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Research Paper

# An Optimized Operational Model for the Development of Micromobility Systems in Metropolitan Areas
## (Case Study: Tehran)

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## Abstract

Micromobility has emerged as a flexible, low-emission alternative for short urban trips, attracting growing interest in densely populated cities. This study evaluates the financial viability of implementing a shared micromobility network in Tehran from the perspective of a private or institutional investor. Employing a discounted cash flow (DCF) model over a 2024–2029 evaluation horizon, the analysis considers direct monetary flows, including capital expenditures (CAPEX), operating expenditures (OPEX), and revenues generated through trip-based fare structures. Demand is disaggregated by trip-duration categories and monetized using calibrated fare multipliers aligned with duration-sensitive usage patterns. A real discount rate of 46.5% is applied to reflect local economic conditions and investment risk. The results indicate that the system operates below cost-recovery levels during the initial deployment years, but reaches operational breakeven in 2026, after which annual revenues exceed annual costs. By 2029, the model estimates total annual revenue of 49,279,481 million rials and total annual costs of 5,060,766 million rials, resulting in a final-year net operating surplus of 44,218,715 million rials, equivalent to approximately 44.22 trillion rials. These findings suggest that, under the assumed demand, pricing, and cost conditions, shared micromobility can become financially viable after the initial capital-intensive phase. The study provides a replicable framework for evaluating clean transport investments in emerging urban contexts characterized by inflation, demand uncertainty, and high operational risk.


**Keywords:** Micromobility Infrastructure, Urban Transport Investment, Financial Feasibility Analysis, Discounted Cash Flow (DCF) Modelling, Electric Bicycle Sharing, Operating and Capital Expenditures (CAPEX & OPEX)

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# 1. Introduction

The escalating challenges of urban transportation, ranging from traffic congestion and environmental degradation to public health risks, demand innovative and sustainable mobility solutions. Among the most promising developments in this domain is micromobility, referring to the use of compact, low-speed, and typically electric-powered vehicles for short-distance travel in urban environments [1]. This category includes electric scooters, e-bikes, mopeds, and other lightweight personal vehicles designed for efficient, flexible, and eco-friendly movement [2]. As cities worldwide strive to transform their mobility systems in line with climate targets and enhance the quality of life, micromobility has emerged as a key component in the discourse on sustainable urban transportation [3]. The global rise of micromobility has been facilitated by several interrelated factors: technological advancements in battery design and mobile applications, the proliferation of shared mobility platforms, and growing public awareness of climate change and air pollution. In numerous cities across Europe, Asia, and North America, micromobility has already demonstrated measurable impacts—such as improving first- and last-mile connectivity, reducing reliance on private automobiles, and alleviating urban emissions. Beyond transportation, these systems intersect with urban health, livability, and equity, forming an integral part of 21st-century urban design [4].

The city of Tehran, home to over 9 million residents and a metropolitan population exceeding 13 million, provides a compelling case for the development of micromobility infrastructure. According to the Tehran Traffic and Transportation Organization, more than 20.3 million daily trips are made within the city, with nearly 70% of these trips being less than 5 kilometers in length. Yet, over 80% of these trips are made using private cars or motorcycles, contributing significantly to traffic congestion and air pollution. A 2023 study by the Department of Environment indicated that transportation accounts for over 50% of Tehran's air pollution, with emissions from motorcycles alone contributing 30% of PM2.5 levels on high-traffic days. Despite a large share of intra-city trips being under five kilometers, non-motorized and micromobility modes account for a negligible percentage of daily travel. Factors such as inadequate infrastructure, poor integration with public transit, cultural biases, safety concerns, and Tehran's hilly topography have impeded widespread adoption. Nonetheless, micromobility remains a viable and potentially transformative alternative, particularly for short commutes and as a complementary solution to public transport systems. While numerous studies have explored micromobility in various global contexts, a notable gap remains in research dedicated to the economic and financial feasibility of implementing such a system in Tehran. This study addresses that gap by proposing an integrated evaluation of micromobility network development, with a specific focus on financial viability and technical and operational readiness. The aim is to support informed decision-making and investment strategies for sustainable mobility infrastructure.

Notably, this research offers a novel analytical perspective by quantitatively evaluating the potential costs and benefits of micromobility in comparison to traditional urban transportation options. Rather than viewing micromobility in isolation, the study frames it as part of a broader ecosystem of dynamic, demand-responsive mobility. It incorporates user travel patterns, behavioral data, and demand modeling to provide forward-looking projections of system performance. The use of predictive modeling tools based on localized data ensures that the analysis is not only theoretical but directly applicable to the realities of Tehran's urban fabric. Another forward-looking aspect of this study lies in its attention to emerging digital technologies and their role in facilitating the deployment of micromobility systems. While not the central focus, the research draws on the experience of cities that have successfully integrated smart mobility solutions such as GPS-enabled vehicles, app-based rentals, shared mobility platforms, and real-time data management. These innovations can enhance both user experience and system efficiency, and this study acknowledges their relevance in scaling up micromobility solutions across Tehran.

The primary objective of this study is to assess the economic and financial viability of establishing a micromobility network in Tehran. In this regard, the research examines both the direct and indirect costs and benefits associated with implementing micromobility systems, while also analyzing their potential impacts on traffic congestion, environmental pollution, and public health outcomes. Furthermore, the study estimates the demand for micromobility services by utilizing behavioral and travel pattern data, and it identifies the barriers as well as the enabling factors that influence the effective deployment of the network and user adoption. The study also recognizes that any urban transport innovation must be justified not only on technical grounds but also through robust economic evaluation. As such, the analysis examines financial costs, revenue potential, return on investment (ROI), and fiscal risks, thereby addressing the broader economic risks associated with both public and private investments, including alternative funding models and ROI scenarios. By combining microeconomic assessments with macro-level impact studies such as reductions in traffic externalities, improvements in public health, and enhanced urban resilience, the research provides a holistic understanding of micromobility's potential value. In addition, it examines the broader social and environmental implications of transitioning to micromobility, including enhanced accessibility, greater equity in transportation services, reduced household travel costs, and contributions to carbon reduction goals. Ultimately, by identifying both the financial risks and opportunities associated with investing in micromobility infrastructure, the study aims to support strategic decision-making, mitigate policy-related uncertainties, and contribute to the development of economically sustainable and socially inclusive frameworks for urban mobility.

This study is structured into five main sections: Section 1, Introduction, which introduces the problem, background, and relevance of micromobility in urban transport, with a focus on Tehran. Section 2, Literature Review Reviews existing global and regional research on micromobility, with emphasis on economic feasibility, policy frameworks, and implementation challenges. Section 3, Methodology Details the analytical framework used for economic evaluation, including cost-benefit analysis, demand estimation models, and risk assessment tools. Section 4, Results and Discussion, presents the findings of the feasibility study, including model outputs, comparative assessments, and implications for urban policy. Section 5, Conclusion and Policy Recommendations, summarizes key insights, proposes actionable policy steps, and outlines future research directions.

### 1.1. Research Objectives

The principal objective of this study is to evaluate the economic and financial feasibility of developing a micromobility network in Tehran. Specifically, the research aims to:

- Assess the direct and indirect costs and benefits associated with the implementation of micromobility systems.
- Examine the impact of micromobility adoption on traffic congestion, environmental pollution, and public health outcomes.
- Estimate the demand for micromobility services using behavioral and travel pattern data.

- Identify barriers and enabling factors for effective network deployment and user uptake.
- Analyze the economic risk associated with public and private investment, including potential funding models and return on investment (ROI) scenarios.

By achieving these goals, the study aims to inform strategic decision-making, reduce policy uncertainty, and contribute to the formulation of economically sustainable urban mobility frameworks.

## 2. Literature Review

This section presents a comprehensive overview of both the theoretical foundations and empirical research relevant to micromobility. The first part outlines the conceptual frameworks that situate micromobility within broader paradigms of sustainable urban mobility. The second part reviews prior studies that examine the operational, behavioral, and economic aspects of micromobility deployment in diverse urban contexts.

### 2.1. Micromobility within Sustainable Urban Mobility Paradigms

Urban mobility has been undergoing a paradigmatic transformation in recent decades, shifting from a supply-driven expansion of infrastructure toward sustainability-centered, user-focused, and environmentally responsible planning frameworks. One of the most influential models guiding this shift is the Avoid–Shift–Improve (ASI) framework, which emphasizes strategies for reducing unnecessary travel (avoid), promoting a shift to sustainable modes (shift), and improving efficiency through technology (improve) [5]. Within this triadic framework, micromobility is primarily positioned in the "shift" domain, as it offers a low-emission, space-efficient, and flexible alternative to car-centric urban travel—particularly over short distances.

Micromobility services such as electric scooters, bicycles, and e-mopeds have shown remarkable capacity to replace short trips that would otherwise be made using private cars. These modes reduce vehicle kilometers traveled (VKT), lower greenhouse gas emissions, and relieve pressure on public transport systems. Furthermore, micromobility enables a more dynamic use of public space, facilitating tactical interventions such as pop-up lanes, shared corridors, and multimodal hubs [6,7]. Their compact physical footprint makes them especially valuable in dense cities with limited roadway capacity and poor air quality, such as Tehran.

Beyond infrastructural and environmental benefits, micromobility is increasingly framed as a key component of Mobility as a Service (MaaS). MaaS envisions a digitally integrated ecosystem in which users plan, book, and pay for various modes of transport—public, private, and shared—via a single interface. In this context, micromobility offers crucial first- and last-mile connectivity, enhancing the usability of public transit systems and reducing modal fragmentation [8]. The digital operability of micromobility—enabled by GPS-based tracking, app-based rentals, and data-sharing platforms—also makes it highly compatible with smart city infrastructure. To understand the multi-dimensional role of micromobility, it is necessary to move beyond narrow definitions that focus solely on vehicle type or trip length. Recent conceptualizations propose a broader understanding that encompasses not only the vehicles and their usage patterns but also the surrounding ecosystems of policies, practices, technologies, and social norms that enable their function.

Figure 1 conceptualizes micromobility as a multi-layered urban mobility system rather than a single transport mode. The figure brings together a wide range of vehicle forms, including e-scooters, bicycles, e-bikes, wheelchairs, and other low-speed devices, and situates them within broader physical, social, technological, environmental, and regulatory dimensions. This conceptualization is important because each dimension affects the conditions under which micromobility can be successfully deployed. Vehicle type, speed, weight, range, and propulsion system shape infrastructure requirements, charging needs, maintenance intensity, vehicle lifetime, and operational reliability. Similarly, social and spatial factors such as user groups, accessibility, public health benefits, and equity considerations influence potential demand, willingness to adopt the service, and the extent to which micromobility can function as a practical first-mile and last-mile solution. The framework also shows that micromobility is embedded in a wider socio-technical and economic system. Regulatory practices, cultural acceptance, political support, street design, energy use, and environmental impacts are not peripheral issues; they directly affect system performance, cost exposure, pricing feasibility, and investment risk. For example, a system based mainly on electrically assisted shared vehicles requires greater attention to battery management, maintenance, fleet availability, theft and vandalism control, and rebalancing operations, whereas systems serving diverse user groups may require more inclusive station placement and differentiated pricing strategies. In this sense, the conceptual layers presented in Figure 1 provide the basis for interpreting micromobility as a spatially sensitive and operationally dependent service whose viability depends on the interaction between demand formation, fleet productivity, infrastructure provision, operating costs, and broader public benefits.

In the context of Tehran, this multidimensional interpretation is particularly relevant. The city's high share of short-distance trips, dependence on private cars and motorcycles, air-pollution pressures, and uneven access to metro and BRT stations create strong potential for micromobility, but this potential can only be realized where spatial suitability, user demand, operational capacity, and cost recovery are aligned. Therefore, Figure 1 supports the analytical logic of evaluating micromobility through an integrated framework that connects urban sustainability objectives with station-level deployment decisions, service design, fleet requirements, and long-term feasibility.

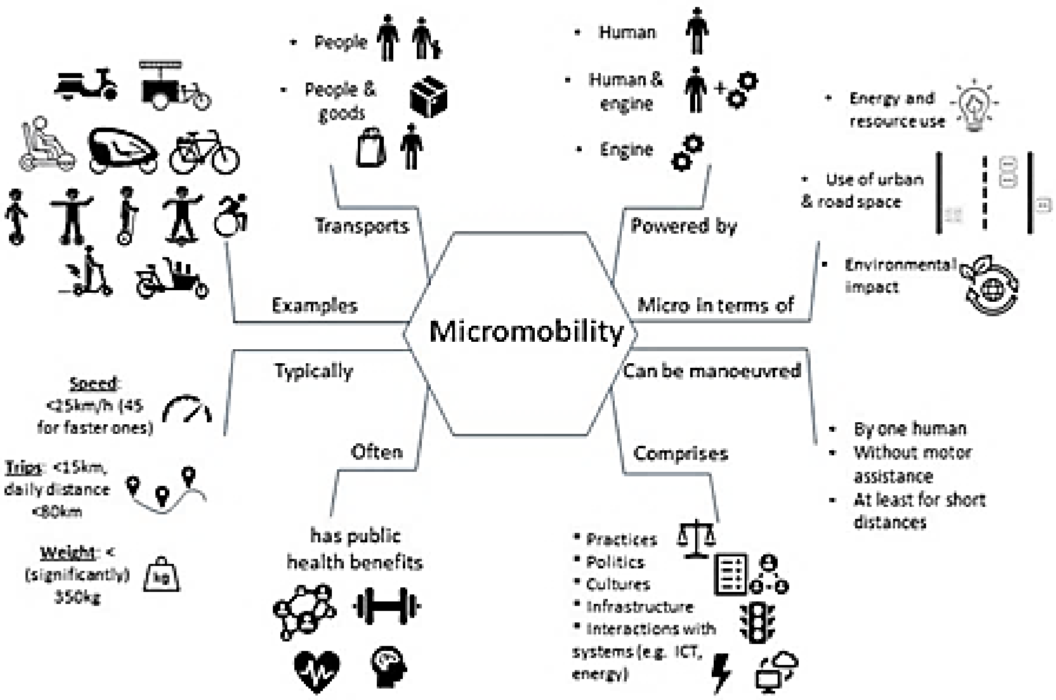


**Figure 1. A Comprehensive Visualization of Micromobility as a Multidimensional Concept, Including Vehicles, Users, Infrastructures, and Associated Benefits**

Beyond the structural and functional integration of micromobility into urban transport systems, recent scholarly work has emphasized the need to assess micromobility through a socio-technical lens. Such a perspective moves beyond interpretations that reduce micromobility either to a technological innovation or to an individual travel choice. Instead, micromobility is understood as a complex urban mobility system shaped by the interaction of environmental imperatives, user behavior, vehicle technologies, infrastructure provision, economic conditions, public health outcomes, and regulatory frameworks. These dimensions are mutually dependent: technological readiness is meaningful only when supported by adequate infrastructure; infrastructure investment is effective only when aligned with actual demand and user acceptance; and regulatory arrangements influence not only safety and equity, but also operating responsibilities, market entry conditions, and long-term service stability. Within this framework, Figure 2 illustrates seven key socio-technical dimensions of micromobility: environment, human, social, cultural factors, vehicle technology, infrastructure, economic conditions, public health, and regulations and policy. The circular structure of the figure emphasizes that these dimensions should not be treated as separate or sequential components, but as interdependent domains that jointly shape system adoption, operational performance, and implementation outcomes. For example, vehicle technology affects capital costs, battery management, maintenance requirements, depreciation, and service reliability. Infrastructure conditions influence accessibility, station placement, parking provision, charging needs, and the level of additional investment required for safe and efficient operation. Human, social, and cultural factors shape willingness to use, frequency of adoption, perceived safety, and willingness to pay, all of which are central to demand realization. The economic dimension in this socio-technical structure therefore functions as an integrative domain rather than a standalone financial category. It translates the implications of the other dimensions into questions of investment scale, operating expenditure, revenue potential, risk exposure, and cost recovery. Regulatory and policy conditions may affect licensing costs, safety compliance, insurance requirements, enforcement mechanisms, and the feasibility of public–private partnership models. Environmental and public health benefits, meanwhile, contribute to the wider social value of micromobility and may justify phased public support, targeted subsidies, or integration with metro and BRT fare systems. In this way, the socio-technical approach links broader sustainability objectives with the practical requirements of deploying and sustaining a shared micromobility system.

For Tehran, this perspective is particularly relevant because the existence of high short-distance travel demand alone does not guarantee successful implementation. Shared e-bike and e-scooter systems require alignment between spatial demand concentration, fleet productivity, maintenance capacity, infrastructure readiness, pricing strategy, and institutional support. Inflationary pressures, theft and vandalism risks, uneven street quality, limited cycling infrastructure, and uncertainty in user adoption can all alter the balance between expected benefits and implementation costs. Accordingly, the socio-technical framework provides a diagnostic basis for identifying where micromobility deployment is likely to be effective, what complementary investments are required, and under what conditions the system can contribute to accessibility improvement, environmental transition, and financially sustainable urban mobility provision.

**Table 1. Comparable Figures for a Range of Vehicles, Taken from a Single Source**

| Transport mode and operation | Vehicle battery manufacture, assembly and disposal (including fluids), plus delivery to point of purchase | Operational services | Energy use, whilst in use, per passenger km (including emission from fuel production) |
|---|---|---|---|
| Bike | 100,398 | 0 | 0 |
| Shared bike | 128,454 | 136,111 | 0 |
| Private e-bike | 168,510 | 0 | 11.8 |
| Shared e-bike | 204,595 | 136,111 | 11.8 |
| Private electric step scooter | 172,685 | 0 | 6.2 |
| Share electric step scooter (new generation) | 374,001 | 140,886 | 6.7 |
| Private moped | 391,272 | 0 | 54 |
| Private car | 6,496,825 | 0 | 125.6 |
| Private e-car | 11,339,015 | 0 | 71.5 |

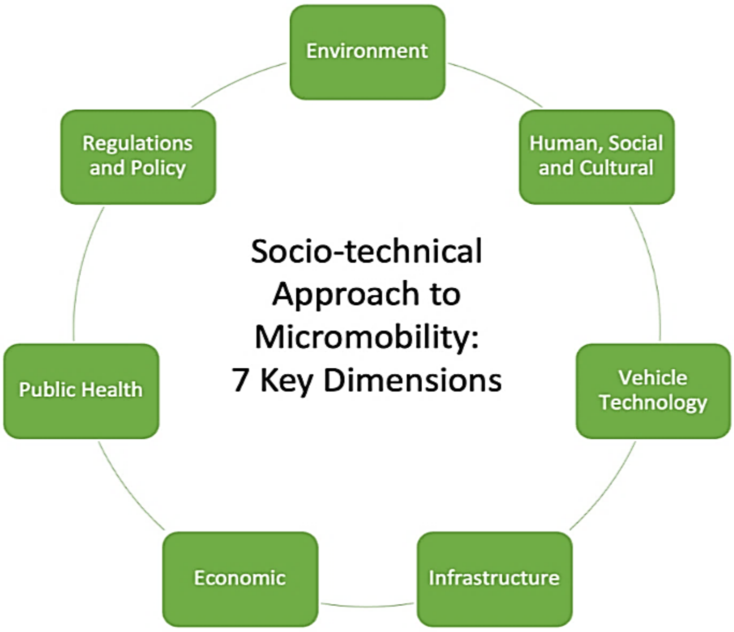


**Figure 2. The Socio-Technical Approach to Micromibility: 7 Key Dimensions**

## 2.2. Environmental Dimension

As transport emissions are rising globally and urgent calls are issued for their reduction [10], being ‘micro’ in terms of energy use is key to micromobility’s significance. The environmental dimension underlines how micromobility offers a form of travel with the potential to decarbonize personal and freight transport. Most micromobility vehicles have relatively low energy requirements because they are small and light enough to be maneuvered by one person, as discussed later, we consider this to be a key part of the definition. Walking is logically, therefore, also a form of micromobility, given that it has the lowest energy requirements of any form of transport. Recent studies estimate that large-scale take-up of LEVs (many of which are considered micromobilities) could lower personal transport-related $CO_2$ emissions by 44% in Germany [11], while several studies assess the potential $CO_2$ savings of shifting from car to e-bike at 12-50% [12, 13, 14]. Partially or fully electrically and human powered micromobility vehicles have zero greenhouse gas (GHG) emissions at the point of use. However, all electric vehicles will incur upstream emissions from electricity generation – depending on how the electricity is generated, stored and delivered. There are also non-tailpipe emissions of toxic particulates from brake and tire wear – but these are very small compared to those from car use. GHG (expressed in carbon dioxide equivalent, CO2-eq) from vehicle manufacture, use and recycling and disposal also factor into the environmental impact metric and are generally lower for micromobility options than for cars [15]: Owning and using lighter, less material intensive and much more energy efficient vehicles is less carbon intensive. Table 1 shows comparable figures for a range of vehicles, taken from a single source [16]. Specifically, this table provides three key measures of the emissions:

- Per vehicle emissions generated by vehicle and battery manufacture, assembly, delivery to point of purchase, and disposal,
- Per vehicle emissions generated by the operational services involved in shared schemes,
- Emissions per passenger km directly generated by vehicle use.

Component figures from the source are given, rather than traditional lifecycle figures (for 'all emissions' per km or per passenger km travelled), since lifecycle calculations are strongly influenced by lifetime mileages. Since a paradigm shift to micromobility vehicles would arguably involve a shift to more localized living and working patterns, and/or combined use with public transport for longer journeys, to understand the scope for emission savings, it is therefore more meaningful to consider emissions separately in terms of 'fixed' emissions (from vehicle creation and disposal) and emissions that result from (different types of) use. Lifecycle figures suggest, for example, that using an ICE car compared to an e-bike would result in emissions that are only 6x greater4. However, according to the data given in Table 4, the 'fixed' emissions associated with manufacturing, assembling, delivering, and disposing a private ICE car are 39 times greater than the same emissions associated with a private e-bike, and the per passenger.km emissions from use are 11 times greater5. Other researchers suggest differences may be even more substantial. Consequently, a shift to micromobility has the scope to deliver considerably greater emissions savings than a consideration that lifecycle considerations might imply. Put another way, suppose someone only travels 2,000 km per year and plans to keep whatever vehicle they buy for 10 years: according to the Table 4 figures, for that type of travel, buying and using an e-bike would generate 0.4 tons of CO2eq, whilst buying and using an e-car would generate 12.8 tons of CO2-eq. A key variable in these calculations is the expected lifetime of each micromobility vehicle, which– as discussed in the economic dimension below – varies across modes. Micromobility also has implications for local air quality and noise levels. Human-powered and electric vehicles have substantial benefits in terms of local air quality, compared to conventional combustion vehicles. Often overlooked or framed as a safety hazard to pedestrians, micromobilities' much lower noise pollution levels are also potentially a key benefit Electric bikes and e-scooters are generally not much louder than their acoustic versions. By contrast, electric cars are often not quieter than ICEs at higher speeds. The environmental dimension of our socio-technical understanding of micromobility is closely linked to the human, social and cultural elements of micromobility that are explored in the following sub-section.

### 2.3. Empirical Studies on Micromobility Deployment

The global growth of micromobility services has sparked a broad spectrum of academic studies focusing on their integration within urban transportation systems. These studies typically explore three interrelated dimensions: user behavior and equity, network planning and infrastructure integration, and environmental and economic impact assessments. Together, they provide a conceptual and methodological foundation for understanding the feasibility of implementing micromobility networks in cities like Tehran.

From the standpoint of transport equity and user segmentation, Guan et al. (2024) conducted a comparative study across three European cities—Malmö, Manchester, and Utrecht—using online survey data and regression analysis. Their research demonstrated how socioeconomic variables such as income level, gender, and vehicle ownership influence the uptake of shared micromobility services. The findings indicated a lower likelihood of usage among marginalized groups, including women, elderly individuals, and suburban residents, pointing to the need for more inclusive planning strategies. The study highlighted that although electric scooters and e-bikes improve accessibility, affordability, and last-mile connectivity, their uptake varies significantly across demographic segments [17]. Building on this, Oeschger et al. (2023) examined the role of micromobility in enhancing first- and last-mile connectivity to public transit. Conducting a mixed-method study in Ireland that employed stated preference experiments and mixed logit models, they revealed that micromobility options are most attractive to younger, male commuters during peak hours. Interestingly, women and older users preferred micromobility for early-stage commutes rather than last-mile extensions. These insights underline the need for infrastructure and policy interventions tailored to trip purpose, user segment, and mode integration [18].

Service quality and operational performance of micromobility systems have also been a critical concern. Hamerska et al. (2022) developed the MMQUAL model to assess user satisfaction in shared micromobility services. Their study categorized service attributes into performance dimensions such as technological reliability, system accessibility, and user experience. The model was validated using e-scooter data, offering practical value to service providers aiming to improve user retention and competitiveness in urban transport markets. The findings advocate for continuous user feedback integration to ensure service quality aligns with rapidly evolving user expectations [19]. Environmental sustainability and mode substitution are another major research theme. D'Acierno et al. (2022) conducted a comparative life-cycle assessment of micromobility, public transportation, and private car usage in Naples, Italy. They applied a multi-criteria analysis to evaluate emissions, service life, and user cost. Their findings confirmed that micromobility—particularly shared electric scooters—significantly reduces $CO_2$ emissions and can supplement public transport under real-world travel conditions. These conclusions support the integration of micromobility into national and local transport policy as a viable tool for reducing the environmental footprint of urban mobility [20]. At the micro-scale, Reck et al. (2022) explored mode substitution patterns and the environmental effects of personal versus shared micromobility in Zurich. Utilizing GPS data and travel logs from over 500 individuals, they found that personal e-scooters were often used as replacements for walking and cycling, while shared micromobility had a higher probability of replacing car trips. Moreover, factors such as travel distance, weather, and vehicle availability significantly influenced users' mode choices. These findings stress the importance of nuanced regulatory frameworks that encourage substitution from motorized to low-emission modes [21]. Behavioral analysis and infrastructure interaction have also drawn scholarly attention. Pazzini et al. (2022) analyzed e-scooter user behavior in Trondheim, Norway, through direct observation and speed tracking. Their study revealed strong correlations between path design and rider behavior, particularly in relation to pedestrian proximity and street layout. Notably, riders slowed down in high-interaction zones, confirming that street design plays a crucial role in safety outcomes. Their dual logit model emphasized the need for infrastructure calibration in response to actual rider behaviors, which is critical for effective risk management [22]. Spatial-temporal dynamics of micromobility usage patterns have been explored by Schwinger et al. (2022), who developed an algorithmic framework to analyze electric scooter and e-bike use in Aachen, Germany. Their results suggested distinct usage profiles: e-scooters were predominantly used for commuting during peak periods, while e-bikes were preferred for leisure activities and distributed more evenly throughout the city. The study further showed that micromobility use was inversely correlated with the strength of the public transport network, indicating both competition and complementarity depending on spatial context [23]. Finally, Fazio et al. (2021) proposed a GIS-based multi-criteria decision-making model for e-scooter network planning in Catania, Italy. Their analysis focused on traffic safety, land use, and street hierarchy to identify optimal corridors for micromobility infrastructure. The study emphasized that urban topology and data-driven prioritization could significantly enhance service deployment efficiency and user satisfaction. This approach is particularly relevant for cities with challenging spatial configurations, such as Tehran, where efficient corridor identification can overcome topographic and infrastructural constraints [24].

Collectively, these studies provide a multidimensional understanding of the operational, behavioral, and policy aspects of micromobility. They serve as a valuable reference point for the present research, which aims to adapt and localize such findings to evaluate the economic and technical feasibility of a micromobility network in Tehran.

# 3. Data Description

The comprehensive Clean Transportation Plan for Tehran outlines an incremental shift toward micromobility modes (e.g., bicycles, e-scooters, walking) as a key strategy to reduce urban pollution and traffic congestion. Based on projected implementation timelines, the share of micromobility in urban travel is expected to rise as follows:

- 2026 (1405): 1%
- 2031 (1410): 2.5%
- 2036 (1415): 4.5%
- 2041 (1420): 7%

This trajectory reflects both behavioral change initiatives and infrastructure development (such as the expansion of bike lanes and shared micro-vehicle stations). The projected modal share increase is based on time horizons aligned with national development plans and urban transportation goals. This shift suggests a sustained compound annual growth rate in micromobility adoption, supported by targeted investments and public engagement campaigns.

## 3.1. Emission Reduction due to Micromobility Expansion

One of the primary environmental benefits expected from this modal shift is the reduction of air pollutants. Table 2 of the Plan quantifies the annual reductions in six key pollutants (in metric tons per year) under three future scenarios; each associated with different time horizons and levels of micromobility expansion:

**Table 2. Estimated Reduction of Air Pollution Resulting from Micromibility Development in Tehran under Proposed Plan Scenarios across Future Time Horizons**

| Year | CO | VOCs | $NO_x$ | $SO_x$ | PM | Gazes |
|---|---|---|---|---|---|---|
| 2026 | 3862 | 633 | 220 | 10 | 26 | 4725 |
| 2031 | 9654 | 1583 | 550 | 25 | 65 | 11812 |
| 2036 | 17378 | 2850 | 989 | 46 | 118 | 21262 |
| 2041 | 28032 | 4433 | 1539 | 71 | 183 | 33074 |

## 3.2. Operational Projections for Short-Trip Micromobility in Tehran

The estimation of micromobility-related trip shares and volumes over a five-year horizon (1403–1408) has been fully developed within the analytical framework of the Comprehensive Clean Transportation Plan for Tehran. This specific time frame was selected because the financial feasibility study of the micromobility network expansion was conducted for a five-year implementation horizon, making it the most relevant basis for impact analysis.

As shown in Table 3, total daily trips in Tehran are projected to increase from 19 million in 1403 (2024) to over 24.6 million in 1408 (2029), with trips under 5 kilometers; representing the primary domain for micromobility; rising from 3.1 million to nearly 3.9 million. During this period, the modal share of clean transport options such as bicycles and e-scooters for sub-5-kilometer trips is forecasted to grow from 1.2% to 7.4%, supported by policy interventions, infrastructure investments, and behavioral change initiatives. The number of micromobility trips per day is estimated to increase from 38,600 to 295,587, with cumulative annual trips surpassing 107 million by 1408. Importantly, e-scooters and e-bikes are expected to account for approximately 60% of these trips, consistently outnumbering bicycles; likely due to terrain suitability and user preferences in Tehran's urban fabric. These projections, as detailed in Table 3, emphasize the institutional commitment to integrating micromobility as a core element of the city's sustainable transport strategy within a financially viable medium-term planning window.

**Table 3. Projected Daily and Annual Mobility Indicators and Micromobility Modal Share in Tehran (1403-1408)**

| Years | Total Daily Trips in Tehran | Daily Trips Under 5 Km | Clean Transport Share of All Trips (%) | Daily Transport Share of Trips < 5 Km | Daily Clean Transport Trips | Annual Clean Transport Trips |
|---|---|---|---|---|---|---|
| 1403 | 19,300,000 | 3,130,000 | 0.2 | 1.2 | 38,600 | 14,089,000 |
| 1404 | 20,265,000 | 3,286,500 | 0.4 | 2.5 | 81,060 | 29,586,900 |
| 1405 | 21,278,250 | 3,450,825 | 0.6 | 3.7 | 127,670 | 46,599,368 |
| 1406 | 22,342,163 | 3,623,366 | 0.8 | 4.9 | 178,737 | 65,239,115 |
| 1407 | 23,459,271 | 3,804,535 | 1 | 6.2 | 234,593 | 85,626,338 |
| 1408 | 24,632,234 | 3,994,761 | 1.2 | 7.4 | 295,587 | 107,889,186 |

### 3.3. Modal Distribution

The estimation of daily and annual micromobility trips by vehicle type; bicycles and electric scooters; has been conducted within the defined five-year horizon of Tehran's Comprehensive Clean Transportation Plan. This specific period, from 1403 to 1408, reflects the financial planning window used to assess the economic viability of micromobility infrastructure and fleet expansion across the city. By focusing on this mid-term horizon, the plan aims to realistically capture the pace of implementation, user adoption, and required investment returns. Rather than providing aggregate figures alone, the projections offer a detailed breakdown of trip volumes by mode, allowing for targeted planning and operational alignment. The data indicate a steady rise in both modes, with electric scooters consistently comprising a larger share—around 60%—likely due to their ease of use in urban gradients and longer effective range. Bicycles, while growing in absolute terms, maintain a 40% share, signaling the need for complementary policy support such as protected bike lanes and safe intersections. The annual growth in total clean transport trips; reaching over 100 million by 1408; is thus driven by both increasing demand and diversified user preferences across micromobility modes.

## 4. Methodology

This study employs a financial evaluation framework to access the investment feasibility of deploying a micromobility network in Tehran, as envisioned in the city's Comprehensive Clean Transportation Plan. Unlike boader socio-economic assessments, this methodology focuses strictly on the investor's perspective, accounting solely for direct monetary costs and revenues. The analysis includes capital expenditures (CAPEX) such as fleet acquisition and infrastructure deployment, as well as ingoing operational expenditures (OPEX) like maintenance, staffing, and system management. Revenue projections are based on fare collection potential subscription models, excluding externalities such as emission reductions, travel time savings, or public health benefits. The framework is grounded in financial viability metrics including Net Preset Value (NPV), Internal Rate of Return (IRR), and Payback Period. The evaluation is conducted over a five-year implementation horizon (1403-1408), reflecting the investment planning window defined in the original plan.

### 4.1. Analytical Framework

The financial assessment in this study is structured around deterministic, single-investor financial modeling based on classical discounted cash flow (DCF) analysis. The goal is to evaluate the viability of micromobility infrastructure from the perspective of a private or institutional investor. The core metrics used for decision-making include Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period (PP). These are calculated under a baseline scenario and subjected to sensitivity analysis on key variables.

The NPV is calculated using the standard DCF formula:

$$NPV = \sum_{t=0}^{T} \frac{R_t - C_t}{(1+r)^t}$$

where:

$R_t$ : Revenue at year t

$C_t$ : Cost at year t

$r$ : Discount rate

$T$ : Total time horizon (in year)

An investment is considered financially feasible if NPV > 0, meaning that the discounted value of expected revenues exceeds total costs over the analysis period.

The Internal Rate of Return (IRR) is defined as the discount rate r* that satisfies the condition:

$$\sum_{t=0}^{T} \frac{R_t - C_t}{(1+r^*)^t} = 0$$

IRR is then compared with the investor's minimum acceptable rate of return (hurdle rate). Projects with IRR > hurdle rate. are deemed attractive. The Payback Period (PP) is calculated as the year in which cumulative net cash flows become positive, serving as a risk proxy for liquidity preference.

The revenue side includes fare-based income derived from per-trip charges and multi-use subscriptions, with demand projections informed by micromobility adoption rates. Cost inputs include both CAPEX (e.g., e-scooter and bicycle fleet, docking infrastructure, backend platforms) and OPEX (e.g., maintenance, rebalancing, staff wages). All cash flows are considered in real terms, excluding inflation, and denominated in local currency adjusted for exchange rate stability assumptions.

The framework assumes reinvestment of interim revenues into system upkeep and limited growth, with no leveraged financing. As a private financial model, it deliberately excludes social benefits such as emission reductions, VOT, or public health gains.

### 4.2. Time Horizon and Discount Rate

The financial analysis in this study is conducted over a five-year horizon, spanning from 2024 to 2029 (corresponding to 1403–1408 in the Iranian calendar). This time frame is directly aligned with the operational and fiscal planning cycle outlined in the Comprehensive Clean Transportation Plan for Tehran, which identifies a five-year period as the primary phase for capital deployment, implementation, and early-stage performance monitoring of the micromobility network. From an investment standpoint, this short-to-medium term horizon offers several analytical advantages. First, it enables greater reliability in demand forecasting and cost estimation, minimizing exposure to speculative long-term variables such as macroeconomic shifts, political instability, or disruptive technological innovation. Second, it reflects a realistic window for observing user adoption patterns, adjusting fare structures, and achieving operational break-even under evolving urban transport conditions.

Moreover, the five-year analysis period corresponds to standard practice in evaluating capital-intensive urban mobility projects in emerging economies, where investment cycles are typically shorter and investor expectations for return on capital are more immediate. This approach is consistent with guidelines from the World Bank and other multilateral institutions, which recommend time horizons tailored to the anticipated lifecycle of infrastructure assets and financing instruments. To discount future cash flows and bring them to present value terms, a real discount rate of 8% was applied. This rate was selected based on two primary criteria: (1) alignment with national infrastructure project appraisal standards used by Iran's Planning and Budget Organization and Ministry of Roads and Urban Development and Iranian Statistical Agency, and (2) consistency with empirical benchmarks in the transport finance literature for projects in middle-income countries. The use of a real (i.e., inflation-adjusted) discount rate ensures that financial viability is evaluated on the basis of actual purchasing power and not nominal growth. It also corresponds to private investor expectations in high-risk environments where capital costs, inflation uncertainty, and return pressures are elevated.

This discount rate is applied uniformly across all financial scenarios in the model. No risk-weighted or social discounting adjustments are introduced, as the focus of the analysis remains strictly within the investor domain, excluding broader economic or societal benefits. Future sensitivity analysis evaluates the implications of varying this rate between 6% and 10% to assess robustness of financial outcomes.

### 4.3. Capital and Operating Expenditures

The financial model distinguishes clearly between expenditures (CAPEX) and annual operating expenditures (OPEX) associated with the micromibility system's implementation. initial fixed costs were calculated for base years 1403 (2024-2025), which corresponds to the planned launch of the system under Tehran's Clean Transportation framework. These upfront investments encompass the purchase of fleet assets, management technology, administrative equipment, and supporting logistics. As shown in Table 4, total capital investment for the first year is estimate at approximately 93,127 million rial, covering both infrastructure nad system initiation costs.

**Table 4. Initial Capital Expenditures for Micromobility Deployment (E-bike) in Base Year (2024)**

| Item | Quantity | Unit cost (million rial) | Total Cost (million rial) |
|---|---|---|---|
| Electric bicycle | 420 | 1,550 | 651,000 |
| Management back-end | 1 | 676 | 676 |
| Light transport fleet (Logistics) | 1 | 11,385 | 11,385 |
| Guard cost | 1 | 162 | 162 |
| Office Equipment | 1 | 2,885 | 2,885 |
| **Total Capital Expenditure** | **-** | **16,631** | **666,081** |

In addition to initial investment, the system incurs recurring annual operational costs, which include personal wages, fuel and maintenance of support vehicles, office rental, and IT system maintenance. as demostrated in Table 5, total OPEX for the first implementation year (1403) amounts to 666,081 million rial. These costs are projected over the five-year evaluation horizon and are subject to inflation adjustment. The financial analysis incorporates Iran's historical macroeconimic context, where average annual inflation over the past decade has hovered aroud 46.5 %. These cost components form the foundation of the financial cash flow model and serve as input for Net Present Value calculations in subsequent sections.

**Table 5. Operating Expenditures**

| Year | Cost Category | Total Cost (million rial) |
|---|---|---|
| 2024 | Salaries and personnel wages | 33,625 |
| | Logistics and security cost | 1,623 |
| | Office rental | 1,266 |
| | Maintenance and repair of bicycle | 19,631 |
| | Theft and vandalism | 27,718 |
| | **Total Operating Expenditures (OPEX)** | **83,862** |
| 2025 | Salaries and personnel wages | 49,260 |
| | Logistics and security cost | 2,377 |
| | Office rental | 1,854 |
| | Maintenance and repair of bicycle | 28,759 |
| | Theft and vandalism | 40,608 |
| | **Total Operating Expenditures (OPEX)** | **122,858** |
| 2026 | Salaries and personnel wages | 72,166 |
| | Logistics and security cost | 3,482 |
| | Office rental | 2,716 |
| | Maintenance and repair of bicycle | 42,133 |
| | Theft and vandalism | 59,490 |
| | **Total Operating Expenditures (OPEX)** | **179,987** |
| 2027 | Salaries and personnel wages | 105,723 |
| | Logistics and security cost | 5,102 |
| | Office rental | 3,979 |
| | Maintenance and repair of bicycle | 61,724 |
| | Theft and vandalism | 87,153 |
| | **Total Operating Expenditures (OPEX)** | **263,681** |
| 2028 | Salaries and personnel wages | 154,884 |
| | Logistics and security cost | 7,474 |
| | Office rental | 5,830 |
| | Maintenance and repair of bicycle | 90,426 |
| | Theft and vandalism | 127,679 |
| | **Total Operating Expenditures (OPEX)** | **386,293** |
| 2029 | Salaries and personnel wages | 226,905 |
| | Logistics and security cost | 10,949 |
| | Office rental | 8,540 |
| | Maintenance and repair of bicycle | 132,474 |
| | Theft and vandalism | 187,050 |
| | **Total Operating Expenditures (OPEX)** | **565,919** |

### 4.4. Trip Duration-Based Demand Normalization for E-bike Usage

to estimate user-level revenue from e-bike operations, this study employs a trip-duration-based demand normalization approach. This method involves disaggregating total daily or annual trip demand into predefined time intervals, reflecting actual usage behaviour and enabling fare structure modeling. As shown in Table 6, the e-bike usage is categorized into four duration brackets:

- 5 to 10 minutes
- 10 to 20 minutes
- 20 to 30 minutes
- More than 30 minutes

Each of these categorise corresponds to a distinct user group with different mobility needs and trip purposes ranging from very short hops to more extensive commutes. Such stratification allows fore better alignment of pricing policies and resource planning. The demand in each category, derived from simulation models and calibrated with empirical micromobility data from Tehran's Clean Transportation study.

**Table 6. Trip Duration-Based of E-Bike Demand**

| Trip duration | Trips |
|---|---|
| 5 to 10 minutes | 45360 |
| 10 to 20 minutes | 113400 |
| 20 to 30 minutes | 45360 |
| More than 30 minutes | 22680 |

This disaggregation not only supports more accurate estimate of revenue (as each trip duration can be associated with a specific fare tier), but also enables the operator to better allocate fleet capacity, manage battery life cycles, and optimize station placement. For instance, shorter trips might indicate last-mile travel linked to public transport hubs, while longer durations might correspond to commuting between residential and business districts.

## 5. Result and Analysis

The annual revenue trajectory of the micromobility system during the implementation period (2024–2029) exhibits a progressive increase in total income, as user adoption expands and demand matures. As illustrated in Table 6, total revenue rises from 384,257 million rial in 2024 to 49,279,481 million rial by 1408, reflecting a nearly 128-fold increase over five years. This growth can be attributed to a combination of factors, including network expansion, increased fleet availability, pricing adjustments, and improved user familiarity with the service.

Notably, the most significant relative increase in revenue occurs between 2028 and 2029, where revenues rise from 17,686,677 million rial to 49,279,481 million rial, marking a 69% year-over-year growth. This aligns with the projected S-curve in adoption rate, where mid-phase acceleration typically results in disproportionate growth relative to prior years.

Further analysis of five years (Table 6) reveals that revenue modeling was refined using trip-duration-weighted fare coefficients. Each time segment (e.g., 5 to 10 minutes, 10–20 minutes, etc.) is assigned a fare multiplier, and demand is aggregated accordingly. In 1408, for example, the highest revenue contributions originated from trips of 10–30 minutes, which constitute the modal core of daily usage. This weighted approach reflects real-world operator strategies and provides a more granular framework for revenue projections. Comparing total annual revenues with corresponding operational and capital costs reveals the project's financial viability trajectory. As shown in Table 8, the micromobility system operates at a net loss during the initial years (2024–2025), which is expected due to high upfront investment and operational ramp-up. In 1403, the project posted a net deficit of -365,686 million rial, while in 2025, losses narrowed to -157,436 million rial as revenues increased and cost efficiencies were introduced. From a purely financial evaluation standpoint, this study assesses the investment justification for developing an electric bicycle (E-bike) sharing system as the central component of Tehran's broader micromobility strategy, with a planning horizon extending through the year 1408. The analysis is based exclusively on internal cash flows, comprising capital expenditures (CAPEX), operating costs (OPEX), and fare-based revenue, without accounting for any externalities, such as emission reductions or public health improvements.

Table 7 presents the calibrated revenue structure and projected operational revenues of the proposed shared micromobility system over the 2024–2029 evaluation horizon. The fare structure was not treated as a uniform or arbitrary charge; rather, it was calibrated according to a duration-based pricing logic commonly observed in shared e-bike and e-scooter systems, where total user cost is strongly influenced by trip duration, time-based tariffs, and operator pricing strategies [25]. In this framework, the 10–20 minute trip category was adopted as the reference fare band, representing the most typical first-mile/last-mile and short urban trip duration. Shorter trips of 5–10 minutes were assigned a lower multiplier of 0.5 in order to preserve affordability for feeder trips to metro and BRT stations, while the 20–30 minute and more-than-30-minute categories were assigned higher multipliers of 1.5 and 2.0, respectively, to reflect longer vehicle occupation, greater battery use, higher exposure to maintenance risk, and the opportunity cost of reduced vehicle availability for subsequent users.

The employer and user fare columns further reflect a differentiated cost-sharing mechanism rather than a single undifferentiated fare. The user fare represents the direct out-of-pocket payment designed to remain competitive with short-distance alternatives such as taxis, motorcycles, and app-based ride-hailing services, while the employer fare represents an institutional or employer-supported contribution that may be applied in workplace, university, or transit-access programs. This two-part revenue structure is particularly relevant for Tehran, where affordability constraints may limit direct user payment, but institutional mobility programs can improve adoption by partially internalizing the accessibility and productivity benefits of micromobility. Accordingly, the revenue values in Table 7 were calculated by multiplying the number of trips in each duration band by the corresponding calibrated employer and user fares, and then aggregating the two components to obtain total operational revenue.

The temporal evolution of revenues in Table 7 should therefore be interpreted as the combined result of duration-sensitive fare calibration, nominal tariff adjustment, and the increasing financial contribution of longer-duration trips. In 2024, total operational revenue reaches 384,257 million rials, which remains below total costs in the launch phase because early deployment is characterized by high upfront investment, fleet acquisition, platform setup, station preparation, and operational establishment. By 2025, total revenue increases to 941,230 million rials, indicating a narrowing financial gap as the system moves beyond the initial deployment stage. In 2026, revenues rise to 2,422,974 million rials and exceed annual costs, marking the first year in which the system generates a positive operational balance. This turning point indicates that the calibrated fare structure is capable of supporting cost recovery once the initial capital-intensive phase has passed.

The subsequent years show a substantial improvement in revenue performance. In 2027, total operational revenue reaches 6,463,806 million rials, while in 2028 it increases to 17,686,677 million rials. By 2029, revenues reach 49,279,481 million rials against annual costs of 5,060,766 million rials, producing a final-year net operational surplus of 44,218,715 million rials, equivalent to approximately 44.22 trillion rials. This pattern demonstrates that the system's financial performance is highly sensitive to the calibration of fares across trip-duration classes, particularly because longer trips generate higher revenue but also impose higher operational and asset-utilization costs. The results are consistent with the broader micromobility literature, which shows that pricing strategy and fleet-size decisions directly affect demand, utilization, profitability, and long-term service efficiency [25]. Overall, Table 7 demonstrates that a duration-based and institutionally differentiated fare structure can support the financial viability of shared micromobility deployment in Tehran, provided that tariff escalation, fleet productivity, maintenance costs, and user affordability remain jointly managed within the operational model.

**Table 7. Revenue Breakdown by Trip duration and Pricing Multiplier (1403-1408)**

| Duration Range | Trips | Multiplier | Employer Fare (rial) | User Fare (rial) | Total Employer Revenue (million rial) | Total User Revenue (million rial) | Total Revenue (million rial) |
|---|---|---|---|---|---|---|---|
| **2024** | | | | | | | |
| 5 to 10 minutes | 45360 | 0.5 | 20,331 | 13,554 | 922 | 615 | 1,537 |
| 10 to 20 minutes | 113400 | 1 | 325,297 | 216,865 | 368,889 | 24,593 | 61,481 |
| 20 to 30 minutes | 45360 | 1.5 | 1,644,819 | 1,097,877 | 74,700 | 49,800 | 124,499 |
| More than 30 minutes | 22680 | 2 | 5,204,850 | 3,469,828 | 118,044 | 78,696 | 196,739 |
| **Total Operational Revenue** | | | | | **230,554** | **153,703** | **384,257** |
| **2025** | | | | | | | |
| 5 to 10 minutes | 45360 | 0.5 | 14360 | 9928 | 676 | 450 | 1126 |
| 10 to 20 minutes | 113400 | 1 | 476560 | 317708 | 54042 | 36028 | 90070 |
| 20 to 30 minutes | 45360 | 1.5 | 3612585 | 2412585 | 164153 | 109435 | 273587 |
| More than 30 minutes | 22680 | 2 | 15249918 | 10166595 | 345868 | 230578 | 576447 |
| **Total Operational Revenue** | | | | | **564738** | **276492** | **941230** |
| **2026** | | | | | | | |
| 5 to 10 minutes | 45360 | 0.5 | 10909 | 7272 | 495 | 330 | 825 |
| 10 to 20 minutes | 113400 | 1 | 698160 | 465442 | 79171 | 52781 | 131952 |
| 20 to 30 minutes | 45360 | 1.5 | 7952500 | 5301566 | 360725 | 240483 | 601208 |
| More than 30 minutes | 22680 | 2 | 44682260 | 29788124 | 1013394 | 675595 | 1688988 |
| **Total Operational Revenue** | | | | | **1453785** | **969189** | **2422974** |
| **2027** | | | | | | | |
| 5 to 10 minutes | 45360 | 0.5 | 7991 | 5327 | 362 | 242 | 604 |
| 10 to 20 minutes | 113400 | 1 | 1022805 | 681872 | 115986 | 77324 | 193310 |
| 20 to 30 minutes | 45360 | 1.5 | 17475618 | 11650386 | 792694 | 528462 | 1321156 |
| More than 30 minutes | 22680 | 2 | 130919021 | 87279203 | 2969243 | 1979492 | 4948736 |
| **Total Operational Revenue** | | | | | **3878286** | **2585520** | **6463806** |
| **2028** | | | | | | | |
| 5 to 10 minutes | 45360 | 0.5 | 5853 | 3902 | 266 | 177 | 442 |
| 10 to 20 minutes | 113400 | 1 | 1498409 | 998343 | 169920 | 113280 | 283200 |
| 20 to 30 minutes | 45360 | 1.5 | 38402671 | 25601724 | 1741945 | 1161294 | 2903239 |
| More than 30 minutes | 22680 | 2 | 383592730 | 255728065 | 8699883 | 5799913 | 14499796 |
| **Total Operational Revenue** | | | | | **10612013** | **7074664** | **17686677** |
| **2029** | | | | | | | |
| 5 to 10 minutes | 45360 | 0.5 | 4287 | 2858 | 194 | 130 | 324 |
| 10 to 20 minutes | 113400 | 1 | 2195169 | 1463451 | 248932 | 165955 | 414888 |
| 20 to 30 minutes | 45360 | 1.5 | 84389869 | 52659789 | 3827924 | 2551944 | 6379869 |
| More than 30 minutes | 22680 | 2 | 1.124E+09 | 749283231 | 25490658 | 16993744 | 42484401 |
| **Total Operational Revenue** | | | | | **29567709** | **19711773** | **49,279,481** |

## 6. Conclusion

This study provided a financial and operational assessment of deploying a shared micromobility network in Tehran, using a five-year discounted cash flow (DCF) framework under inflationary and high-risk investment conditions. The analysis focused on direct monetary flows, including capital expenditures, operating expenditures, and trip-based revenues calibrated by travel-duration categories. The results show that the system remains below cost-recovery levels during the initial deployment phase. In 2024, total system costs reached 749,943 million rials, while revenues amounted to 384,257 million rials, producing a net deficit of 365,686 million rials. A deficit also remained in 2025, when costs reached 1,098,666 million rials compared with revenues of 941,230 million rials. A transition toward operational viability occurs in 2026, when revenues increase to 2,422,974 million rials and exceed total costs of 1,609,546 million rials, generating a positive annual operating surplus of 813,428 million rials. This indicates that the system reaches annual operational breakeven in the third year of implementation. Profitability expands substantially in the following years, with revenues of 6,463,806 million rials against costs of 2,357,985 million rials in 2027, and revenues of 17,686,677 million rials against costs of 3,454,448 million rials in 2028. By 2029, total annual revenue reaches 49,279,481 million rials, while total costs amount to 5,060,766 million rials, resulting in a final-year net operating surplus of 44,218,715 million rials, equivalent to approximately 44.22 trillion rials.

**Table 8. Annual Financial Balance**

| Years | Total Costs (Million rial) | Total Revenue (Million rial) | Net Present Value (NPV) |
|---|---|---|---|
| 2024 | 749,943 | 384,257 | 10,854,094 |
| 2025 | 1,098,666 | 941,230 | |
| 2026 | 1,609,546 | 2,422,974 | |
| 2027 | 2,357,985 | 6,463,806 | |
| 2028 | 3,454,448 | 17,686,677 | |
| 2029 | 5,060,766 | 49,279,481 | |

Over the full evaluation horizon, the model produces an undiscounted cumulative net surplus of 62,847,071 million rials, equivalent to approximately 62.85 trillion rials. In addition to annual cost–revenue comparisons, the investment performance indicators further support the feasibility of the proposed system under the assumed demand, pricing, and cost conditions. The discounted cash flow analysis yields a positive Net Present Value (NPV) of 10,854,094 million rials at a real discount rate of 46.5%. The estimated Internal Rate of Return (IRR) is approximately 231.9%, indicating that the project's expected return exceeds the applied discount rate. The undiscounted payback period is estimated at approximately 2.64 years, meaning that cumulative net cash flows become positive during the third operating year. When discounted cash flows are considered, the payback period is approximately 3.07 years, placing cost recovery shortly after the beginning of the fourth evaluation year. These indicators provide a more explicit basis for interpreting the financial performance of the proposed micromobility system. Beyond financial performance, the results suggest that shared micromobility can support short-distance urban travel, improve first-mile and last-mile access to public transport, and contribute to a gradual shift away from private motorized modes. E-bikes and e-scooters are particularly relevant for Tehran because they can serve short and medium-distance trips while responding to local constraints such as congestion, station-access gaps, and variations in urban topography. The trip-duration-based demand normalization and fare-calibration approach also provides a structured method for aligning revenue estimation with user behavior, vehicle utilization, and operational cost exposure. Overall, the findings indicate that shared micromobility can become financially viable in Tehran after the initial capital-intensive deployment phase, provided that demand growth, fare adjustment, fleet productivity, maintenance costs, and operational risks are effectively managed. The results also show that financial viability is not determined by demand volume alone; it depends on the interaction between spatial deployment, pricing structure, vehicle availability, maintenance performance, theft and vandalism control, and institutional support.

Future studies should extend the model by incorporating external benefits such as avoided emissions, reduced congestion, health improvements, and travel-time savings. Further research should also examine distributional and equity impacts across socioeconomic groups, test alternative discount-rate and inflation scenarios, evaluate integration with public transport under Mobility-as-a-Service frameworks, and assess the role of AI-based demand forecasting, IoT-enabled fleet monitoring, and dynamic pricing in improving operational efficiency and financial resilience.

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