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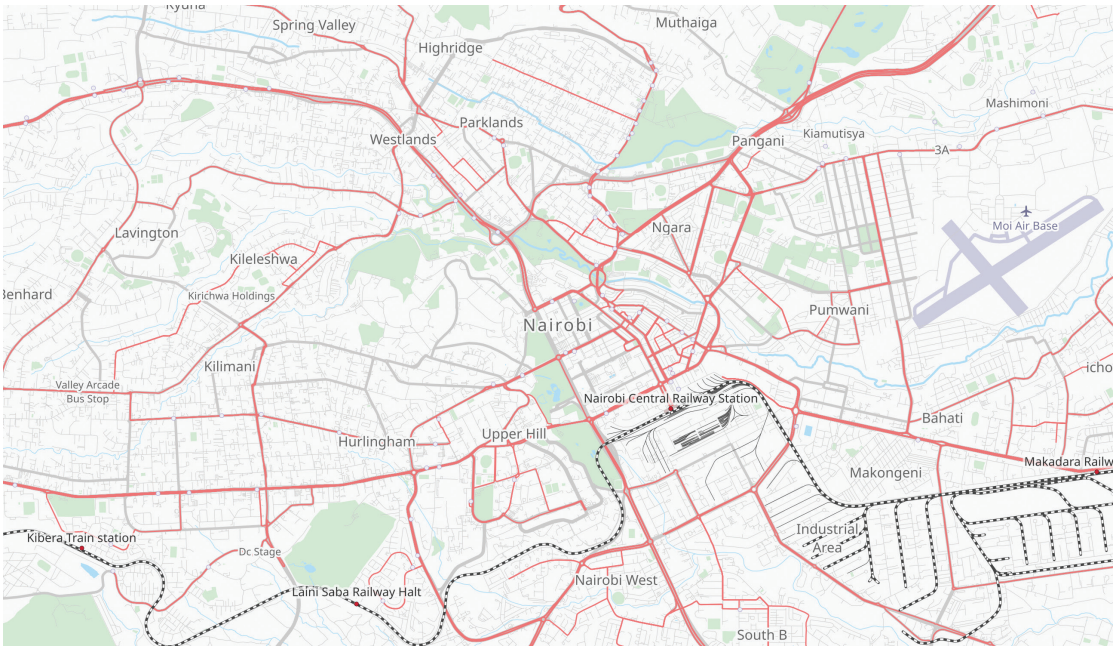


Figure 1: Map of Nairobi (OpenStreetMap, 2025)

E-Buses Implementation in the Nairobi BRT System

By Sofia Zarama

EXECUTIVE SUMMARY

This consultancy project is written for the Nairobi Metropolitan Area Transport Authority (NaMATA), which is the government agency responsible for overseeing and managing the transportation system within the Nairobi Metropolitan Area. NaMATA has initiated a project to implement a Bus Rapid Transit (BRT) system in Nairobi in order to offer faster, more reliable, and environmentally sustainable public transportation. The consultancy provides key recommendations on analyzing business models for the implementation of electric buses on BRT Line 2 in Nairobi. Key findings include:

- Public-private collaboration is identified as essential for the implementation of electric buses, ensuring a proper allocation of responsibilities and risks between the involved parties.
- Securing favorable financing conditions and leveraging private operator expertise are crucial for the success of the business model.
- The preliminary analysis suggests an intermediate business model in which operators lease the fleet from a provider, with the option to transfer fleet payment rights to the provider to secure financing.
- An analysis of stakeholder perceptions provides valuable insights into market supply and demand; however, it must be accompanied by a comprehensive technical, financial, and legal structuring to determine the appropriate business model for electric bus provision and operation.
- From a technical perspective, it is recommended to determine an optimal fleet size that maximizes economies of scale while minimizing reliance on a single operator, incorporate service quality indicators into contracts to improve the user experience, develop infrastructure, such as dedicated lanes, to facilitate efficient and high-speed bus operations, and ensure public entities maintain operational control through strategic planning, continuous real-time monitoring, efficiency analysis.

- From a financial perspective, it is recommended to implement electronic payment systems to enhance resource management and build investor confidence, manage user payments through trust accounts for improved resource administration and distribution, and, if subsidies are necessary, allocate them to capital investments rather than operational costs to facilitate asset financing. Proper risk allocation is essential, assigning risks to the parties best equipped to manage them. Additionally, alternative financing sources, should be explored if subsidies are required. Finally, remuneration fees must align with reimbursed costs to ensure compensation accurately reflects incurred expenses.
- From a legal perspective, it is recommended to establish decarbonization targets within regulations to support national planning efforts, align with international commitments, and provide clear signals to the market to adjust supply and demand accordingly. Additionally, offering tax benefits for goods and services related to electromobility enhances their financial viability. Lastly, it is crucial to ensure that contract durations align with the operational life of the fleet to avoid the need for fleet replacement within the same contractual period.

INTRODUCTION

Currently, public transportation accounts for 46% of the total modes of transport in Nairobi. Public transport is provided through minibuses known as Matatus, large buses, motorcycle taxis referred to as Boda Bodas and ride hailing. (TUMI, 2022)

Public transportation faces challenges such as overcrowding, high levels of traffic congestion, safety concerns, poor access and pollution. (Gauff JBC Ingenieure, ETC TraNsport Consultants, PB-Consult, 2014). It is estimated that the transport sector is responsible for 24% of total CO2 emissions, with road transportation accounting for nearly three quarters of these emissions. Particularly, Matatus plays a significant role in this. (Sitati, C., Oludhe, C., Oyake, L., Mbandi, A., 2022)

Additionally, Kenya is guided by the National Climate Change Action Plan, which aims to reduce greenhouse gas emissions by 30% by 2030 compared to a business-as-usual scenario. This reduction target includes efforts within the transportation sector, especially in Nairobi. (Government of the Republic of Kenya, 2018)

In response to this situation, NaMATA, as the government agency responsible for overseeing and managing the transportation system within the Nairobi Metropolitan Area, has initiated a project to implement a BRT system. This system is anticipated to offer faster, more reliable, and environmentally sustainable public transportation. The full BRT network will consist of 5 corridors, with a length of approximately 137 km. The pilot phase will begin with Line 2. This line has a total length of about 27 km. The estimated ridership for the BRT pilot is 163,040 passengers per day, and the initial fleet will consist of 100 buses, growing to 660 buses when operations peak across the entire line. (NaMATA, 2022)

For the effective implementation of a BRT system with electric buses, it is essential to define the fleet provision and operation model, which will determine the relationship between the public and private sectors. The search for an appropriate business model has gained importance recently due to the unique characteristics of operations with electric buses, requiring attractive and robust financial structures, as well as additional services beyond bus operation.

Given the preceding information, this consultancy project aims to provide recommendations to NaMATA for the analysis of business models under which the new electric buses could be implemented within their BRT system, Line 2.

The methodology to achieve this objective will involve reviewing international and local case studies and conducting workshops with local stakeholders, applying a SWOT matrix, a stakeholders identification matrix, and a multi-criteria matrix.

NAIROBI PUBLIC TRANSPORT SYSTEM

Nairobi, Kenya's capital, is strategically positioned as the gateway to East Africa. It ranks among the largest cities in the region, with a population of nearly 4.4 million and an estimated 6 million in the metropolitan area. (ITDP Africa, 2022). Nairobi has a population density of 6,385 people per square kilometer. (Demographia, 2023)

In Nairobi's modal split, 46% of trips are made by public transportation (Matatus, buses, ride-hailing, boda bodas), 39% by walking, 13% by cars, 1% by cycling, and 1% by other modes. (TUMI, 2022). "78% of passengers utilize public transport while only 22% of passengers utilize private cars and yet public transport comprises only 33% of vehicle traffic volume while private transport accounts for the remaining 67%." (NaMATA, P. 11, 2022)

The city's rapid growth has made it increasingly difficult to reach major destinations on foot within a reasonable time, forcing poorer segments of the population to spend more time walking. As urban expansion has increased, distances between residential areas and key employment or activity centers have grown significantly. Many destinations now incur unpredictable and substantial time costs, regardless of the mode of transport, leading to the exclusion of certain social groups from the labor market and exacerbating the gap between social classes. (Gauff JBC Ingenieure, ETC TraNsport Consultants, PB-Consult, 2014)

The public transport system in Nairobi is primarily composed of privately-owned vehicles, including buses and matatus. Participation in the public transportation sector requires affiliation with a SACCO, which is responsible for managing operations and ensuring compliance with regulatory standards. To qualify as a public transport SACCO, an entity must own at least 30 vehicles that are registered as Public Service Vehicles (PSVs) by the National Transport and Safety Authority (NTSA). (GIZ, 2020)

For a better understanding of the public transportation context in Nairobi, within the framework of this consultancy project, workshops were conducted with transportation sector stakeholders. The workshops were conducted individually with international organizations such as the Institute for Transportation and Development Policy (ITDP); government entities like NaMATA and the State Department of the Ministry of Transport; and financiers such as the European Union (EU).

The methodology applied to better understand the context of the public transportation system was a SWOT matrix, which is a visual tool that organizes information into four quadrants: 1. Strengths: Internal factors within NaMATA that are positive aspects of the current public transport system, providing it with an advantage over others. 2. Weaknesses: Internal factors within NaMATA that may limit the performance of the current public transport system. 3. Opportunities: External factors to NaMATA that could be leveraged to benefit the current public transport system. 4.Threats: External factors to NaMATA that could pose challenges or risks for the current public transport system.

The following strengths, opportunities, weaknesses, and threats in the current public transport system were identified:

STRENGTHS
- People understand that transportation needs to improve.
- BRT Project is ongoing.
- The potential to restructure Matatu buses as feeder services for the BRT system.
- There is an entity responsible for managing the transportation system that can coordinate with other stakeholders to improve public transportation.

OPPORTUNITIES
- Lack of subsidies and private investments
- The private sector has an understanding of transportation service delivery and addresses mobility needs.

WEAKNESSES
- Public transport requires development and public investment.
- Lack of regulation.
- Payment method.

THREATS
- Competition among operators saturates the market.
- Public transport is not safe.
- Public transport is not reliable, it is not predictable, it is not organized.

Table 1: Public Transportation System context (Source: Prepared by the author)

In this context, NaMATA aims to implement 5 BRT corridors covering approximately 137 kilometers, starting with Line 2 which the following features:

Component	Description
Infrastructure	-- 27 km in length. -- Along the line on Thika road, there will be ten (10) intermediate stations on the existing footbridges. -- The footbridges will be modified to add staircases and ramps in the middle to allow passengers to enter and exit the stations. -- The Project will also have three (3) terminals at KNH, Ruiru Depot, and Kasarani Depot
Buses	-- The initial fleet is sized at 100 buses growing to 660 buses when the operations peak on the entire Line 2 -- The buses will have a combined capacity of seated and standing passengers of 94 pax and are assumed to operate at a 58% occupancy rate on average. -- In terms of dimensions, the buses are 12m in length and will have either biodiesel or electric propulsion. -- The economic life of the fleet is assumed to be 12 years, with a midlife battery overhaul schedule for electric buses (or general rehabilitation for biodiesel). -- The buses are to be designed to open to the right to permit boarding and alighting on the median-aligned platforms.
Operation	-- The estimated ridership for the BRT Pilot is 163,040 passengers per day -- In 2019, surveys by ITDP in partnership with NaMATA revealed high passenger volumes at peak hours, with as many as 26,000 passengers per hour moving on one route. For example, at Ngara before Globe Cinema Roundabout, there is a demand of 16,000 passengers per hour in one direction in the morning. This is very high demand by any standard worldwide -- The BRT services of 100 buses will not be anywhere near meeting the demand - at this level, it can only meet 27 percent of this demand. This means that the current demand will allow operations of matatus to continue and provide room for even more expansion of the BRT service into the future. Further, as Thika Road attracts more developments, more and more passengers will need to use the public transport system
Operators	-- The registered SACCOs/Companies will be invited to participate as shareholders. They would take primary responsibility for organizing their individual members to participate in the capital raise. -- The respective affected SACCOs will be offered a share for each license held on Line 2. -- The SACCOs may establish Matatu Investment Companies (MICs) for investing into the BRT Bus Operating Company. This would allow the SACCOs to continue with their core functions -- To achieve inclusivity of affected operators and other interested stakeholders, including incumbent operators, painters, mechanics, sound system providers, to name a few, it is proposed that a new company be established and various classes of shares created for the L2 Bus Operating Company.

Table 2: BRT Line 2 project (Source: NaMATA (2022, p. 8-15)

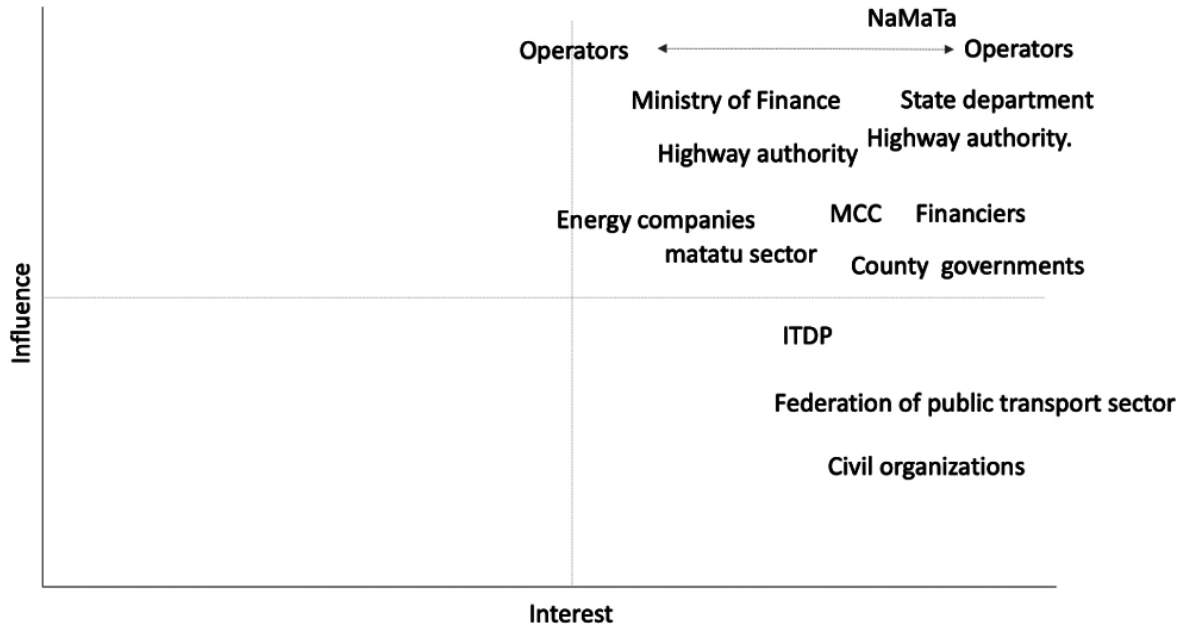
The implementation of a BRT project of this kind would help reduce traffic congestion, improve accessibility, and shorten travel times. The implementation of this project with electric buses would contribute to a reduction in pollutants -a factor that affects public health-, a decrease in carbon emissions, and the utilization of renewable energy sources.

United Nations estimates indicate that urban buses account for approximately 25% of black carbon emissions from the transportation sector, contributing to the harmful pollution in cities like Dar es Salaam, where fine particulate matter kills seven million people annually. (TUMI, 2024)

By 2030, public transport usage is expected to increase by 50%, with urban transit buses responsible for 25% of the sector's emissions. If met by internal combustion engine vehicles, this will significantly increase carbon emissions and other pollutants, while electric buses produce no exhaust emissions. (TUMI, 2024)

In Kenya, an electric four-wheeler is projected to emit 80% fewer pollutants than a conventional internal combustion engine vehicle, owing to the country's electricity grid, which is over 90% powered by renewable sources, primarily hydroelectric and geothermal energy. This positions Kenya as a favorable candidate for the adoption of e-mobility. According to Jit Bhattacharya, CEO of BasiGo, replacing one of Nairobi's 20,000 diesel buses with an electric bus would result in an immediate reduction of 50 tonnes of CO2 per year, a marginal impact on CO2 emissions that is greater than that observed in many other regions globally. (TUMI, 2024)

For the effective implementation of the project, the following stakeholders were identified in the aforementioned workshops, based on their level of interest and influence:



Graphic 1: Stakeholders identification (Source: Prepared by the author)

It is relevant to mention that some stakeholders identify the current operators as having varying levels of interest in participating in the implementation of Line 2. However, the interest among all stakeholders, including the operators, is high.

E-BUSES INTERNATIONAL AND LOCAL EXPERIENCES

Latin America and Africa are both experiencing rapid urban growth, leading to higher demand for public transportation. This puts pressure on existing transport systems, making electric buses an appealing solution. Both regions face challenges in local manufacturing and rely on imported buses or parts. However, both are working to develop local industries, either through assembly or building supply chains for electric vehicle components. Additionally, both regions have strong renewable energy potential, Africa with its solar, wind, and hydro resources, and Latin America with its hydropower capacity. This renewable energy potential can help charge electric buses, making the shift to electric public transport more sustainable. Finally, according with E-bus radar (2024), of the 6.057 electric buses currently in operation across Latin America, 64% are between 12 and 15 meters in length, which aligns with the type of buses intended for implementation in Nairobi BRT system.

In Latin America, the following countries have implemented electric buses on a larger scale:

Country	No. buses	Current status
Chile	2.659	Santiago is the city with the most electric buses in Chile, with a total of 2.480 electric buses that operate on mixed traffic lanes and on BRT lines.
Colombia	1.590	Bogotá is the city with the most electric buses in Colombia, with a total of 1.485 electric buses that operate on mixed traffic lanes.
Brazil	686	Sau Paulo is the city with the most electric buses in Colombia, with a total of 460 electric buses that operate on mixed traffic lanes. Brazil has 20 more cities where a smaller number of electric buses are in operation.
México	744	Mexico DF is the city with the most electric buses in Colombia, with a total of 607 electric buses that operate on mixed traffic lanes and on BRT lines.

Table 3: Implementation of e-buses in Latin America
Source: E-Bus Radar (2024)

The main business models for the implementation of electric buses are explained as follows. These models differ based on the degree of separation between the fleet and charging infrastructure provider, and the fleet and the charging infrastructure operator. The most representative business models in Latin America have been as follows:

1. **Unified ownership business model:** Buses and charging infrastructure are procured and operated by a private operator.
2. **Ownership separation business model:** Public entity as a supplier: Buses and charging infrastructure are procured by a public entity and operated by a private operator.
3. **Ownership separation business mode**: Private company as a supplier: Buses and charging infrastructure are procured by a private provider and operated by a private operator.
4. **Intermediate business model:** Buses and charging infrastructure are procured and operated by a private operator. However, the private operator subsequently contracts a private provider for the buses and charging infrastructure. The private operator transfers the payment rights for the fleet and charging infrastructure to the private provider.

The following section provides a detailed description of each of these business models:

Unified ownership business model

The business model of property unification proposes that the private operating company be responsible for both the provision and operation, as well as the maintenance of buses and charging infrastructure. The BRT system in Bogotá initially started under this model with non-electric buses. However, on a smaller scale, it has been successfully implemented in cities such as Bogotá or Mexico to introduce electric buses.

Agent	Public entity	Private operator
Responsibilities	-- -Structuring selection processes -- -Selecting the operator -- -Compensating the operator -- -Managing and controlling the operation	-- Providing buses, charging infrastructure and depots -- Operating buses and charging infrastructure
Risks		-- Operational risk -- Technological risk -- Financial risk
Compensation		-- A single fee that compensates both fixed and variable costs, or different fees based on the specific costs to be remunerated, namely: -- Fee per vehicle: Investments in vehicles, charging infrastructure, depots. -- Fee per passanger: Administrative costs, capital return, financial cost and taxes, scrappage. In BRT system with payment at stations, there is no compensation based on a fee per passenger. -- Fee per kilometer: Variable operating costs per km (fuels, tires, lubricants), maintenance costs, drivers.

Table 4: Description of the unified ownership business model
Source: Prepared by the author based on TRANSMILENIO (2010)

The advantages and disadvantages of this business model are as follows:

Advantages	Disadvantages
The operator is familiar with the market and, therefore, can achieve better negotiations with fleet manufacturers.	The operator assumes the operational risk and, as a result, it can be difficult to secure financing for investment in the fleet and charging infrastructure.

Table 5: Advantages and disadvantages of the unified ownership business model
(Source: Prepared by the author)

Ownership separation business model

It could be argued that the origin of the business model of ownership separation dates back to the United Kingdom in 1992, when the decision was made to privatize and restructure the railway industry in order to make better use of infrastructure, improve service quality, and provide a service more highly valued by the public. The Railway Act of 1993 subsequently established the division of responsibilities between the administration and design of the system, the operation of trains, and the ownership of the trains themselves. This led to the creation of three new entities: the Department of Transport (DfT) in the UK, which became responsible for overseeing the entire transportation system; the Rolling Stock Operating Companies (ROSCOs), which owned the trains and carriages and were responsible for leasing them to train operators along with a set of associated services; and the Train Operating Companies (TOCs), which were tasked with operating passenger and freight train services across the UK. (Transfondo, 2017)

The ownership separation business model for buses places the responsibility for fleet provision and charging infrastructure with one agent, while the operation is managed by another agent. The model can differ depending on whether these agents are public or private entities and the specific activities they are responsible for.
The revenue to cover fees may derive exclusively from payments made by users when utilizing public transportation, or alternatively, from government subsidies.

Ownership separation business model – Public entity as a supplier
In this case, a public entity is responsible for providing the fleet and charging infrastructure, while a different agent manages its operation. This business model has been used to implement electric buses on a small scale in cities in Colombia, such as Medellín, and in Brazil, such as the State of Bahia.

Agent	Public entity	Private or public operator
Responsibilities	-- Providing buses, charging infrastructure and depots -- Structuring selection processes -- Selecting the operator -- Compensating the operator -- Managing and controlling the operation	-- Operating buses and charging infrastructure
Risks	-- -Technological risk -- -Financial risk	-- Operational risk
Compensation	-- -Fee per vehicle: Investments in vehicles, charging infrastructure, depots.	-- A single fee that compensates variable costs, or different fees based on the specific costs to be remunerated, namely: -- Fee per passenger: Administrative costs, capital return, financial cost and taxes, scrappage. In BRT system with payment at stations, there is no compensation based on a fee per passenger. -- Fee per kilometer: Variable operating costs per km (fuels, tires, lubricants), maintenance costs, drivers.

Table 6: Description of the ownership separation business model – public entity as a supplier
Source: Prepared by the author based on ICLEI (2023)

The advantages and disadvantages of this business model are as follows:

Advantages	Disadvantages
The public entity may secure financing under more favorable conditions.	The public entity assumes the risks associated with providing the fleet and charging infrastructure. The public entity may lack the administrative capacity to effectively manage these functions.

Table 7: Advantages and disadvantages of the ownership separation business model – public entity as a supplier (Source: Prepared by the author)

Ownership separation business model – Private company as a supplier

In this case, the fleet and charging infrastructure provider is a private company, separate from the private company that operates the service. Under this business model, the electric fleet was successfully scaled up in Bogotá and Santiago.

Agent	Public entity	Private provider	Private operator
Responsibilities	-- Structuring selection processes -- Selecting the provider and the operator -- Compensating the provider and the operator -- Managing and controlling the operation	-- Providing buses and charging infrastructure -- Depots -- Maintenance of electric charging infrastructure	-- Operating buses and charging infrastructure -- Fleet maintenance -- Depots maintenance
Risks		-- Technological risk -- Financial risk	-- Operational risk
Compensation		-- Vehicle investment fee: Investments in vehicles, registration, ITS sytems, battery. -- Vehicle administration fee: Personnel administration, isurance, taxes -- Depot fee: Lease of depots, infraestructure services.	-- Fee per vehicle: Variable vehicle cost. Eg. Drivers. -- Fee per kilometer: Variable operating costs per km. Eg. Fuels, tires, lubricants. -- Fee per passanger: Taxes. In BRT system with payment at stations, there is no compensation based on a fee per passenger.

Table 8: Description of the ownership separation business model – private company as a supplier Source: Prepared by the author based on TRANSMILENIO S.A. (2020)

The advantages and disadvantages of this business model are as follows:

Advantages	Disadvantages
The fleet provider does not assume operational risk, allowing it to secure financing under more favorable conditions. New actors, such as investment funds, become interested in participating as fleet providers. In the event of non-compliance by the fleet operator, it is possible to reclaim the buses from the provider and reassign them to another operator.	The public entity must have the institutional capacity to structure and manage the various contracts, making sure it does not take on unnecessary risks. As more agents participate, transaction costs tend to increase. Traditional operators may resist this model, perceiving it as a threat to their existing business interests

Table 9: Advantages and disadvantages of the ownership separation business model – private company as a supplier (Source: Prepared by the author)

Intermediate business model

Recent experiences in Chile have tried to implement electric buses using a business model that sits between full unified ownership and complete separation of ownership. The public entity signs a contract with a private operator, who is responsible for both providing and operating the fleet. However, the private operator hires the fleet provider and transfers the right to the fee per vehicle. In this way, the public entity directly pays the fleet provider for the fleet. It should be agreed that the buses are dedicated to the service for their entire useful life.

Depots and charging infrastructure can also be provided either by the private supplier or by the public entity. In the case of Valparaíso, they were provided by the public entity.

Agent	Public entity	Private operator	Private provider
Responsibilities	-- Structuring selection processes -- Selecting the operator -- Compensate the operator and transfer the vehicle fee to the provider in virtue of the right ceded by the operator -- Managing and controlling operation. -- Providing depots and charging infrastructure	-- Contract a private provider to supply the fleet. -- Transfer to the private provider the right to receive the vehicle fee -- Operating buses and charging infrastructure	-- Providing buses
Risks		-- Operational risk	-- -Technological risk -- -Financial risk
Compensation		-- Fee per kilometer. -- Fee per passenger. In BRT system with payment at stations, there is no compensation based on a fee per passenger.	-- -Fee per vehicle.

Table 10: Description of the intermediate business model Source: Prepared by the author based on Gobierno de Chile (2024)

The advantages and disadvantages of this business model are as follows:

Advantages	Disadvantages
Traditional operators are familiar with the market and, therefore, can achieve better negotiations with fleet manufacturers. The fleet provider can obtain financing on favorable terms through the transfer of the right to the fee per vehicle. Traditional operators perceive that they continue to retain their business.	In the event of a legal claim, the provider's relationship is through the operator, not directly with the public entity.

Table 11: Advantages and disadvantages of the intermediate business model
Source: Prepared by the author

The four business models described above can be summarized as follows:

Business model	Fleet and charging infrastructure provider	Fleet and charging infrastructure operator
Unified ownership business model	Private operator	Private operator
Ownership separation business model – Public entity as a supplier	Public entity	Private operator
Ownership separation business model – Private company as a supplier	Private supplier	Private operator
Intermediate business model	Private operator contracting a private provider	Private operator

Table 12: Summary of business models (Source: Prepared by the author)

In the four business models, compensation to providers and operators depends on the investments and costs. The fleet and charging infrastructure provider is compensated for investments in fleet and charging infrastructure, while the operator is compensated for operational costs associated with the service.

The compensation for each agent can be structured based on concepts that cover investments and costs, such as, vehicle fees, passenger fees and kilometer fees. These fees are proposed during selection processes by participants within the limits established by the public entity. During the execution of contracts, operational variables are multiplied by the established tariffs to remunerate each agent over a specified period, for example, the number of buses available multiplied by the vehicle fee, the number of passengers multiplied by the passenger fee, and the number of kilometers traveled multiplied by the kilometer fee. The compensation for providers and operators may not necessarily align with the fee paid by users when using the bus, as in some cases, to maintain reasonable public transport expenses for users, the state provides subsidies.

The compensation composition, as well as the characteristics of provider and operator agents, should be defined within the comprehensive framework of the project's structure.

Turning to local experiences in Africa, efforts to implement electric buses have also been undertaken, as detailed below:

Country	No. buses	Current status
Cameroon	3	Corporate fleet of e-buses exists. Significant urban population centres have potential for e-bus adoption.
Egypt	200	Existing deployment of e-buses. High urbanization rate and government focus on sustainable transportation solutions.
Ethiopia	229	Ambitious electric mobility goals and government interest in sustainable transport. The government indicates 2030 vehicle electrification goals were exceeded in 2024.
Kenya	22	E-bus companies BasiGo and ROAM are present, leading the way in e-mobility initiatives with ongoing projects and policy support.
Morocco	12	Previous and upcoming deployment of e-bus pilots and strong domestic automotive industry already moving to electric vehicle production, Government initiatives promoting renewable energy and electric mobility.
Nigeria	15	Recent pilot for e-buses, rapidly growing urban areas with increasing demand for sustainable transport options.
Rwanda	19	BasiGo present, partnering with local bus operators. Strong government commitment to sustainability and innovation, making it an ideal candidate for e-mobility projects.
Senegal	150	Recent implementation of BRT buses, increasing urbanization and efforts to address environmental challenges through clean energy solutions.
South Africa	6	Golden Arrow piloting e-buses. Well-established automotive industry and growing interest in electric vehicles.
Uguanda	4	Kiira Motors piloting e-buses, with heavy support from the government.

Table 13: Implementation of e-buses in Africa
Source: Prepared by the author, based on TUMI (2024, p.10.)

The business model applied in Nairobi and Dakar are summarized below. Dakar was chosen as a model because of its implementation of electric buses within the BRT system, while Nairobi was selected because it is the city under review.

Senegal, Dakar

"Dakar is arguably the first city in the Africa region to attempt to formalize the informal bus system and also involve the private sector in the renewal of citywide bus fleets. Informal operators participating in the project were required to form cooperatives which would be responsible for loan repayments for the new fleet, initially financed and guaranteed by the government with credit from the World Bank. The government was able to regulate services through concession agreements." (ITDP, 2024)

"The World Bank and the European Investment Bank financed the construction of the Dakar BRT. The bus fleet was financed, procured, and operated by the private sector through a 15-year concession agreement signed in 2021. The private sector partner, Dakar Mobilité, constitutes Meridiam and Fonds d' Investissement du Sénégal (Senegal Investment Fund, or FONSIS) have a 70/30 shareholding agreement. The overall private sector investment amounts to USD $144 million, with an additional USD $22 million financed by the World Bank's Multilateral Investment Guarantee Agency (MIGA)." (ITDP, 2024)

"The risks to the private sector are mitigated through clearly outlined risk and role allocation in the operating agreement, including a minimum revenue guarantee and minimum passenger guarantee set at 100,000 passengers per day. The operator is expected to collect revenues as well as maintain the necessary infrastructure. The government, on the other hand, will ensure adequate operations and passenger volumes on feeder services. The BRT fares are zone-based and were set based on affordability through preference surveys and existing fares as well as the financial viability of the concession." (ITDP, 2024)

Kenya, Nairobi

BasiGo is an electric vehicle technology and financing company based in Nairobi, Kenya, focused on introducing electric bus services in sub-Saharan Africa. The company provides electric buses, charging, and maintenance services to city bus operators, with 28 buses currently in operation, mainly in Nairobi. (Hay, 2024)

BasiGo have helped Kenya Bus Service, the country's oldest bus operator, introduce its first electric bus, marking a transition into the electric age. This move ensures that public transport remains affordable for passengers despite fluctuating diesel prices. Currently, BasiGo has secured reservations for 500 electric buses from Kenyan operators and 300 from Rwanda. Additionally, the company recently launched Kenya's first dedicated electric bus assembly line at the Kenya Vehicle Manufacturers plant, with plans to locally assemble 1,000 electric buses by 2026. (Hay, 2024)

Central to BasiGo's mission is its 'Pay-As-You-Drive' financing model, which makes electric buses affordable and profitable for operators. Instead of facing high upfront costs, operators can lease the buses with a low deposit, gaining access to the economic benefits of electric buses. The lease also covers charging, service, and maintenance costs. As a result, bus operators break even within a few months of operation. (Hay, 2024)

The main challenges in the implementation of electric buses in Africa, along with strategies to address them, are outlined below. It should be noted that these challenges have also arisen in the implementation of electric buses in Latin America.

Topic	Challenge	Strategy
Stable public policies	Significant advancements in regulations are needed to create an enabling environment that attracts investment. In many African countries, policies to regulate and support the electric bus sector are still under development, and these needs will vary depending on local economic and political contexts.	Governments should expand or maintain existing VAT, excise duty, or import duty exemptions for electric buses to enhance their competitiveness with fossil fuel vehicles. Additionally, clear time horizons for these incentives, either based on a phaseout date or a specific number of vehicles sold, are essential to ensure policy stability and attract investment.

Topic	Challenge	Strategy
Financial sustainability	The high upfront costs of electric buses in Africa, along with low operating revenues, create significant financial challenges. "In Kenya, e-buses range from 20 to 26 million KSH (approximately €141,600 to €184,100) per unit compared to ICEV buses, which range from 3 to 5 million KSH (approximately €21,200 to €35,400) per bus." (TUMI, p. 4, 2024)	E-buses can be more cost-effective and require less maintenance than diesel buses over five years. However, financial incentives, such as tax breaks, financing options, and VAT and tariff exemptions for electric buses, can reduce high upfront costs and make e-buses more financially attractive, while higher tariffs on imported diesel buses further encourage their adoption. "International partnerships with organisations and private investors can provide the necessary funding and technical support, Companies like BasiGo in Kenya and Rwanda have been awarded a $225,000 (€210,000) grant by the Green Fund in Rwanda to help create efficient charging infrastructure for the buses deployed." (TUMI, p. 5, 2024)
Sufficient grid infrastructure	Insufficient infrastructure, including charging stations and maintenance facilities.	Improving infrastructure and ensuring a reliable energy supply are essential for the successful implementation of electric buses. Africa's vast renewable energy resources can be utilized to power e-buses, supporting sustainable energy goals. It is crucial to invest in charging infrastructure and prioritize the deployment of charging stations to ensure consistent and reliable operations.
Domestic industry support	Africa depends heavily on imported buses, primarily from China, or locally assembled buses using parts from other countries. High startup costs for manufacturing, a lack of skilled labor, and global supply chain challenges for EV components further complicate the situation.	Regional entrepreneurs are developing electric bus prototypes and business models, which will help create local jobs and stimulate the economy. Africa possesses significant raw materials necessary for electric vehicle production, presenting an opportunity to grow local industries, whether in manufacturing or processing, and drive economic development. The appropriate policy response is to maintain low tariffs on imported parts and fully-built buses to support the development of skilled workforces. Tariffs on fully-built vehicles and locally available parts should only increase once local markets have the capacity to establish their own EV manufacturing sectors. Additionally, tax incentives should be provided to local e-bus companies engaged in assembly or manufacturing. Governments must align with global supply chains, collaborate with other African countries to source and process raw materials, and attract foreign investment in battery production.
Awareness about electric buses	Many users and potential stakeholders are unaware of the costs and benefits associated with transitioning to electric buses.	Public awareness campaigns will be crucial in enhancing acceptance and support for electric buses. Targeted initiatives that highlight the benefits of e-buses will help overcome resistance to their adoption.

Table 14: Challenge and strategy for the implementation of e-buses in Africa
Source: Prepared by the author based on TUMI (2024)

STAKEHOLDERS PERCEPTION

Workshops were conducted with stakeholders from international organizations, government entities, and financiers to prioritize business models for e-bus implementation in BRT Line 2, considering financial, technical, legal, and organizational criteria.

Financial Criteria assesses the economic viability and profitability of each business model. It includes factors such as initial investment costs, operating expenses, revenue potential, return on investment, and overall financial sustainability. Evaluating the financial aspect helps determine whether the model can support its costs and generate sufficient income over time.

Technical Criteria evaluates the technical feasibility and efficiency of the proposed business models. It includes aspects such as the technology required for operation, compatibility with existing systems, reliability, maintenance requirements, and innovation potential. Understanding the technical dimension helps ensure that the model can effectively deliver services and meet operational demands.

Legal Criteria focuses on the legal implications and regulatory compliance associated with each business model. It examines factors such as licensing requirements, contracts, liability issues, and adherence to local, national, and international regulations. Assessing the legal aspect is essential to mitigate risks related to non-compliance and ensure that the business operates within the legal framework.

Organizational Criteria looks at the organizational structure and capacity required to implement and operate each business model. It includes considerations such as the availability of skilled personnel, management capabilities, governance frameworks, and the ability to coordinate among different stakeholders. Evaluating the organizational aspect ensures that the model can be effectively managed and supported by the necessary human resources and organizational processes.

The methodology used was the multi-criteria matrix approach. The stakeholders assigned a weight to each criterion based on its relative importance, ensuring that the sum of all weights equaled 100. Subsequently, they evaluated each alternative according to each criterion, using a scale of 1 to 5 to rate the alternatives. Then, the rating of each alternative was multiplied by the weight of the corresponding criterion. The sum of the results provided the total score for each alternative. By comparing the total scores, the most favorable alternative was determined.

As observed in international experiences, Business models can exhibit multiple variations depending on the degree of involvement of the state or the private sector, as well as the distribution of activities and risks between the parties involved in the transaction. The transportation economics literature has also identified different organizational models based on the level of state intervention. For example, De Rues, Campos and Nombela (2023) stated that “transportation markets can be organized according to four main models: (a) public monopoly; (b) regulated market; (c) free competition among operators with public infrastructure provision; (d) private provision of infrastructure and services.” (p. 404).

It is important to note that only three business models were selected for evaluation by stakeholders in order to simplify the workshops, as these models exhibit the most significant differences among them in the implementation of electric buses. These three business models were described in international experiences and are: (a) Unified ownership business model with a private company as a supplier and operator, (b) ownership separation business model with a private company as a supplier, and (c) ownership separation business model with a public entity as a supplier.

The results of the methodology are summarized below:

Criteria	Weight (%)	Unified ownership business model Private company as a suplier and operator	Ownership separation business model Private company as a suplier	Ownership separation business model Public entity as a suplier
Financial	30%	4	5	4
Technical	30%	5	4	4
Legal	10%	5	5	5
Organizational	30%	5	4	5
Total	100	4,7	4,4	4,4

Table 15: Workshop 1 (Source: Prepared by the author)

Criteria	Weight (%)	Unified ownership business model Private company as a suplier and operator	Ownership separation business model Private company as a suplier	Ownership separation business model Public entity as a suplier
Financial	40%	2	4	4
Technical	30%	4	3	3
Legal	10%	4	4	4
Organizational	20%	3	4	2
Total	100	3	3,7	3,3

Table 16: Workshop 2 (Source: Prepared by the author)

Criteria	Weight (%)	Unified ownership business model Private company as a suplier and operator	Ownership separation business model Private company as a suplier	Ownership separation business model Public entity as a suplier
Financial	35%	2	2	2
Technical	15%	3	3	3
Legal	15%	3	3	3
Organizational	35%	3	4	3
Total	100	2,65	3	2,65

Table 17: Workshop 3 (Source: Prepared by the author)

Criteria	Unified ownership business model Private company as a suplier and operator	Ownership separation business model Private company as a suplier	Ownership separation business model Public entity as a suplier
Total 1	4,7	4,4	4,4
Total 2	3	3,7	3,3
Total 3	2,65	3	2,65
Final total	10,35	11,1	10,35

Table 18: Consolidated workshops (Source: Prepared by the author)

On average, the financial criterion was assigned the highest weight. The stakeholders interviewed perceive that a business model enabling access to financing under favorable conditions is essential for making the implementation of electric buses on BRT Line 2.

The interviewees considered that, on average, the organizational criterion was the second most important. Stakeholders perceive that both the public entity responsible for managing the transportation system and the companies in charge of providing and operating the buses should have a solid organizational structure and sound corporate governance practices.

The technical criterion was ranked third on average by the interviewees. Stakeholders perceive that technical knowledge regarding passenger demand, as well as the operation of electric buses and their charging infrastructure, is necessary.

On average, the legal criterion was assigned the lowest weight. The stakeholders interviewed perceive that the existing regulations inspire investor confidence and enable the implementation of any of the business models analyzed.

Stakeholders perceive that the ownership separation model, where a private company is the fleet provider, is the most advantageous, particularly due to the financial and organizational criteria. However, they also highlight that private operators have the greatest expertise in the technical criterion.

It is noteworthy that the scores across business models evaluated by different stakeholders were quite similar. Although this represents the first exposure for many stakeholders to the analysis of business models, the

convergence in scores could be attributed to a shared inclination among respondents to adopt the so-called normative model in decision-making assessments, which emphasizes optimization through economic reasoning. In this regard, Thaler (2015) has argued that "the organizing principle was the existence of two different kinds of theories: normative and descriptive. Normative theories tell you the right way to think about a problem. By right I do not mean right in some moral sense; instead, I mean logically consistent, as prescribed by the optimizing model at the heart of economic reasoning, sometimes called rational choice theory" (p. 25). Conversely, descriptive theories explain decision-making based on biases, limitations, and cognitive patterns.

In this context, the reasoning of the interviewed agents was focused, as previously mentioned, on creating safe conditions for investors and leveraging the experience of current operators, thus aiming to reduce costs that would make the implementation of electric buses unfeasible. In the responses of the interviewees, no notable biases typical of descriptive theories were identified, such as loss aversion, endowment effect, overconfidence, regret, or empty intuitions. (Kahneman, D., 2013). Judgments of this type would have led, for example, to extremely high ratings for the unified ownership business model due to the endowment effect, that is, because of the familiarity with the bus service used for years with the same operator. Similarly, it could have led to extremely high ratings for the ownership separation model due to overconfidence in new service providers' ability to transform Nairobi's mobility without considering the current operators.

It is recommended to apply the methodology to a larger sample of stakeholders in order to gather more comprehensive insights into the market's perception of the e-buses business models. It is also important to note that this methodology captures stakeholders' perceptions of the business models for the implementation of electric buses. However, the selection of the model should be complemented by a technical, legal, and financial structuring that aligns with the realities and specific circumstances of each project.

RECOMMENDATIONS FOR BUSINESS MODEL IN NAIROBI

The main recommendations for the implementation of electric buses on Line 2 of the BRT system in Nairobi, considering the context of the city, stakeholders' perception, and local and international experiences in the deployment of electric buses, are as follows:

The implementation of electric buses requires the coordinated involvement of multiple stakeholders, such as manufacturers, assemblers, financiers, operators, government entities, international organizations, civil society organizations, among others. It is crucial to understand the perception of these stakeholders regarding the most suitable and timely business model for the deployment of electric buses. It is recommended to apply the methodology outlined in this consultancy project with a broader sample of stakeholders.

In the specific case of implementing electric buses on Line 2 of the BRT in Nairobi, based on stakeholder perceptions, the need to secure financing for the acquisition of buses and charging infrastructure is identified, along with an appreciation for the experience and knowledge of private operators. In this regard, preliminary it may be beneficial to consider the implementation of an intermediate business model that leverages the expertise of private operators while simultaneously involving fleet suppliers who can finance the initial investment.

Under this business model, the public entity contracts the operator, who subsequently engages the fleet and charging infrastructure provider. The public entity pays the provider a fee for the fleet and charging infrastructure based on the assignment of payment rights by the operator to the provider. The fleet is committed exclusively to service delivery for its entire useful life. It is not necessary for the public entity to guarantee the private operator a specific number of kilometers or passengers. The operational risk remains with the private operator.

If, within the financial structuring framework, there is a need to implement subsidies, one way to subsidize is through the public entity providing depots and charging infrastructure. This would reduce cost pressure on user fares. Furthermore, the characteristics and requirements for suppliers and operators are defined within the framework of the project structuring process.

The perception of different stakeholders serves as a valuable input for understanding market readiness; however, the final selection of the business model should also be based on a comprehensive project structuring for the implementation of electric buses on Line 2 of the BRT, considering technical, financial, and legal perspectives.

The elements recommended for review in each perspective are as follows:

Technical	Financial	Legal
• Demand • Routes • Indicators and mileage • Bus typology • Number of buses • Bus technology • Environmental and social impact • Energy supply infrastructure • Depots • ITs • Staff training • Communication strategy	• Project costs • Compensation structure • Project income • Financial model • Economic formulation of extraordinary aspects • Risk analysis • Financial conditions of the agents • Economic and financial impact • Financial feasibility analysis • Supervision • Buses, batteries and infrastructure second uses	• Legal framework • Contact term • Contracting entity • Type of legal relationship • Compatibility between new business model and existing transport schemes • Administrative procedures • Permits and licenses • Organizational structure and requirements

Table 19: Project structuring (Source: Prepared by the author)

Despite the aforementioned, there are several key elements that should be considered from each perspective:

Technical	Financial	Legal
• **Operation size:** It is recommended to contract a number of buses that allows for the exploitation of economies of scale, while avoiding dependency on a single operator. • **Quality indicators:** It is recommended to establish service quality indicators in the contracts to enhance the user experience. • **Operation control:** While the service may be provided by private companies, it is crucial for the public entity to retain control over the operation, including transportation planning, continuous real-time monitoring, and the analysis of efficiency indicators to implement service improvements. • **Proper infrastructure:** It is recommended to provide infrastructure that enables efficient operations, such as dedicated lanes that allow buses to operate at high speeds, thereby transporting passengers in shorter times and utilizing fewer assets.	• **Electronic payment:** User payments made electronically, rather than in cash, contribute to better resource management and, consequently, to greater confidence among investors in the assets. • **Trust accounts:** Managing user payments through trust accounts contributes to better administration and distribution of resources. This also enhances investor confidence. • **Subsidies for investments:** In the event that subsidies are necessary, it is recommended to allocate them to cover investments rather than operational costs. This will facilitate the acquisition of asset financing. • **Proper risk allocation:** Risks should be assigned to the party best positioned to assume and manage them. • **Alternative sources of financing:** If subsidies are required, it is advisable to consider alternative financing sources, such as the “polluter pays” principle. Examples include congestion charges, on-street parking fees, vehicle taxes, among others. Sources of financing can also be considered from property ownership or land value capture. • **Remuneration rates consistent with reimbursed costs:** Tariffs should align with the actual reimbursed costs, ensuring that the compensation reflects the true expenses incurred.	• **Establishing decarbonization targets in regulations:** This contributes to national planning efforts to meet international commitments and sends a clear signal to the market, prompting it to prepare its supply and demand accordingly. • **Tax benefits:** Granting tax benefits to goods and services related to electromobility contributes to their financial viability. • **Contract term:** Ensuring that the contract duration aligns with the lifespan of the fleet helps avoid the need to replace buses under the same contract.

Table 20: Key elements of the project structuring (Source: Prepared by the author)

Some of these recommendations are consistent with those put forward by the ITDP regarding the business model for Nairobi's BRT Line 2. In this context, the ITDP proposed adopting "a gross-cost contract, where fare revenue is held in a trust fund and payments to operators are contingent on compliance with service level standards. The bus operating contract should include a system of financial rewards and penalties based on the quality of service. If a net cost contract is adopted, NAMATA should provide service schedules and apply fines in order to incentivise compliance with service levels." (ITDP, 2022)

CONCLUSIONS

The consultancy project aimed to provide recommendations to NaMATA for the analysis of the business models under which the new electric buses could be implemented within their BRT transport system, Line 2. To this end, the current public transportation context in Nairobi was analyzed, local and international experiences with electric buses were reviewed, stakeholder perceptions regarding the implementation of electric buses on Line 2 of Nairobi's BRT were examined, and recommendations were provided to make this implementation feasible.
In the context of public transportation in Nairobi, it is important to highlight that the service is primarily provided by private operators organized in SACCOs, mainly through small buses known as Matatus. The Line 2 BRT project represents an opportunity to reorganize the transportation system by offering an alternative that increase quality of service for users and could potentially integrate some of the current Matatus as feeder services. This context was analyzed using the SWOT methodology.

International experiences were drawn from Latin America, considering that, although electric buses have been deployed on a larger scale there than in Africa, both regions are experiencing rapid urban growth, have renewable energy generation, possess local manufacturing potential, and have implemented buses of a similar typology.
In Latin America, different business models for electric buses have been implemented, based on the degree of separation between the fleet and charging infrastructure provider, and the fleet and charging infrastructure operator. These models include: 1. Unified ownership business model. 2. Ownership separation business model – Public entity as a supplier. 3.Ownership separation business model – Private company as a supplier. 4. Intermediate business model.

In Africa, Senegal's experience is particularly notable, where electric buses were recently introduced into the BRT system. The bus fleet was financed, procured, and operated by the private sector through a 15-year concession agreement signed in 2021. Informal operators involved in the project were required to form cooperatives responsible for loan repayments for the new fleet, initially financed and guaranteed by the government with credit from the World Bank. The government was able to regulate services through these concession agreements. (ITDP, 2024)

Similarly, in Nairobi, the implementation of electric buses is underway under the 'Pay-As-You-Drive' financing model, which makes electric buses both affordable and profitable for operators. Rather than facing high upfront costs, operators can lease the buses with a low deposit, thereby gaining access to the economic benefits of electric buses. (Hay, 2024)

For the case of the electric buses in the Line 2 BRT project in Nairobi, stakeholders were interviewed using a multicriteria matrix methodology, under which different business models were evaluated based on technical, legal, and financial criteria. The results indicated that stakeholders perceive the need to create favorable conditions for securing financing for the assets while simultaneously leveraging the experience of private operators.

Preliminary, this analysis suggests that it is timely to apply an intermediate business model, where private operators are organized to manage both the operation and provision of services but can acquire the fleet through arrangements such as leasing from a fleet supplier company. Considering the scale of the investments and with the aim of securing their financing, a transfer of the operator's fleet fee payment rights to the supplier could be implemented.

It is important to note that while stakeholder perceptions provide an understanding of market supply and demand, it is advisable to complement them with a comprehensive structuring from technical, financial, and legal perspectives to make the final determination of the business model for the provision and operation of electric buses.

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