these stations. Standards for electric two-wheeler are also currently under development, such as:

- o QCVN 75:2019/BGTV-T - National technical regulations regarding engines used for electric bicycles

- o QCVN 76:2019/BGTV-T - National technical regulation on traction batteries for electric bicycles

- o QCVN 90:2019/BGTV-T - National technical regulation on engines for electric motorbikes or motorcycles and mopeds

- o QCVN 68:2013/BGTV-T - National technical regulations on electric bicycles

According to lessons learned from global case studies, however, vehicles used for shared vehicle systems require higher and more specific technology than typical vehicles, necessitating separate standards for this type of vehicle.

- **Public space usage fees:** Bus stations, sidewalk parking lots, and public places are publicly owned according to the provisions of the Law on Management and Use of Public Assets. Therefore, service providers must rent public property or pay fees to use sidewalks and public spaces. Fees for temporary use of roadbeds and sidewalks are authorized by the Provincial People's Council under the Law on Fees and Charges No. 97/2015/QH13. However, the use of public space also requires approval and appraisal from various authorities.

Environment, Travel Behaviors, and Users' Knowledge

- **Weather conditions:** Unfavorable weather and climate, combined with mixed traffic, discourage people from using roofless vehicles, especially bicycles.

- **Limited adoption among elderly:** The use of public transport and phone apps among the elderly is still limited. Especially after the COVID-19 pandemic, the number of people using public transport decreased as many switched to private vehicles. Once individuals have their own vehicles, they are often reluctant to return to using public transport.

- **Unregulated job positions:** The job positions in this business model have not been regulated, which may lead to a lack of professionalism among the staff of the operation

team. Additionally, the pilot projects have not been implemented for a sufficient duration nor on a large enough scale to allow people to become accustomed to this new type of public transport.

5 POLICY RECOMMENDATIONS

Based on the pilot results and the analysis and evaluation presented above, it is necessary to propose a policy for the development of shared electric two-wheelers in Hanoi. This transport mode has seen strong development in many cities worldwide, with varying policies depending on local characteristics such as transport infrastructure, travel behavior, and weather conditions. However, the shared electric two-wheeler service in Hanoi is still in its early stages. When developing these policies, it is crucial to draw lessons from the experiences of other countries while also considering Hanoi's unique characteristics. This approach will help mitigate potential losses and risks and ensure the adoption of the latest shared electric two-wheeler models to meet the mobility needs of the populace.

Notes for policy makers:

Important factors related to the success of shared mobility services include system expansion, solid regulatory frameworks, sustainable financing models, user-friendly pricing structures, effective management, integration of advanced technologies, public-private partnerships (for bike and e-bike/ e-mopeds sharing services), and adherence to safety regulations.

5.1. Principles of Deploying Shared Electric Two-Wheelers

These principles are based on the city's political will to develop shared electric two-wheelers in Hanoi. Shared electric two-wheeler systems should be considered a mode of public transport service to be eligible to qualify for incentives related to public services. The current policies related to shared electric two-wheeler services in Hanoi should be clarified.

The city needs to take action to establish a legal framework for the shared electric two-wheeler system. This will support planners, investors, and other partners in their innovative roles and contributions to the shared electric two-wheeler activities.

The Hanoi People's Council will need to consider policies that encourage, incentivize and support the development of shared electric two-wheelers. The Hanoi People's Committee should also issue plans and specific regulations based on the recommendations mentioned in the next sections.

The policy targets can be listed as follows:

- *Developing shared electric two-wheeler systems contributes to the city's green transportation system and aligns with the city's public transport strategies and plans.*
- *Create an enabling environment to encourage businesses to participate in the city's shared electric two-wheeler services.*

The city needs to propose a set of policies to create enabling environment to encourage private sector and other stakeholders to invest and participate in providing services for shared electric two-wheeler. Since the concept of vehicle-sharing is not yet included in Viet Nam legal system, building an appropriate strategy to promote vehicle-sharing system will be challenging. The absence of vehicle-sharing concept in almost all of the regulations is identified as a major barrier in attracting private sector to invest in this new business model. This is due to lack of knowledge regarding applicable regulations

and legal framework, generating high risk for the investment. From the government's side, this absence also led to difficulties in managing this type of services.

Some key terms below to be considered:

- *Shared electric two-wheelers is a two-wheeled means of transport serving the purpose of connecting public transport, including electric-assisted bicycles and electric mopeds, that are used for shared electric two-wheelers system.*
- *Shared electric two-wheeler system is a collection of multiple stations and borrowing/ returning points of a service provider, aiming to provide two-wheeled vehicles for people to travel on short routes in a short time within the designated area. The system's two-wheelers can be used for free or for a fee.*
- *The station is a location where service users can borrow and return two-wheelers.*
- *IoT comprises the vehicle's lock control device and cruise monitoring. It is an electronic device mounted on a vehicle to automatically lock/ unlock the vehicle, allowing users to borrow/ return the vehicle. The IoT device is also used to record, store and transmit the required information related to the vehicle's journey.*
- *Management software or the mobile app is an application installed by users on their phone to borrow/ return the vehicle. This app is also used for managers to monitor the activities of users and vehicles.*
- *User account is a set of usernames, passwords or other authentication measures that are used in shared two-wheelers management software.*

The road map for shared electric two-wheelers should fully include the following contents:

- *Set clear targets based on the transport development strategies/ masterplan and plans of the cities*
- *Set of the objectives for each planned area based on the traffic characteristic of specific areas. The system should take place as feeders to enhance accessibility of the city public transport system.*
- *Propose a policy package for development and operation of the shared electric two-wheelers services, such as fiscal incentive policies, pricing policies, public and private partnership policies, vehicles and infrastructure technical standards, public awareness raising policies, and operation models for specific investment types.*

The roles of People's Council: promulgating a resolution stipulating policies to encourage, give incentives and support the activities of shared electric two-wheelers in Hanoi.

The roles of People's Committee: developing and implementing the roadmap to develop the activities of shared electric two-wheelers in Hanoi city. Formulating the regulations on organization, management and exploitation of shared electric two-wheelers in Hanoi city.

The role of the Department of Transport: management of specific cases of investment in shared electric two-wheelers.

5.2. Specific Policy Recommendation in Developing Shared Electric Two-Wheeler System

Infrastructure Development Policies

Policy on infrastructure should consider two key aspects: a plan and implementation roadmap to develop the shared electric two-wheeler system in Hanoi city and specific regulations and technical requirements on infrastructure related to the sharing system.

The physical infrastructure for shared electric two-wheelers is relatively small compared to other transportation infrastructure. However, it will mostly be located

in public spaces and managed by multiple sectors. The planning and development of infrastructure for shared electric two-wheelers depend on various factors, such as:

- The scale or areas of provided services: Defined based on minimum coverage area, station density, e-two-wheeler-per-resident ratio and the parking-per-e-two-wheeler ratio.
- Selection of stopover stations: Influenced by the connection to other public transport system, connection between residential area and workplace/schools, connection between tourism or commercial areas with public transport system.
- Technologies to be applied: Bicycle and e-bicycle sharing services can be either free-floating or station-based, while mopeds and e-moped sharing services are exclusively free-floating. Free-floating systems offer greater convenience and flexibility, while station-based systems provide more organized infrastructure and centralized management.
- Fleet size: A larger fleet ensures vehicle availability, extends service coverage, and optimizes system efficiency.
- Ownership and operation models: Two-wheeler sharing systems can include public ownership, private ownership, or hybrid arrangements.

Regarding the roadmap for developing shared electric bicycles and motorcycles in Hanoi city, the planning for shared electric bicycles and motorcycles is an important aspect. The development of shared electric bicycles and motorcycles in the city in a planned and systematic manner will help the city proactively manage effectively and avoid the risks of excessive or insufficient development. Simultaneously, it contributes to adjusting the overall urban traffic landscape, including passenger transport activities through mass transit. During the planning process, the following recommendations should be considered:

- Organize tenders: With potentially numerous “shared electric bicycles and motorcycles” service providers throughout the city, it is necessary to organize tenders to enhance competition and transparency.
- Alignment with existing plans: The plan to develop “shared electric bicycles and motorcycles” in Hanoi city must be in accordance with Plan 201/KH-UBND dated October 16, 2020 of the Hanoi People’s Committee regarding the “Development of public passenger transport in Hanoi city during the period from 2021 to 2030”.
- Zoning plans: Zoning plans according to district administrative boundaries could be considered to facilitate planning and management.
- Tourist districts: Districts with high tourist concentrations may consider using bicycles (non-electric) for short-distance connections.
- Station density: The distance between stations in a shared bicycle system ranges from 300 to 500 meters, while in the shared electric motorcycle system, it is between 0.8 and 1.25 kilometers. Station density should

gradually increase according to actual system operating needs.

- **Priority locations:** The contractor will propose station locations, prioritizing areas near railway stations, bus stations, BRT stations, urban railway stations, shopping centers, schools, and densely populated areas.

Regarding infrastructure regulations: Based on the plan and roadmap for developing shared electric bicycles and motorcycles throughout the city, specific regulations on infrastructure and technical requirements for shared electric bicycles and motorcycles services need to be specified and included in the bidding documents with the following specific recommendations:

- **System scale:** The scale of a shared electric bicycles and motorcycles system can cover from one to several districts with a minimum area of 10 km² per system.
- **Minimum vehicle regulations:** Regulations should mandate a minimum number of vehicles for each station, calculated based on the local population, with a ratio between parking locations and vehicles at each station. According to ITDP's recommendations, the number of vehicles calculated based on local population is about 10-30 vehicles/1000 residents. The ratio between parking locations and vehicles at each station is about 2-2.5 times.
- **Location preferences and station permits:** Preferential policies regarding location, area (especially sidewalk use regulations), station construction permits, station architecture and structure should be clearly stated by the City. Stations should be close to public transport stops and stations, facilitating increased connectivity and accessibility to mass public transport and last-mile connectivity. They should also be situated on safe roads for two-wheelers to access and on or near street corners for easy access from multiple directions.
- **Power connection and technical requirements:** Regulations on power connection for charging stations, technical requirements, appearance, and fire protection plans need to be established, especially concerning sidewalks.
- **Station equipment:** Regulations on equipment that can be installed at the station, such as signs (electronic or regular), surveillance cameras, and vending stations, should also be considered to enhance revenue for the operator.

An appropriate infrastructure development plan from the government can also enhance the implementation of the city's transport development plan, improve the accessibility of the public transport system, and contribute to the city's emission reduction targets. The plan should be associated with Plan 201/KH-UBND, dated October 16, 2020, of the Hanoi People's Committee on the development of public passenger transport vehicles in Hanoi city from 2021 to 2030.

Financial Policies

Smaller electric two-wheeler sharing systems, such as e-bicycles and e-mopeds, can be funded through a mix of public and private sources, including government subsidies, corporate sponsorships, and public-private partnerships. However, e-moped sharing

systems primarily depend on private funding sources, including venture capital investment and investments from companies and individual shareholders. Therefore, Hanoi city should establish a financial mechanism that includes regulations for venture capital and start-ups, incentives for utilizing public infrastructure, pricing strategies, tax waivers, and registration fee waivers for private companies that pioneer these areas and catalyze the expansion of the system in the future.

Incentives are important for promoting electric two-wheeler sharing systems among operators and users, which can drive adoption and usage. Electric two-wheeler operators may receive financial support, subsidies, partnerships, and preferential access to public spaces. These incentives can contribute to the success and growth of shared mobility systems, fostering positive environmental, social, and economic outcomes. There is a dearth of information available on operator incentives for the e-moped sharing service, which may be due to the lack of direct government involvement in this system.

Main cost items:

Investment cost: vehicle fleet, station (including all equipment at station), IT system components, control center, maintenance equipment, service vehicle service and media regulation of the system. Working capital, the cost of running the organization before revenue begins, including pre-opening staffing, installation, marketing, website creation, and launch costs, can also be capitalized.

Operating costs: reflect the size and complexity of the system. These costs include staff salaries, spare parts, fuel for service vehicles, vehicle regulation costs, marketing, website hosting and maintenance, electricity and Internet connections for stations, card membership, warehouse insurance and administrative costs, interest rate.

Revenue: revenue including user service fees and other revenue sources generated by the city's facilitation will be mentioned below.

User incentives for ride-sharing services may include discounted rides, memberships, integration with public transportation, and rewards for desired behaviors. Users can earn points, credits, or discounts for frequent usage, referrals, or other desired behaviors to encourage long-term engagement. For instance, in 2017, Mobike, a leading bike-sharing company in China, introduced a new feature that rewards users with credit or cash for discovering and using bikes left in remote or less desirable locations. The aim is to encourage users to park their bikes in more suitable areas (Quartz, 2017).

Management and Operation Policies

Management Model

The organizational structure of bicycle, e-bicycles, and e-mopeds sharing systems varies significantly globally. Some systems are publicly owned and operated by local governments, while others are privately owned and operated by companies. In some cases, a hybrid model exists where the system is publicly owned but operationally managed by a private company through partnerships. This exemplifies the various approaches used to implement and oversee shared mobility services across the world.

- Publicly owned and operated systems: Publicly owned and operated systems are owned and operated by the local government. This model helps stabilize the system but requires high investment budget and management costs from the public budget.

- Public-private hybrid model: Owned by public transportation agencies and operated by private companies, allowing for a more flexible model compared with publicly owned and operated model. However, this model still requires high investment cost from government.
- Privately owned and operated systems: These systems are privately owned and operated, with partnerships with the government, requiring the government to provide clear policies and incentive mechanism for the private sector.

The management model of the shared electric two-wheelers system generally includes two constituent agencies: the management authority and the operating unit.

- Managing authority: The city agency responsible for overseeing the planning, organization of tenders, and implementation and operation of the shared electric two-wheelers system is the governing body with management authority. It is preferable that this agency has control over roadways and sidewalks and is authorized to build or administer public works. The management agency serves as an arbitrator, prioritizing the best interests of the city and users while maintaining objectivity and facilitating the operator's effective exploitation of the system. Ideally, the agency should be independent of the contractor operating the system.
- Operator: Operator is the winning bidder to provide shared electric two-wheelers service in a specified area in the city.

Bidding and Service Licensing

Organizing tenders for the provision of shared electric two-wheeler services will increase transparency in the operation of these services throughout the city. Additionally, the bidding process will help select operators capable of meeting the city's demand for shared electric two-wheelers and curbing their rapid development.

Bidding documents would contain requirements and regulations on these following items;

- Rights and responsibilities of enterprises while using roadbeds and sidewalks for parking
- Minimum density of vehicle borrowing/ returning stations in the enterprise's shared electric two-wheelers system
- Minimum number of vehicles at each parking location
- Financial and technical capacity requirements (means and management software, other ancillary equipment)
- Human resource requirements
- Regulations on communication and advertising
- Responsibility for the safety and handling of discarded end-of-life products
- Regulations on data storage and ownership of operating data of the system

Selecting contractors for shared electric two-wheeler services can be similar to bidding for bus transport services in Hanoi. The Department of Transport will oversee planning, developing bidding documents, and organizing bidding. The selected entity will receive authorization to operate a shared electric two-wheeler service within the designated region. Designating a focal point, such as the Department of Transportation, as suggested earlier, will aid in streamlining the process of obtaining operating licenses for businesses.

Vehicle's Characteristics and Related Equipment

Vehicles

Shared electric two-wheeler systems typically use standardized two-wheelers with specially designed or proprietary components to increase durability and prevent theft or resale. The appearance of the two-wheeler is a crucial factor in the branding of the shared electric two-wheeler system. The design can differentiate public two-wheelers from ordinary city two-wheelers using distinctive colors, frame styles, moldings, and graphics. It is important to study shared electric two-wheelers as they will be used daily, unlike regular two-wheelers designed for less frequent use. System designers must define two-wheeler guidelines as a crucial aspect of the system's brand and experience. Features that should be considered include:

- One size fits most users: Shared electric two-wheelers systems usually provide only offer one size two-wheeler. While it is essential for the two-wheelers to be comfortable for users, the limited size options mean that it must be chosen to be relatively suitable for most users. Cities can determine the average height of their users and make recommendations based on that. A design with an adjustable seat and handlebar post can easily accommodate a variety of heights.
- High durability: Public two-wheelers are subject to significantly higher usage rates compared to privately-owned ones, often being used between six to nine times per day. Therefore, vehicles should be of good quality and durable.
- Low maintenance: Two-wheeler designs should have less maintenance, including tire inflation, chain adjustment and lubrication as well as brake adjustment, reducing the operating costs.
- Resistant to theft and vandalism: To prevent theft, two-wheelers must be securely locked into the station space and have unique, distinctive features to prevent the removal and sale of vehicle parts.
- Safety: All two-wheeler colors, appropriate reflectors and nighttime lights must be considered and must meet local laws relating to two-wheeler safety.
- Storage basket: The front basket is often preferred over the rear rack to help users carry their belongings. Many systems use rear racks and baskets to discourage a second person from sitting in the back or carrying too much weight.
- Helmets: To ensure the safety of vehicle users and comply with the Road Traffic Law, helmets need to be provided. Helmets need to be individually

identifiable, designed to reduce the possibility of theft. In addition, the implementation of initiatives to use helmet buttons as vehicle “keys” and other initiatives to ensure helmet management are encouraged⁷.

Some notes: *The shared electric two-wheelers system need to be specially designed and manufactured, specialized to overcome the shortcomings and meet the requirements mentioned below:*

- *Bicycles are a convenient mode of transportation as they do not require a driver's license and do not rely on electricity. However, their usage may be limited in Viet Nam due to inclement weather conditions such as rain or heat. Bicycles are best suited for short routes.*
- *Electric bicycles can overcome the limitations mentioned above, but their carrying capacity is limited to one person with a small luggage bag. It is important to note that the quality and durability of these vehicles are often limited, so maintenance and repair work should be a priority. For Hanoi's traffic conditions, electric bicycles designed specifically for public use may be the best option.*
- *High-value electric mopeds often require complex maintenance work. Some models have tightly controlled battery and electric systems, making the installation of IoT devices potentially problematic. When operating an electric mopeds, it is important to carry the vehicle's registration certificate in accordance with Clause 2, Article 58 of the Road Traffic Law.*

Technology application

Shared two-wheelers systems heavily rely on technology to operate and provide users with a convenient and efficient means of transportation. Most shared electric two-wheeler systems have GPS tracking, mobile apps, QR code scanning, NFC-enabled cards, Bluetooth unlocking, machine learning algorithms, sensor fusion technology, smart card-based system, and centralized control system for efficient operation and user convenience. These items serve this following function:

- GPS tracking: identify users' routes and ensure vehicles will place at the designated locations
- Mobile apps: provide information for users and to pay the use fees
- QR code scanning: facilitate payment or lock/ unlock the vehicle

In addition, swappable batteries can be considered for battery management. By implementing swappable batteries, the operational efficiency of shared micro-mobility systems is significantly improved, resulting in reduced energy consumption and emissions.

Equipment maintenance and repair

Depending on the size of the system, the coverage areas and the number of vehicles involved in the system, operators can develop their strategies for maintenance and repair. Many maintenance activities for the infrastructure such as charging stations, power supply and vehicles need to follow the government regulations. Thus, the operator can consider developing a workshop for maintenance and repair activities or use the service providers for more professional practice. specific conditions, is essential.

⁷The helmet button is designed to function as a “key” for returning the vehicle. User who wants to return the vehicle to end his trip must use the helmet button to plug it in vehicle's helmet lock

Training Policies, Communication, Capacity Building, Scientific Research and International Cooperation

- Communication and education: Awareness-raising efforts should receive consistent and long-term attention. Developing a comprehensive program at the city level, followed by smaller, tailored programs at local and organizational levels, based on specific conditions, is essential.
- Regulations for decommission and recycling: Implement strict regulations for the decommissioning, collection and recycling of components or vehicles from the shared electric two-wheeler project to ensure environmental safety and resource management.
- Funding policy for research: Develop a funding policy to encourage research projects, pilot programs for shared electric two-wheelers. This will support innovation and provide insights for system improvements.
- Implementation conditions: Provide suitable conditions for the implementation of the shared electric two-wheelers pilot project. Necessary infrastructure, legal frameworks, and financial support should be made available to facilitate successful execution.
- Strengthen international cooperation: Enhance international cooperation to improve the capacity of shared electric two-wheeler initiatives. Collaborating with global partners can bring in new technologies, best practices, and additional funding opportunities.

6 CONCLUSIONS

Vietnam, particularly Hanoi, requires strong actions to reduce GHG and toxic gas emissions, alleviate traffic congestion, and mitigate traffic accidents. These actions are crucial for fulfilling the government's commitment made at COP26. Priority should be given to policies aimed at encouraging public transportation usage, with a focus on solutions utilizing public two-wheelers.

Based on the findings above, the Hanoi Department of Transport, as the agency in charge of the city's transportation sector, should lead and collaborate with relevant agencies to propose the aforementioned policy measures to the Hanoi People's Committee. These actions aim to facilitate the effective and sustainable operation of shared electric two-wheeler services, ultimately achieving goals such as reducing private vehicles usage, alleviating traffic congestion, as well as decreasing GHG emissions and toxic pollutants from engine exhaust in Hanoi City.

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ANNEXE

Annex 1: Examples of good practices of e-moped, bike and e-bike/moped sharing schemes from different countries

Type of shared mobility	Type of shared scheme system	Name of the shared mobility service	Location	Regulatory framework	Financing model	Organisational structure	Type of Incentives	Used technology
Bike sharing	Station-based service	Hangzhou Public Bicycle	Hangzhou, China	Minimum number of bikes in operation; guidelines for parking and maintenance	Financing: Government investment, sponsorship, advertising revenue Pricing: Free for the first hour, additional fees for subsequent hours based on a tiered pricing system.	Publicly owned and operated by the Hangzhou government	Free in the first hour and integration with public transport (for users); Government subsidy (for the operator)	Smart car, centralized control system (for real-time data)
E-bike sharing	Station-based service	YouBike 2	Taipei, Taiwan	A bicycle (in a free-floating bicycle sharing system) will be towed if it is parked where bicycle parking is prohibited.	Financing: Public and private sources (government subsidies and corporate sponsorships) Pricing: Tiered charging system based on usage duration, with discounts for combined transportation.	Publicly owned but privately operated by Giant Bicycles	Discount for combined transportation (for users); Partnerships with local governments (for the operator)	Electric system, smart panel, universal docking system, and light pile design
Bike sharing	Station-based service	ADCB Bikeshare	Abu Dhabi, UAE	Permits required from municipalities to operate; guidelines for bike maintenance, safety, and parking; helmet requirements for e-bikes and scooters	Financing: Public-private partnership funded by Abu Dhabi Commercial Bank Pricing: Complimentary 30-minute usage, charges apply for longer durations, with different pricing structures for daily passes, three-day passes, monthly memberships, and annual memberships.	Publicly owned but privately operated by Cyacle	Unlimited 60-Minute Trips, flexibility for longer rides, competitive pricing (for users); Financial support from a public-private partnership (for the operator)	Touchscreen kiosk, docking System, and code-based unlocking

Type of shared mobility	Type of shared scheme system	Name of the shared mobility service	Location	Regulatory framework	Financing model	Organisational structure	Type of Incentives	Used technology
Bike sharing/ e-bike sharing	Free-floating	Tel-O-Fun	Tel Aviv, Israel	City-level regulations; permits required; guide-lines for bike maintenance, safety, and parking; helmet requirements for e-bikes and mopeds	Financing: Public-private partnership, sponsorships, and advertising Pricing: Bike unlocking fee, per-minute charges, subscription programs, and discounted rates for different membership programs.	Publicly owned but privately operated by FSM Ground Services Ltd	Flexibility and cost-saving subscriptions (for users); partnerships with local government (for the operator)	Mobile apps, QR code scanning, GPS, electric locking and operating system, and smart LED lights
E-moped-sharing	Free-floating	Scoot	San Francisco, USA	A permit system for e-bike/e-mopeds sharing companies	Financing: Venture capital investment Pricing: Unlocking fee and per-minute charges for usage.	Privately owned and operated	Scoot community plan, Red, White and Scoot, low monthly cost, Scoot equity rentals, incentives for short trips, account credits for good behaviour, free helmets, parking behaviour feedback, community mode, and safety measures (for users); citation fine reduction incentive policy (for operators)	Mobile applications, GPS tracking, data analytics, machine learning algorithms, and sensor fusion technology
E-moped sharing	Free-floating	Loop Mobility	Doha, Qatar	Maximum speed limits, mandatory use of helmets, and designated areas for moped use. Riders must be at least 18 years old (Aurora Electrico, 2023).	Financing: User fees, sponsorships, partnerships, and government entities Pricing: Per-minute charges, unlocking fee, and different plans with varying pricing and free minutes.	Privately owned and operated	Choice of different pricing plans (for users); Partnerships with local governments (for the operator)	GPS technology and QR code scanning

Type of shared mobility	Type of shared scheme system	Name of the shared mobility service	Location	Regulatory framework	Financing model	Organisational structure	Type of Incentives	Used technology
Moped sharing	Free-floating	Revel	New York, USA	Mandatory use of helmets, and designated areas for moped use. Riders must be at least 21 years old	Private investment and venture capital funding	Privately owned and operated	Discounted ride packages, financial assistance discounts, and special discounts for service members	GPS tracking, a mobile application, code-based unlocking, and an app-based rental management system
Moped sharing	Free-floating	Cityscoot	Paris, France	Mandatory use of helmets and designated areas for moped use.	Equity financing, fleet financing	Privately owned and operated	Daily and monthly subscriptions, prepaid minute plans, special offers (e.g., free rides, reduced pricing), corporate customer discounts	GPS tracking, a mobile application, code-based unlocking, and an app-based rental management system

Sources from respective shared mobility service

