POLICY ADVICE PAPER: E-PARATRANSIT

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Purpose	This deliverable aims to provide an overview on the multiple implications of electrifying vehicles used for paratransit services. The objective is to foster the electrification of paratransit services and ensure a sustainable and inclusive transition for vehicle owners and operators, and for service users.
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The report draws from publications from SOLUTIONS+ partners, including the "STF Recommendations for public authorities for procuring, awarding concessions, licences and/or granting support for electric recharging infrastructure for passenger cars and vans," developed for the European Commission by TNO, POLIS and reviewed by FIER (Sustainable Transport Forum, 2021), "The impact of electric buses on urban life" (UITP, 2019) and "Large-scale bus electrification, the impact on business models" (UITP, 2021).

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Executive Summary

In many cities of the global South, considerable attention has been drawn over the past years towards the paratransit sector, as it keeps on providing services for a large share of the urban population at a minimum cost for the local authorities. The notable negative externalities generated by the sector, among which the important GHG emissions and poor working conditions of the operators, led decision-makers to undertake reform programmes in several countries and cities. Past experiences had mitigated outcomes; in some cases, fleet renewal programmes enabled to consolidate the sector and improve the travel conditions for passengers, while in other cases it exacerbated already existing tensions between operators and the public authorities. Building from these experiences, the electrification of the sector might be considered as a lever to tackle, at the local level, both the environmental impacts of the sector and the social aspects related to the workforce, and at the national level to pursue commitments towards NDCs through the design and implementation of a national e-mobility strategy.

Whether the relevance of electrifying specific types of paratransit services might seem obvious, it differs sharply depending on the local context and the specific features of the paratransit sector in each city. Besides, on top of the technical and practical challenges elicited by such projects, further issues must be addressed in the case of the paratransit sector as it is a considerable job provider in most cities of the global South, a crucial transportation offer for captive passengers and often a highly politicized sector. Reforming the paratransit sector thus requires to carefully consider the social, political and economic impacts, and electrification can only be considered as an appropriate lever when conceived and designed to promote a just transition. In this perspective, paratransit electrification projects can be considered as opportunities to (re)define and acknowledge the role and function of paratransit services within urban mobility systems and increase the sector's resilience according to an inclusive and sustainable approach. Such transition however requires an ambitious policy framework at the national and local levels, which are often missing.

To support the elaboration of relevant and sustainable project of paratransit electrification, this policy paper aims to provide decision-makers, practitioners, experts and consultants with background information and technical content to identify the rightful conditions and set-ups to develop and implements paratransit electrification projects, as well as policy measures and regulation tools to support the electrification of paratransit services and ensure its sustainability. Built on international case studies, experts' interviews and a literature review, the paper suggests three levels to address paratransit electrification through dedicated policies:

- At the national level, recommendations regard the technical environment, the sectorial regulation, the economic and financial aspects and the social policies.
- At the local level, the suggested policies should target the governance set-up to develop e-paratransit services, the possible incentives to motivate stakeholders, and the policies related to the deployment of operating support.
- At the stakeholder level, another set of policy advice considers the operational impacts of e-paratransit on business models, how to introduce agility and openness to a new environment for the current and new operators.

For each level, detailed policies and measures are suggested, international experiences are presented within boxes and recommendations are articulated.

Contents

1. Background

1.1. The SOLUTIONSplus project

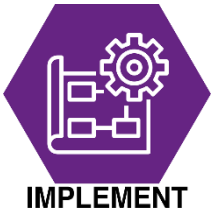
The SOLUTIONSplus project aims to enable transformational change towards sustainable urban mobility through innovative and integrated electric mobility solutions. To deliver this objective the project will boost the availability of electric vehicles, foster the efficiency of operations and support the integration of different types of e-mobility in large urban areas and address user needs and local conditions in Europe, Asia, Africa, and Latin America.

The project SOLUTIONSplus sets up a global platform for shared, public and commercial e-mobility solutions, and to kick start the transition towards low carbon urban mobility. The project encompasses city level demonstrations to test different types of innovative and integrated e-mobility solutions, complemented by a comprehensive toolbox, capacity development, and replication activities.

SOLUTIONSplus brings together highly committed cities, industry, research, implementing organizations, and finance partners. Through numerous synergistic projects, networks, and a strong technical experience, the project will be able to deliver its highly ambitious goals. Direct co-funding contributions will be provided by partner cities and SOLUTIONSplus works closely with UN Environment and the International Energy Agency (IEA) on a joint global urban e-mobility program that will significantly boost replication and impact of this Innovation Action.

Through the regional platforms, a global program and local teams, the project aims to develop highly effective and innovative approaches to urban e-mobility ensuring that mobility systems and interventions from this project deliver on the Paris Agreement, meet the Sustainable Development Goals, and address the New Urban Agenda.

	Boost capabilities of local and national authorities, public transport operators, and entrepreneurs about innovative urban e-mobility solutions across various transport modes by informing them about tools to plan, assess, implement and operate e-mobility solutions. The capabilities to develop policy, implement business models, and operate e-mobility solutions are vital steps in the transition process towards sustainable mobility. The first pillar of this project builds on a range of tools, methods, and guides and adapts them for a comprehensive toolbox on e-mobility solutions across all modes.
	Foster the take-up of e-mobility innovations by businesses, start-ups, local and national governments, and transport operators by inspiring officials, operators, industry, and businesses through peer-to-peer exchange on innovative e-mobility products and services. Implementing new policies, adopting new technologies, or testing new business models can be inspired by peer-to-peer exchange. This pillar facilitates exchange among city officials, transport operators, and

	entrepreneurs to share their experiences on specific technologies, policy and infrastructure measures, implementation processes, operations, business, and financing solutions.
	Strengthen policy and business collaboration by initiating partnerships between local and national governments and local and European entrepreneurs and supporting the development of new e-mobility models business implementation plans. E mobility solutions need a solid economic and operational concept to flourish. This pillar of the project initiates partnerships among local and European companies and facilitates the joint development of business models, building on sound assessments of economic, social, and environmental costs and benefits.
	Create reference models for e-mobility innovation by implementing demonstration actions to test innovative e-mobility technologies and services, foster their replication and ensure their long-term sustainability. Implementation is the evidence basis of the innovation. Demonstration projects serve as proofs of concept and their evaluation is the enabler for up-scaling. Several demonstrations in different contexts are necessary to show the adaptability of e-mobility innovations.
	Contribute to global sustainability and climate goals by boosting the impact of this project through the integration of innovative concepts into policy, funding, operation, research, and business practice. Long-term impacts can only be achieved if e-mobility innovations are embedded in local and national policies, in business strategies and operations, funding and financing programs. This pillar of the project will help integrate the innovations initiated and tested by the project into local, national, and global policy, finance, and business decision-making processes.

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2. Introduction

Cities such as Lima, Kampala, Manilla, Kumasi, or Panama City – and many others worldwide – share a common feature regarding their urban mobility system: they all account for a large share of paratransit services in the daily mobilities of their inhabitants. Indeed, in the global South as well as in some cities of the global North, paratransit services often represent one of the main transport options, if not the only one, especially in secondary cities and smaller towns (MYC Paratransit Toolkit). Despite their function in urban areas, these services are often not acknowledged by the national and local authorities and face a lack regulation. The difficulty to oversee the paratransit sector mostly result from the heterogeneity of the sector: it encompasses a variety of modes in each city, and sometimes even within the same city, such as 2 wheelers (boda-boda or ojek), 3 wheelers (bajaj, rickshaws), 4 wheelers (collectivos, gbaka, minibus) and even boats (pinasses, water taxis), which operate a diversity of services (fixed routes, on-demand, both…). It gathers a considerable number of operators, who traditionally gathers into professional organizations with different types of status (associations, cooperatives, operating companies…).

Despite the difficulties to frame and regulate the paratransit sectors, over the past years national and local authorities, as well as International Financing Institutions, changed their perspective on this sector and the services it provides: it represents sizeable modal shares in many cities of the global South, while being completely unsubsidized worldwide. Thus, lately efforts have been pursued to reform the paratransit sector rather than trying to eradicate it (Schalekamp & Klopp, 2018), mostly by limiting the negative externalities generated by paratransit services and improving the service quality, the working conditions and the environmental impact. In this perspective, the introduction of electric might be considered a lever in the implementation of such reforms. Besides, it is important to recall that the paratransit sector, despite its heterogeneity and against some pre-conceived stereotypes considering it to be not in line with the idea of a “modern city”, is far from resistant to the innovations and transformations taking place in the urban mobility sector globally. For instance, electric rickshaws have been existing in India already for a few decades, and prototypes of electric 4-wheelers for the paratransit sector were produced in the Philippines in the 1980’s (Espelia-Codatu, 2022). Eventually, decarbonizing the paratransit sector through the introduction of electric vehicles is even considered as a way to promote sustainable transportation at different levels (NASAC & IAP, 2024): the decrease of GHG emissions, air and noise pollution has a direct effect on health and well-being of the population(SDG 3), the production of electric vehicles contributes to the promotion of a green industry (SDG 9) and the development of sustainable cities (SDG 11).

Whether the relevance of electrifying specific types of paratransit services might be clear, it does not apply to all cities where these services exist. Besides, introducing electrified services takes on a dimension even more complex in the case of the paratransit sector: beyond the technical and practical challenges elicited by such projects, further issues must be addressed in the case of the paratransit sector. In most cities, the sector is highly politicized, first as it represents the main transport offer for the population, a considerable job provider and due to the vested interests that might exist between officials and transport operators. In some cities, paratransit operators also suffer from a lack of recognition by the local authorities, leading sometimes to antagonist positioning and conflictual relations. Reforming the paratransit sector thus requires to carefully consider the social, political and

economic impacts, and electrification can only be considered as an appropriate lever when conceived and designed to promote a just transition. It is also important to emphasize that reform projects of the paratransit sector represent opportunities to (re)define and acknowledge the role and function of paratransit services within urban mobility systems. When considering electric mobility, the way towards sustainability relies on a systemic and holistic approach of urban mobility systems, of which paratransit services are part.

To support the elaboration of relevant and sustainable project of paratransit electrification, this policy paper aims to provide decision-makers, practitioners, experts and consultants with background information and technical content to identify the rightful conditions and set-ups to develop and implements paratransit electrification projects, as well as policy measures and regulation tools to support the electrification of paratransit services and ensure its sustainability. The information presented in this policy paper mostly result from the expertise developed in the context of SolutionsPlus project and collected through the feedback from the partners and stakeholders involved in the demo cities. Interviews were also conducted by experts and practitioners involved in paratransit electrification projects in the context of sister projects or local projects in cities of the global South. Review of the literature on decarbonization of the paratransit sector and electrification of public transport also provided useful information to elaborate the policy paper. As the projects dealing with the electrification of paratransit services are still few and many of them are still exploratory, authors of the policy paper opted for a global approach on the topic, presenting case from cities of the global South and considering 2-wheelers, 3-wheelers and 4-wheelers in order to provide extensive content and systemic knowledge to the reader.

The policy paper advice is structured as follows: Section 3 provides a brief presentation of the paratransit industry worldwide, making the case for the relevance of paratransit electrification as well as emphasizing its challenges and limitations in global South cities. Section 4, 5 and 6 present detailed policies that could be implemented for the feasibility assessment, the conception or implementation of a paratransit electrification project. Section 4 presents the policy environment that could be set up at the national level. Section 5 considers the policy implications at the local level, while Section 6 provides indications of policies that could be implemented in direction of specific groups of stakeholders involved in the e-paratransit operations. Recommendations are articulated in a conclusive paragraph at the end of each section.

3. Electrifying the paratransit sector: goal, approaches and challenges

3.1. Paratransit services in urban mobility systems

3.1.1. The paratransit sector: an essential industry in cities of the global South

Prior to undertaking any action or reform regarding the paratransit sector, it is important to recall the essential role these services play in cities of the global South and some of the specificities of the sector. The number of trips provided each day, and the modal share of the paratransit sector are indicators of the vital role of these services in the functioning of urban areas. In cities such as Kampala, Lomé or Niamey for instance, paratransit services account for almost 100 % of the trips made with public transport services. In Douala, minibus and moto-taxis represent 41 % of all trips daily, in Dire Dawa paratransit services account for 42 % of all trips, in Kumasi 53 %, in Casablanca 6 %, in Maputo 33 %, in Nagpur 26 %, in Medan 7 % and in Abbottad 16 % (MobiliseYourCity, Global Monitor 2024). The importance of these modal shares induce that a large part of the urban population depends on the paratransit industry to move daily and reach employment places, friends and relatives, as well as amenities and public services.

Besides the number of trips, the importance of the paratransit sector also translates in the number of jobs provided, direct or indirect. In Manilla, it is estimated that 118 000 families depend on an income from the paratransit sector (Mettke et al., 2016). In Dhaka, rickshaw drivers are estimated to be between 280 000 and 400 000 (2022), and in Lagos there were more than 500 000 in 2012 (SSATP). In Kampala, the paratransit sector accounts for 256 000 jobs (GLI, 2019). Besides the drivers, many other jobs exist in the sector, such as line regulator, “coxeur” organizing vehicles arrivals in the station, dispatchers, assistants collecting the passenger fares in the vehicle, as well as mechanics and vehicle cleaners, and staff involved in the professional organizations. The list is not exhaustive, as depending on the context some other types of work exist. Most of these jobs do not require specific qualification and are thus accessible to a large share of the population. The high level of unemployment rate is many cities of the global South also justifies the attractiveness of the paratransit sector.

Due to the importance the paratransit sector assumes in many cities as a trip provider and a job provider, it gained a strong political and social clout. This results mostly from the ability of the paratransit sector to cause nuisance, in the case of a strike for instance, and paralyze the local economy. Moreover, connections between the paratransit industry and the political sphere are sometimes intertwined: may it be because of vested interests when officials own a fleet of vehicles, or to get access to an enlarged electoral base for decision-makers and elected officials. Local set-ups might also play a part, when specific tribal, religious or cultural groups are being over-represented among the paratransit workers (Baffi, 2024). Eventually, relationships between paratransit operators and local authorities are often complex and tense, due to the operators’ perception that the government tries to restrict their business, whereas on the other side, local authorities tend to consider paratransit operators as troublemakers and a sector difficult to regulate. These misconceptions can possibly have a strong impact on the achievement of public transport projects and reforms.

3.1.2. Negative externalities

Historically, the attitude of local and national authorities, as well as international stakeholders, has been to try to jugulate the development of the paratransit sector, mostly because of the negative externalities that are associated with this sector. They can be detailed in brief over 4 categories:

- Air pollution, noise and environnemental impacts

The paratransit sector is often held responsible for the emissions of pollutants, among which greenhouse gas. The level of emissions can be correlated with the age of the fleet as operators tend to over-use vehicles to make it profitable. In the case of Sub-Saharan countries, paratransit vehicles are often second-hand vehicles imported from North America, Europe and Japan (Boateng & Klopp, 2022). Coupled to the age of the vehicles, the lack of maintenance can also impact the pollutant emissions, and in some cases, operators use adulterated fuel to limit their daily expenses, which also in return increases the GHG emissions. Specific practices also increase the pollutant emissions, such as driving around with an empty vehicle when looking for passengers, and the sudden breaking from drivers to stop to load passengers. The difficulty to estimate the emissions generated by the paratransit sector remain a sensible issue when considering its environmental impact. Research also suggests that by considering the life cycle of the vehicles and the capacity of the vehicles, the overall emissions generated by the paratransit sector might be in some cities less than private vehicles and even mass-transit vehicles (Godard, 2008). Noise pollution (from the breaking, horns or from the assistant who tries to attract more passenger along the paratransit route) is also a common negative externality undergone by the inhabitants living close to the routes where paratransit operators drive or experienced by other drivers on the road.

- Unequal quality of services

Due the nature of the sector, paratransit services are attractive regarding the spatial coverage offered, their adaptability to connect new areas in cities where the urban development take place at a rapid pace, or the flexibility in terms of stops, fares and operating hours. However, as operators are mostly driven by the necessity to generate revenue, passengers' expectations and comfort is not prioritised, resulting in a mediocre quality of service. This is particularly the case during non-peak hours, when it can become difficult for passengers to find an operating vehicle. The necessity to maximise the operators' profit explains that drivers often operate according to the "fill and go" system, which requires to wait for the vehicles to be fully loaded with passengers between departing, which can result in long waiting times for the passengers and a great uncertainty. Maximising the capacity of the vehicles is also a common tactic used by the operators, who do not hesitate in some case to over-charge their vehicle, may it be 2 wheelers, 3 wheelers and 4 wheelers, with the addition of extra makeshift seats in the later. Besides from the uncertainty and discomfort, such habits entail as well poor safety conditions for the passengers.

- Lack of optimization in the operations

The mediocre quality of service is closely related to the poor performance of the paratransit sector. Several factors explain this lack: the first one being the restricted access to data. The lack of information and data regarding the vehicles and their operations prevent operators to understand finely their operations and to optimize. The pilot project led in Cape Town, based on data collection and the introduction of scheduling enabled operators to downsize the fleet, reduce the numbers of working hours while maintaining a steady revenue (UITP Policy brief, 2024). Another major obstacle

regarding the operations optimization is the fragmentation of the industry: the high level of competition between operators translates into an increased number of vehicles on the roads competing for the same market and often adopting reckless behaviour.

- Poor working conditions

Whether the paratransit sector is a substantial job provider, the working conditions of the operators, especially of the drivers, might vary and are generally difficult and depend on the level of consolidation of the industry[1]. In most cities, in the absence of a regulation, operators tend to operate *for* the market, rather than *in* the market. The high level of competitiveness is reflected in the small margin that the operators get at the end of the day. Indeed, revenues for the entire industry rely on the passenger fares, which explain the tight business model of operators. From this source, drivers – when not owners of the vehicle – shall repay the vehicle use according to the "target system": a dedicated amount is paid back to the owner daily, and the driver start his/her own profit only after reaching this amount. This system tends to encourage reckless behaviour from the drivers, who seek to get as many passengers as possible. To do so, they work extensive hours, sometimes without break, speed up and do not always respect safety rules. Besides from purchasing fuel, which is an unavoidable expense, drivers might neglect maintenance of the vehicles to limit their expenditures. Eventually, workers of the paratransit sector do not benefit from social protection while being exposed to a polluting and tiring industry.

3.1.3. Main approaches to reform the paratransit sector

Depending on the countries and cities, various actions and measures have been undertaken by the authorities to reform the paratransit sector. These actions and measures can be schematically encapsulated as follows:

- Modernisation

This category gathers measures aiming at transforming the rolling stock and introducing modern equipment. The most common type of measure in this category are fleet renewal programmes, which are often correlated with a scrapping scheme to facilitate the exit from the market of older vehicles, as well as the identification of operators by conditioning the obtention of the scrapping allowance to the enrolment of the owners towards the authorities. More recently, modernisation also relies on the introduction of digital tools to facilitate the operations on the operators' side and the experience on the passengers' side.

- Professionalisation

This set of measures regard the training of operators to gain basic skills such as driving, safety and maintenance, as well as capacity on topics such as management, business operations and legal aspects. Professionalisation also encompasses measures to improve the working conditions of the operators, such as introducing medical aid and insurance coverage, and even in some cases salaried

[1] In Abidjan for instance, a survey led by the Global Labour Institute found that paratransit operators perceive, on average, a daily revenue between 20 and 29 000 FCFA (approximately 33 to 47 dollars), in Kampala boda-boda drivers were found to earn at most 12 000 to 13 000 Ugandan Shillings (approximately 3 to 3,50 dollars) and in Dakar, where the paratransit sector is more consolidated, an average salary of 42 150 FCFA (approximately 69 dollars) was estimated by the Senegalese National Agency for Statistics and Demography (compilation of data made from the authors from GLI reports).

work and pension funds. These measures generally require operators to regroup within professional organizations to be able to pool resources.

- Optimization of operations

Correlated to the fragmented and competitive nature of the paratransit sector, the management of the fleet and the services remain often very poor and translates into a mediocre service quality. By enabling the pooling of resources and introducing appropriate tools, it becomes possible to optimize the operations of the paratransit services without decreasing the offer nor impacting the business models of operators. The reform of the fill and go system by scheduling operations for instance might enable to rationalize the use of vehicles while offering a reliable service for users. However, optimization requires access to reliable data to understand both the paratransit service and the operators' business models.

- Integration

Mapping of paratransit services represents a first step to integrate paratransit services into urban mobility systems. These types of measures might also entail the integration of paratransit services within Bus Rapid Transit projects, either as feeder or operators of the service. In addition, the deployment of ticketing systems facilitating intermodality between transport services and even fare integration is another important type of actions, which remains very complex to implement.

Parallel to these set of measures, the acknowledgement of the role and functions of the paratransit services by the national and local authorities is a crucial step to undertake before any type of action on the sector. As a corollary, understanding the paratransit sector through an in-depth diagnosis and building a trustful relationship with the operators and stakeholders of the industry are a pre-requisite to any reform (See Mobilise Your City Paratransit Toolkit Tool I, II and III for further information). Also, it is important to stress that whether approaches to reform the paratransit sector exist, and steps have been identified, there are no already made solutions or recipes and each reform or action on the paratransit sector should be co-constructed with the local stakeholders and adapted to the local characteristics of the sector and the urban mobility system.

Considering the various approaches presented above, the electrification of the sector intersects with several measures:

- Modernisation: the introduction of electric vehicles might be an opportunity to introduce a fleet renewal scheme.
- Professionalisation: driving electric vehicles require additional training for drivers, and capacity-building on business models. Besides, as the capital expenditures of the vehicles is higher, pooling of resources is even more important for operators to get access to loans which thus require an advanced consolidation of the sector and its operators.
- Optimization: the technical specifications of electric vehicles might represent an opportunity to reflect on the planning of the paratransit services.
- Integration: the constraints introduced by the operations of electric vehicle (range, recharging, facilities) call for a better integration of paratransit services in the urban mobility system.

3.2. Introducing electric vehicles in the paratransit sector

3.2.1. Transition towards new vehicles

Electric vehicles used for paratransit services are comparable to ICE vehicle, may it be 2, 3 or 4 wheelers. The differences come more from the uses, adaptations to passengers and freight transport than from technical aspects. Similarly, the barriers to the change of motorisation identified both by drivers and other stakeholders are often similar, particularly in terms of reluctance to behaviour change, knowledge regarding the technology, availability of charging stations and the vehicle purchasing costs (Amedokpo, 2024). In addition, encouraging paratransit operators to transition towards electromobility must be part of a broader city-level electromobility strategy. Indeed, operators will need charging stations, secured and adapted parking spaces, and training of the various stakeholders (in particular drivers) should be part of a sustainable mobility plan at the city level.

Despite the similarities between ICE vehicles and EV, attention should be drawn towards specific aspects, such as:

- Battery efficiency: vehicles must have high-performance batteries with durable technical characteristics to ensure a large autonomy range, a long life cycle
- Recharging: to optimize the vehicle operations and operators' business model, it is necessary to minimize the charging time. This can be done by swapping low-power batteries, and for vehicles with larger storage facilities, it is necessary to consider powerful charging systems or optimized charging organizations. In addition, the means of recharging must be accessible to all vehicles, including petrol or diesel-powered vehicles.
- Business models: the capital expenditure for electric vehicles remains more important than their combustion equivalents. However, several studies show that considering the Total Cost of Ownership, electric vehicles become less expensive than ICE vehicles.
- Regulation: electric vehicles have a different engine. Regarding 4-wheelers for instance, the power train is similar to internal combustion vehicles with automatic gearboxes which, in many countries, require specific driving licences
- Human: the resistance to change is an important factor to consider when introducing electric vehicle, both for drivers and operators. Improving working conditions, promoting the structuration of the sector through professional organizations and providing capacity building can be introduced in the context of EV introduction, and thus create more appetite towards change.
- Safety: Several studies have shown that drivers of electric vehicles, regardless of the vehicle size, tend to drive more safely for both passengers and their surroundings. However, specific training must be set up to teach drivers how drive vehicles and optimise both energy expenditure and charging times.
- Adaptation: vehicles must also be adapted to the local conditions, such as the road conditions, vulnerability towards floods and heat, or the local practices regarding for instance women needs or freight transportation.

3.2.2. Manufacturing and accessing electric vehicles

The development of electrified paratransit services in the global South is strongly correlated to the access to electric vehicles. In Asia, the development of an electric vehicle industry over the past decades facilitated the spread of EV mainly from China, which is the leader in the manufacturing market for electric cars, 2 and 3-wheelers, and India arriving second for the sale of 2 and 3-wheelers (Global EV Outlook, 2024). Although the first electric vehicles appeared at the end of the 19th century in Europe , electrification of paratransit vehicles started to be developed after Second World War by Chinese and Japanese motor vehicles manufacturers and was further developed in the Philippines in the 1980's with the electrification of jeepneys (4-wheelers) by Francisco Motor Corporation and in India in the late 1990's with the conception of e 3-wheelers (Espelia-Codatu, 2022). In contrast, access to EV remains very scarce in Africa, where the vehicle manufacturing industry is not very developed. Besides, 2 and 3 wheelers are much more affordable in terms of construction and purchasing costs, which explains their strong upsurge. In the context where no local or regional EV manufacturing industry exists, vehicles are either imported and sometimes facing high taxes to enter the country or assembled locally to minimize those taxes. However, the existence of a local assembling industry or manufacturing industry is also an asset to facilitate the access to current spare parts and expertise on the maintenance of EV.

Considering the limited presence of an EV manufacturing industry outside Asia for the paratransit sector, efforts have been drawn towards the retrofitting of ICE vehicles as it was done for the first electric vehicles in Europe in the 90's and experimented again for buses in the past decade. A preliminary case has been developed at Stellenbosch University, South Africa. The team of scholars and students involved in the project converted a minibus-taxi vehicle (Toyota HiAce) from an ICE propulsion to an electric propulsion. Whether this experimentation opens perspectives, the prototype mostly enabled to enlighten the complexities related to the adaptation of such vehicles to the local operations and the strong impact on the local grid (NASAC and IAP, 2024). Regarding 2 and 3 wheelers, the current low purchasing costs of EV on this segment disqualify retrofitting as a viable option.

Besides the existence of a local assembly or manufacturing industry, access to EV remains mostly constricted by the purchasing cost of the vehicles and the limited capacities of investment of the paratransit operators. Except in the case of individuals owning a fleet of vehicles who can reinvest in their fleet and activities, most operators rather own a very small revenue and do not necessarily realize margins, and when they do they tend to reinvest in other sectors. Thus, access to EV in the paratransit industry requires dedicated business models. A commonly used measure to foster fleet renewals rely on the earning of a scrapping allowance to replace an old vehicle with a new vehicle. However, even though these measures turned out to be efficient in several cities to renew and modernize the fleet of vehicles in the paratransit industry, it remains more difficult to implement with vehicles showing a higher purchasing cost. One main obstacle to overcome to facilitate the access of the EV for the paratransit operators therefore rely on the possibility to access loans at an affordable interest rate. So far, this obstacle remains unsolved in most cities in the case of 4-wheelers vehicles. In the case of 2 and 3-wheelers, access to the vehicles has been largely facilitated by the emergence of new types of stakeholders offering various purchasing options (repayment, leasing, …) to the paratransit operators.

3.2.3. Collecting and generating data for e-paratransit

Access to data on current paratransit operations is essential at the pre-feasibility stage of paratransit electrification project, and to scale up pilot projects. Indeed, modelling and planning of electric paratransit services should rely on detailed and accurate data on the existing paratransit services, and in particular: data regarding the vehicles (total cost of ownership, income generated by the operators, expenditures related to the operations and maintenance of the vehicles (fuel, spare parts, etc.), taxes, … another set of data needed upstream regards the operations of the paratransit vehicles, such as the distance covered, the ridership, the routes operated (to figure out the topography and its impact on the driving) and the driving behaviours of the operators (stops, speed, etc.). eventually, precise data on the organization of the paratransit sector, and how financial flows are dispatched are also important. A third set of data regards the GHG emissions and negative externalities associated with the paratransit sector. This is a strategic information in order to measure the improvements electrification could provide. However this data is particularly difficult to get due to the limitations of the tools available to track GHG emissions, and the reluctance of the operators to fix in on their vehicle.

Due to the very nature of the paratransit sector, it is very difficult to access tangible and accurate data on vehicles, operations and emissions. in many cities, information is often not properly tracked by operators who either do not have the means or are deliberately reluctant. Besides, the fragmented nature of the paratransit is a major blockage to access data and information, so as the different existing ownership models (GIZ-VREF, 2024). Surveys are thus most of the time needed as a prerequisite in a paratransit electrification project, and some of the tools presented in the Mobilise Your City Paratransit Toolkit might be useful to collect the missing data (see Box 7 below). In the case of a pilot project, the data collection might be conceived in the form of an iterative process. Due to their technical characteristics and the digital monitoring of the powertrain, EVs generate a considerable amount of data which could help refine the estimations and projections made in the pre-feasibility study such as real working time, distances, speed, energy consumption, …

Besides the technical value of the data collected to model and plan, the production of data and its dissemination is strategic for the local authorities to communicate among operators' and users', and a powerful tool to gain support whether the introduction of EVs happens to improve business models, operation performances and service quality. Nonetheless, a trust relationship between operators and local authorities is essential to facilitate the data collection and to ensure the accuracy of the data collected. The emergence of new actors such as the ride-hailing platforms and companies dedicated to the leasing and renting of EVs also opens a greater access to data and information, but agreements with local authorities shall be set to enable the exchange of information.

3.3. Beyond the vehicles, the transformation of a whole sector

3.3.1. Upstream: investing in the paratransit sector

Far from being a simple transition from one type of technology to another, the introduction of EV in the paratransit sector requires in-depth transformations that should be undertaken by different stakeholders. First, as mentioned above, the introduction of EV has direct implications on the business model of operators. Indeed, the capital expenditure is often higher in the case of EV, whereas

operating costs tend to be less important than ICE vehicles, bringing the total cost of ownership to be in some cases less for EV (this needs to be revised for each type of vehicle and based on the business model of operators). Therefore, the shift towards EV requires operators to invest more in this industry than they used to for the capital expenditure, even though the business model might be more viable over the long term. This behaviour (i.e. investing in the sector) is even more unusual for operators that the turn-over in the sector is rather high, with few operators building a career in the paratransit sector.

Second, on the side of the local and national authorities, a change of paradigm is required to operate the transition from ICE vehicles towards EV. Indeed, the introduction of electrified services is an opportunity for the authorities to legalize and regulate the paratransit sector – when it is not already the case – and acknowledge its role as public transport provider. Besides, due to the impact of EV on the local infrastructures and grid, the involvement of public authorities might be essential to ensure the viability of the electric services, which is rather unusual in the context of the paratransit sector. Moreover, beyond its involvement as a coordinator or support for the deployment of electric paratransit services, public authorities might be in a position to finance or participate in the financing of infrastructures such as depots, stations and stops equipped with charging stations. This can also be the opportunity to develop multi-usage services and consider these infrastructures as a service provider at the scale of a neighbourhood or a district. Investment in transport infrastructures for paratransit operators would then represent a major change in most cities, as very little cities worldwide invested in infrastructures aimed for the paratransit sector so far.

In return from such investments and commitment from the public authorities, some positive feedback and returns are expected. First, social benefits can be expected, mainly at the local level (NASAC & IAP, 2024). If planned in a consistent and sustainable way, the development of e-paratransit services might be a lever for the growth of electromobility. Then new jobs could be locally created over the short and mid-term, both in the public transport sector and vehicle manufacturing industry. For workers already part of the paratransit industry, improved working conditions may be expected thanks to the new motorisation and driving easiness of EVs. Another social benefit regards the existence of well-adapted and sustainable e-paratransit services would be the provision of transport service for the growing urban population, without increasing the GHG and pollutant emissions.

3.3.2. Transformation of the planning and operations of paratransit services

To assess the magnitude of the changes involved by the introduction of electrified vehicles, it is important to identify the transformations taking place at the level of the industry. As a major action on the sector, the introduction of EV is an opportunity for authorities and local stakeholders to redefine the role of paratransit services in the urban mobility system. If this should be elaborated in dialogue with the local operators, paratransit services might be for instance the main transport provider in cities, in other case complimentary to mass-transit services, or connecting specific neighbourhoods. Depending on the local set-up and the function allocated to paratransit services, these might impact the planning, conception and implementation of the electrified services. However, the integration of paratransit services within the urban mobility system and its mention in planning documents remain rather exceptional, and hence rely on a shift in the mindset of decision-makers and planners. This is even more the case when considering 4-wheelers and electric fleet of vehicles requiring the use of charging stations. Indeed, the localisation of these stations should be made in

accordance with a larger spectrum of usage and should also consider the possibility to charge other types of vehicles (e-buses, private vehicles, utility vehicles).

Regarding the operations, transformations are expected at several levels as the paratransit sector is characterized by its flexibility which is not always adapted to the specificities of electrification. Regarding the operators themselves, the high turnover observed in the industry might impede operators to be sensitized and gain knowledge on EVs. Moreover, in many cities of the global South, paratransit services are more competitive than other transport services due to their flexibility and fast adaptation to urban dynamics (uneven access to neighbourhoods, spontaneous building of new neighbourhoods, changing of routes due to natural hazards, …). The restrictions regarding the possible itineraries related to the operations of electric vehicles, more specifically in the case of 4-wheelers (location of charging stations and hubs), might then be contradictory with the very nature of the services delivered. Another specificity of the paratransit services is that they often target captive passengers, i.e. low-income urban dwellers who cannot afford other public transport services. In this case, maintaining affordable services despite the transformation of the operators' business models is of foremost importance to ensure the accessibility of the local population.

Electrification requires training for a broad range of stakeholders. ICE vehicles and EV have distinct operational requirements which call for dedicated drivers' training; maintenance is also different although easier, and specific spare parts and batteries shall be made available. Training also regards the stakeholders involved with the planning, the regulation and enforcement of the e-paratransit services, to understand the specificities of the vehicles and their impacts on the services. Eventually, sensitization among users is important, as they might be reluctant to use a different type of vehicle, or vehicles that might be considered unsafe due to a lack of information and knowledge on the topic of EV. This last aspect is particularly important to maintain the business model of the operators and ensure that users do not shift towards other transport modes.

3.3.3. Emergence of new markets and new actors

More and more attention has been drawn towards the paratransit sector over the past years. First, the acknowledgement of the role played by this sector is many cities of the world, including multi-millionaire cities, and its important modal shares raised the attention of actors who traditionally did not considered paratransit services or even dismissed its function and importance. Second, several technological innovations turned out to be well-suited to the sector. In particular, the spread of smartphones with GPS and the access to data translated into the development of ride-hailing applications, including in the paratransit sector (Espelia-Codatu, 2022). As the sector is far from being resistant to innovations, the introduction of electric vehicles has been progressively taking place, in particular in Asian cities, as mentioned above and is starting in Africa.

The introduction of new technologies and innovations in the paratransit sector participates in the opening of new markets for the private sector. In the case of the EVs, new types of actors emerged either from the automotive manufacturing industry (for instance Spiro by the Indian company M Auto or BasiGo by the Chinese company BYD) or the ride-hailing industry (such as Ola). These actors have in common to offer e-vehicles made for the paratransit industry, may it be 2-wheelers (Spiro), 3-wheelers (Ola) or 4-wheelers (BasiGo, Spiro). Depending on the types of vehicles, re(charging) solutions are made available, as well as maintenance centres dedicated to EVs. Operators are also allowed to repay or lease their vehicles, which turns out to be more affordable for many who do not

have the CAPEX to buy an EV. Obviously, through these appeal products, the major companies aim at tapping into an untouched market which gathers billions of operators across the world.

3.4. Main challenges

3.4.1. E-Paratransit as one of the key sectors to mitigate climate change

In the context of climate change, the role of the transport as a main contributor to GHG emissions has been largely acknowledged. In cities of the global South (first and secondary cities), the dominant modal shares of paratransit services (Codatu, 2015) make this sector responsible for a large share of GHG emissions, while at the same time providing for most of the motorized trips for the urban population. The urge to mitigate the GHG emissions is twofold: on the first hand, the pollution of the sector is related to the age of the fleet, as vehicles are often second-handed from the US, Europe and Japan (UNEP, 2020). On the other hand, the increase of motorization rates per capita in cities of the global South might lead to the modal report of urban population from paratransit services towards private cars, which could lead to a further increase in GHG emissions. Whether many local governments attempt to prevent such a scenario by developing mass-transit services to provide and anticipate the mobility needs of the urban population, these services and infrastructures remain expensive for many local authorities, not always adapted and cannot provide for most daily trips. Most likely, paratransit services will remain the dominant public transport mode for the next decades in many cities, and therefore the decarbonization of paratransit services should be a priority to reach NDCs.

In this context, electrification of the paratransit fleet shall not be considered as the only action to decarbonize the sector. This should be one of the possible levers accessible to the local and national authorities as part of a more global strategy depending on the characteristics of the energy mix, local transportation infrastructures, and population needs among others. Other options have been examined and implemented, such as the development of CNG and LPG 3-wheelers in India since the late 1990's, as well as in Thailand and Cambodia (Espelia-Codatu, 2022). Biofuel and hydrogen solutions are also being currently tested in several countries (Giliomee et al., 2023). More generally, it is also important to recall that these transitions are and will take place over the mid and long-term and remain parts of the solution. As recalled in a post from SSATP, the decarbonization of the public transport sector cannot simply rely on a technology transition but shall rely on the fundamentals of a consistent and sustainable transport planning[2].

3.4.2. Current limitations on energy provision

An obvious challenge in many cities of the global South regards the provision of electricity and its accessibility, the availability of infrastructures such as charging stations and the capacity of the grid. A first concern is that a sizeable share of the population still does not have access to electricity, and this is even more prevalent in Africa where 43 % of the population was without access to electricity in 2021 (NASAC and IAP, 2024). The availability of electricity and charging infrastructures also differs sharply depending on the countries, and within countries. Regarding the access to electricity, it

[2] https://www.ssatp.org/news-events/beyond-electric-vehicles-what-will-it-take-decarbonize-transport-sector-africa

sometimes varies greatly between cities and rural areas, and between first and secondary cities. Access does not only regard the production of electricity and accessibility of infrastructures, but also its affordability: in South Africa the costs of electricity were identified as a barrier for the diffusion of EVs (Sovacool et al., 2022).

When access to electricity does exist, its production also raises questions considering the energy mix: most countries do not have a decarbonised energy mix, which makes vehicle electrification more complex to implement to enhance as it should then be correlated to the concomitant development of renewable energies. This is the case for instance in South Africa, where electricity remains mainly coal-powered, with recent incentives from the national government to strongly develop renewable energies as an alternative. Other countries such as Nepal or Kenya, mainly relying on hydro-generated electricity, represent relevant grounds to develop EV fleets. Currently, many countries of the Global South are developing the production of renewable energies, mostly solar or wind for the time being. Their objective is to increase their independence regarding fossil energy which should lead to substantial money savings. As a result, the energy mix is already changing in several countries (for instance in Morocco) and within the next ten years, the production of energy from renewable energies could reasonably become normal for countries such as Senegal or Mauritania, … which should enable them to develop the appropriate distribution network and deploy electromobility in meantime.

Besides, the existence of infrastructures to enable the charging of EVs and the capacity of the grid to sustain the charging of batteries are also limiting factors. The availability of charging stations differs between cities such as Nairobi, which displayed less than 10 stations in 2020, Cape Town 19 and Cairo almost 100 with a plan of extra 200 station (Odhiambo et al., 2021). On this topic, an argument towards the development of EVs in cities of the global South regards the possibility to integrate charging stations within urban planning while urban infrastructure and road are still to be built in many cities of the global South, especially in Sub-Saharan Africa (Sovacool et al., 2022). The capacity of the grid to sustain the charging of EVs is today a barrier to the development of EVs in the public transport sector. Recent studies show that in the case of South Africa, the electricity need of minibus-taxis, which are the dominant 4-wheelers paratransit vehicles, would use about 10% of the daily national energy generation (Abraham et al., 2021). However, the deployment of renewable energy network will offer sufficient supply in many countries which are already envisaging to export energy (cf for instance the recent World Bank reports on "energizing Eastern and Southern Africa like the programs ASCENT or managed by UNEP).

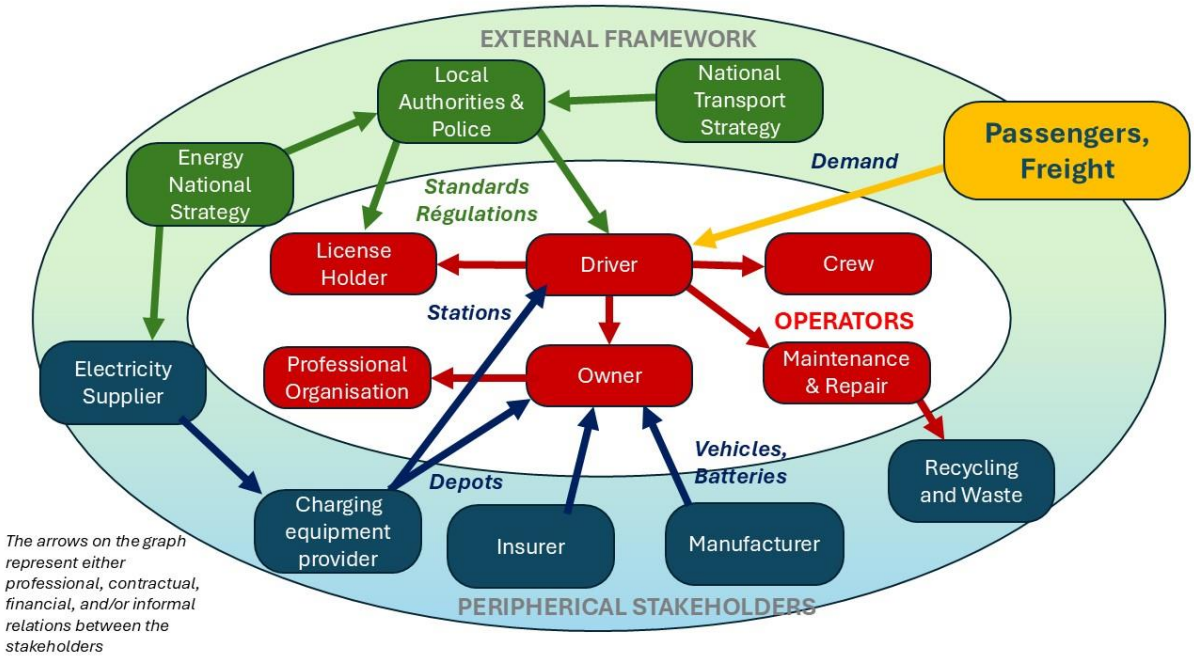
3.4.3. Coordination of a complex ecosystem of stakeholders

The introduction of paratransit electrification has many underlying implications, especially for what regards the power dynamics and relationships between the stakeholders part of the industry and related to it. Considering the first ring of actors in the sector, it is important to recall that it gathers both owners and drivers of the vehicles, who are sometimes the same individuals. Worldwide, the sector is largely fragmented with a variety of small-scale entrepreneurs who gather in the form of associations, cooperatives and sometimes even companies. The consolidation of the industry is a prerequisite before a reform on the sector and the introduction of a new type of vehicles: this is especially a lever to facilitate the pooling of resources between operators and facilitate the access to loans for operators who otherwise struggle to access the banking system (GIZ-VREF, 2024). It is

important to note that the options regarding the consolidation of the industry is very different from one city to another and depending on the vehicles operated: due to the augmented capex needed for 4-wheelers purchase and the characteristics of the operations, the consolidation of the industry is vital, which is not always the case regarding 2 and 3-wheelers. When they do exist, associations of operators are a key actor to enrol in the conception and planning of e-paratransit services, as a part of a broader dialogue between paratransit operators and local authorities

Besides from the necessary coordination within the paratransit sector and with the local authorities, trans-sectoral discussions and synergies shall be initiated with the energy sector. Even though this is a common consideration in the context of the public transport sector, energy providers and the related stakeholders (EV manufacturers, charging stations providers, leasing companies, etc…) do not necessarily have an in-depth knowledge and understating of the paratransit sector. The expansion of the ecosystem thus calls for a strong integration between sectors which are often considered in-silo and the roles of the various stakeholders involved in the paratransit ecosystems are expected to evolve, as it will be later presented in the paper, may it be for the public authorities or the private sector. The role of universities and educational institutions is even more strategic, as they seem to be a key player regarding innovations and the development of a local expertise on paratransit electrification (GIZ-VREF, 2024).

The capacity to identify, gather the stakeholders who are part of the ecosystem of e-paratransit vehicles and facilitate their discussion could be instrumental in creating a local ecosystem and limit the dependency towards foreign technology and expertise.



Tentative overview of the typical ecosystem of stakeholders for the e-paratransit industry

3.5. Conclusion

In many cities of the global South, considerable attention has been drawn over the past years towards the paratransit sector, as it keeps on providing services for a large share of the urban population at a minimum cost for the local authorities. The notable negative externalities generated by the sector, among which the important GHG emissions and poor working conditions of the operators, led decision-makers to undertake reform programmes in several countries and cities. Past experiences had mitigated outcomes; in some cases, fleet renewal programmes enabled to consolidate the sector and improve the travel conditions for passengers, while in other cases it exacerbated already existing tensions between operators and the public authorities. Building from these experiences, the electrification of the fleet might be considered as a lever to tackle both the environmental impacts of the sector, and the social aspects related to the workforce.

Prior to any action on the sector, several considerations and prerequisites shall be considered.
First, the introduction of electric vehicles requires a change of mindset both from operators and public authorities, mostly related to the necessity from all stakeholders to invest in the sector, which yet has not been a common practice.
Second, the change of technology also entails an opening of the ecosystem of actors to external stakeholders such as energy providers, electric vehicle manufacturers, battery providers, etc. which will contribute to shift the power dynamics and financial flows in the sector.
Third, a successful electrification project will rely on the collection of precise data informing, among other items, the existing operations of paratransit services, the business models of operators and the conditions of the fleet. Accessibility to this data will be crucial to establish the relevance and feasibility of an electrification process and ensure a just transition for the stakeholders.
Fourth, the feasibility and viability of an electrification project in the paratransit sector will mostly depend on the level of consolidation of the operators, which will determine the capacity to engage a dialogue among stakeholders, the possibility to access financial incentives for vehicle purchase and to integrate training and capacity building programmes.
Fifth, a high level of coordination will be expected at the local level between the urban planning and transport planning to ensure that e-paratransit services are integrated in the urban mobility system, which also implies capacity building among civil servants, officials and technicians.
Sixth, it is important to recall that paratransit electrification is not the only option to undertake the decarbonization of the paratransit sector and might not be appropriate in all contexts. A thorough diagnosis and pre-feasibility study shall be implemented locally to assess whether it is the most viable option.

Eventually, it is also noteworthy to consider that if the case for paratransit electrification might not be obvious in all contexts, it however recalls that this sector is far from being isolated from the issues and transformations taking place worldwide in the transport and urban mobility sector in general. The need for political support to foster and facilitate a transformation of the urban mobility in line with the international requirements remains a priority and could materialize through the policies presented in the next sections.

4. E-paratransit and national urban transport strategies

The deployment of e-mobility – and even more so of e-paratransit – in urban areas strongly depends on the national strategies on mobility, and more generally strategies regarding environment and energy. These strategies are often also correlated to the national orientations regarding energy transition and climate changes together with economic growth. Of course, beyond these sectoral approaches, the impacts of e-mobility are manyfold, such as impacts on health, quality of life of citizens, etc.

To develop electromobility at the national level, several policies must be examined and adapted to the specificities of paratransit such as the availability of energy, the standards for the vehicles and charging facilities, the pricing of electricity, …

As mentioned in the previous chapters, the deployment of e-paratransit depends on the policies related to:

- The development of e mobility and associated infrastructure.
- The consideration of this specific type of transportation by national transport authorities and its role in urban mobility among other transportation modes for passengers and goods.

Once this global framework is established, the specific policies related to e-paratransit may be classified in 4 main types of policies:

- **Technical**: to homogenise the various components related to electric vehicles and charging systems, as well as to simplify the exploitation and maintenance.
- **Regulatory**: to facilitate the integration of e-paratransit in urban and interurban mobility systems.
- **Economic and financial**: to support the deployment of the services and ensure their viability for the users, the operators and the stakeholders involved.
- **Social**: to encourage the utilisation and enlarge the number of users and guarantee a just transition for the operators of the paratransit sector.

National strategies must be elaborated regarding each type of policies so as to set up a global framework for electrification of the paratransit sector at the local level.

4.1. Technical policies

4.1.1. Technical standards

Deployment of e-mobility requires the elaboration of specific standards for all the technical fields concerned by this type of motorisation and based on the category of vehicle (minibus, cars, 2 or 3 wheelers) such as charging plugs or protocols, electrical components…

The main standards which need to be considered would be:

- The type of vehicles or some components,
- The batteries and the Battery Management Systems ; these cover various aspects such as battery performances, safety, durability, life cycle impacts on emissions,…
- Charging infrastructures and connection to the grid, including plug types, voltage levels, communication protocols.

- Interoperability and compatibility of charging systems both in stations and in vehicles
- Data exchange protocols such as charging status, battery level, vehicle location,….

These standards must also concern vehicles' safety or the services' quality such as e-paratransit locations are accessible and user friendly for all passengers. On top of these standards, it could be relevant to have dedicated standards for paratransit vehicles in order to homogenise the practices and equipment over the country – especially if the deployment of e-paratransit services is undertaken at a national level and entails the development of a manufacturing industry and its associated value chain.

Regarding the technical aspects, a set of international standards has been set for the deployment of electromobility at the national level which are based on interoperability between supply and charger, safety risks and electromagnetic compatibilities. These standards are IEC, ISO, CEN-CENELEC, ETSI, BSI,… The development of e-paratransit services must be in line with the standards adopted at national level.

Box 1. The complexity of setting standards and enforcing them in India

In the context of the Faster Adoption and Manufacturing of (Hybrid) & Electric Vehicles (FAME) in India, substantial efforts and investments have been drawn over the past decade to develop the electromobility sector in India, and notably the paratransit sector with the iconic rickshaws. In parallel to the investments made in the development of a local manufacturing industry of e-vehicles and incentives to purchase vehicles, improvements were made regarding the regulation and the respect of standards. Indeed, manufactured models of e-rickshaws have to comply with the standards enacted by the Automotive Research Association of India (ARAI) and the International Centre for Automotive Technology (ICAT). These two State agencies are responsible for setting standards and controlling e-vehicles. If the electric vehicles testing leads to approval, the vehicle can then be register by the Regional Transport Office. However, despite the existence of this framework, difficulties elicit from the lack of traceability regarding the parts that not locally manufactured (which remains a common situation), and local observers emphasised the lack of enforcement and control of the vehicles by the local authorities.

Source: Espelia-Codatu (2022).

4.1.2. Technical supports

Actions in this field aim to support or facilitate the technical evolution of the competences of paratransit stakeholders in the domain of electromobility. These supporting actions are related to different types of development programs to guide stakeholders and to improve their expertise such as:

- Defining technical strategic orientations for research and innovation projects, facilitating the cooperation between academics and entrepreneurs
- Setting up a national strategy for capacity building to promote skill development at various levels and in several sub-fields: basics of electronics, engineering for the design of new vehicles and digital tools, etc… These capacity building programmes should be aimed to a

broad audience, with a specific focus on the operators, technicians and practitioners involved in the paratransit services.

- Offering advice for technology upgrades such as real time communication devices, tracking systems as these would be crucial in generating data on the services, enabling to better design and plan the services, to improve the business models and the passenger information.
- Developing specific technical agencies to help, advise and coach the operators.
- Ensuring adequate infrastructure, such as grid and electricity supply, vehicle built-in Intelligent Transportation Systems (ITS) devices and software.
- ….

4.1.3. Accessibility to energy

Paratransit activities may represent an important demand for energy at the national level, such as the 10% estimated in the case of South Africa, as mentioned before (Abraham et al., 2021). Access to electricity will be made possible at local level in charging stations or depots.

At national level, actions to facilitate e-paratransit aim to ensure the quality and availability of electricity for all operators and are related to:

- The energy costs, which influences the OPEX and at least must be equal for all operators although incentives may be given for the smallest.
- The quality of the electricity distribution (guarantee of availability and correct voltage), since many countries still encounter voltage drops or even power outage.
- The development and implementation of intelligent grid infrastructure, which could be dedicated or prioritised for operators such as on street charging at "intelligent lampposts" or specific secured grid connections, energy buffers (for instance second life batteries) for depots.

The electricity demand will increase only progressively according to the penetration rates of electrification among paratransit operators. It is then important to set up indicators to follow this growth (for instance number of vehicles and distances) in order to anticipate future demand. The implementation of energy production plants, such as solar power plants, could be an answer to this increase, as well as decentralised renewable energy production units (such as photo voltaic panels) which could be installed by operators running fleets through incentives to develop such units in their premisses or nearby cities wanting to develop e-paratransit.

4.2. Regulation

The objectives of regulation actions concerning e-paratransit are firstly to ensure the homogeneity of rules at national level and secondly to improve the security and safety of drivers, passengers and transported goods.

Apart from the application of standards, main actions concerning the homogeneousness are:

- The scheduling of the transition of the paratransit fleet towards decarbonisation, which may be quicker than for private vehicle owners, for instance setting earlier targets for the electrification of ban of ICE vehicles.
- The drivers training and qualification norms to ensure that they are skilled for operating electric vehicles and are aware of the safety issues for passengers and other road users.

- The allocation of road spaces (special routes, dedicated lanes, low emission zones, delivery areas, …..).
- The implementation of an observatory of e-paratransit to monitor the evolution of the sector and help determine further policies.
- Regulation also regards the ride-hailing platforms and EVs leasing and renting companies, to ensure their compliance to the national and local legislation and that they are willing to share basic information with the local authorities.

Concerning road safety and security, the main actions are:

- The technical control of the vehicles used for e-paratransit with the underlying objective to build and update a database on the number and type of vehicles, for instance thanks to the implementation of automatised tracking devices in vehicles to follow the maintenance operations.
- The set up of a drivers' database listing accidents involving e-paratransit vehicles (in partnership with insurance companies for instance).
- Securing the access of charging infrastructures in the urban space by using monitoring of the infrastructures and through improved accessibility (for instance with prioritised access) of the charging stations (on-street especially), e-hubs, …

Box 2. Evolution of the regulation frame regarding e-paratransit in India

In the context of the FAME programme (see box 6 for further details), the introduction of e-rickshaw entailed an evolution regarding the regulation of the paratransit sector. First, the operations of e-rickshaws were officially acknowledged by the Motor Vehicle Amendment Act in 2014, which specified, among other items, the conditions to obtain a licence to operate a e-rickshaw or e-cart up to 2 000 watts. The Amendment was augmented in 2015 to include e 3-wheelers up to 4 000 watts, and the Central Motor Vehicles Amendment Rules also specified the procedure to obtain a licence the same year. Further integration of e-rickshaw into urban mobility systems was made in 2016, when the Ministry of Road Transport and Highways introduced a Draft Taxi Policy mentioning the role of e-rickshaws as first and last-mile feeder services in Indian cities. The progressive acknowledgment of the role allocated to e-rickshaws in Indian cities as well as the conditions to obtain licences to operate are some of the factors explaining the rapid uptake in the number of e-rickshaws operations. However, as the conditions to obtain an operating licence were initially lighter than for “traditional” rickshaws (as electric vehicles are simpler to operate), a high number of road incidents was recorded during the first years of the FAME programme. This resulted in the evolution of the conditions for licence obtention, which became stricter and correlated with the necessity for drivers to attend specific training.

Source: Espelia-Codatu (2022).

4.3. Economics and financial aspects

In the field of electromobility in general, incentives regarding the development of EVs are necessarily elaborated at the national level, especially financial incentives, which might be adapted or completed

at the federal or local level. In the context of paratransit services, the same scheme prevails, may it be directed to paratransit operators as well as other stakeholders.

4.3.1. Operators-oriented actions

These actions aim to support the owners and operators of e-paratransit vehicles. The incentives shall be tailored to the category of the vehicles targeted (2, 3 or 4-wheelers):

- Tax reduction for purchasing vehicles or energy, for importing parts or implementing technology (2, 3 or 4-wheelers).
- Adapting the administrative, financial and technical requirements of the licencing process and permit obtention for e-vehicles (similar to what exists for automatic vehicles).
- Guarantees for bank loans or low interest rate to purchase new vehicles (4-wheelers).
- Funding to provide financial assistance to procure vehicles, starting business (2, 3 or 4-wheelers).
- Public-private partnerships between e-paratransit providers and other organisations to improve services, such as vehicle sharing or digital ride hailing (2, 3 or 4-wheelers).
- Subsidies (at least temporarily) to keep the fare prices low and affordable for passengers.
- Provision of infrastructures aimed for the operations of e-paratransit services and managed by the paratransit operators. These infrastructures (such as e-hubs) can offer multi-use services and amenities to cater as well for the needs and use of the traditional paratransit operators and the local population.

Box 3. Planning and implementing an e-hub for freight paratransit operators in Quito.

In the context of the SOLUTIONSPlus project in Quito, a Zero Emission Zone intermodal corridor has been designed in the historic centre of Quito to plan low-carbon last mile movements for logistics transportation. Based on an extensive freight survey among 241 businesses identified in the historic centre of Quito, a Logistics Plan was elaborated on top, in cooperation with Zaragoza Logistic Center, and private and public parking buildings were identified. Through this initiative, a further step was to design and implement a distribution hub, a collaborative cross-docking platform for the allocation of goods, and the charging of the light electric freight vehicles. This is a case for multi-use services that can be offered in the context of e-hubs.

Source: SolutionsPlus.

4.3.2. Financial schemes to foster industrial innovations

In many countries, the manufacturing environment, i.e. the production of electric vehicles, is critical but not sufficient. However, the existence of a local industry is of foremost importance to limit the technology dependence, to contribute to the creation of employment opportunities and to ensure balanced business models by limiting imports. The sustainability of e-paratransit and electromobility in general will mostly depend on the structuration of a local industrial sector in this field.
The development of a local industry must be pushed at the national level through various levers, which might be different according to the nature of the products/service developed. Besides the standards that offer a regulatory framework, complementary actions can be implemented such as:

- Financial support to vehicles manufacturers, equipment providers and vehicle assemblers, and all the enterprises of the supply chain of e-paratransit vehicles.
- Capital support (eventually within public-private partnerships) aimed at start-ups and industry developers, to facilitate investment and kick-start the development of a local industry.
- Innovation or Research and Development (R&D) projects, to stimulate the emergence of new concepts, new products with international and/or academic partners.

Box 4. Fiscal rebates in India to foster the transition towards electromobility through FAME programme.

In the context of the FAME programme (see Box 6 below), massive investments (1,5 billion $) were made by the national government to encourage the purchase of electric vehicle and to develop a local manufacturing industry of electric vehicles in India. In the first phase of the programme (FAME I), the fiscal rebates targeted all types of vehicles (2, 3 and 4 wheelers) among a list of 62 vehicles, 40 % of them being less than 25 km/hour. The rebates were calculated based on the battery size of the vehicle – the vehicles having a larger battery being eligible for a higher subsidy – from 110 to 320 $ (INR 7 500 to 22 000). In FAME II, 2-wheelers had been excluded from the list of the beneficiary vehicles, the priority being made on public transportation.

Parallel to the fiscal rebates offered by the National Government, further incentives were introduced at the Federal State level to encourage both the purchase of electric vehicles and the development of a local manufacturing industry. In Uttar Pradesh, a 5-year dedicated policy was set in 2018 to encourage investments and economic activities in the field of electric mobility, which included for instance tax exemptions, interest-free loans and subsidies for the purchase of e-vehicles. in Uttarakhand, a similar policy set also in 2018 offers tax exemptions and land provision for electric vehicles manufacturers, 100 % electricity duty exemption and favourable conditions for loan obtention. In Maharashtra, buyers and EV manufacturers can benefit from tax exemptions, subsidies for vehicle purchase and cheaper electric tariffs than the commercial rates.

Source: Espelia-Codatu (2022).

4.3.3. Support to the local authorities

Local authorities are central stakeholder regarding the deployment of e-paratransit services since they are, in most cases, in charge of the regulation and coordination of paratransit services and have the mandate to promote electromobility.

To ensure the implementation of the national policies aforementioned, support might be needed at the local level, which may translate into:

- Financing grants, since the electrification of paratransit services requires transformations regarding the governance of urban mobility (new responsibilities at the local level, institutional evolutions and new organogram for the local authorities in charge of e-paratransit planning and regulation) and investments into infrastructure.
- Capacity building and training at various levels: practitioners and experts involved in the design, conception, planning and implementation of the e-paratransit services, officials in charge of the regulation of the sector, officers responsible for the enforcement of the

regulatory framework, officials and practitioners in charge of the consultation with the paratransit sector, …

- Transfer of expertise from national agencies and scientific institutions to local authorities, via innovations or research and development call for tenders or through capacity building programmes dedicated to the local authority staff.

4.4. Social policies

The transition towards a new technology might raise anxiety and questions among operators, users and the population in general. Among the concerns usually identified, operators often mention the constraints regarding the autonomy of the vehicles and the difficulties to travel long distances. Operators and users also might be afraid using electric vehicles, showing anxiety regarding the possibility that the vehicle could be set on fire, or from the risk of electrocution.

These concerns shall be considered seriously, as they might otherwise undermine the transition towards e-vehicles, either among the operators or among the users. To beat the odds, efforts shall be directed towards the dissemination of rightful information to prevent preconceived ideas and ensuring that services are safe and comfortable for all users as well as operators, and communication about it.

To do so, the following measures and tools might be considered:

- Sensitization campaigns on e-vehicles and the importance of transport decarbonization.
- Raising awareness on e-paratransit benefits for all users and promoting the comfort of such motorisation.
- Offering specific insurance rates including the risk coverage for the vehicles and for the drivers.
- Including as a requirement to operate e-vehicles a mandatory training for operators offered by the authorities.
- Tracking number in the vehicles to enable reporting of drivers or vehicles if users feel unsafe.
- Recognition and awards for paratransit operators delivering better service and performance.
- Free vouchers for people with disabilities or low-income families to incentivize the use of e-paratransit vehicles.
- Support job creation or competences evolution to facilitate the access to these new technologies for all paratransit actors (See Box 5).

Box 5. Facilitating the access to e-paratransit to new operators: women drivers in Rwanda and Nepal.

Introducing electric mobility is a lever to make the paratransit sector more inclusive. Traditionally deprived of women, the change of technology can be a lever to attract new types of operators and ensure a better representation of women within the transport sector and better consideration and care of women passengers as well (worldwide women experiences of harassment are common in transportation). In Kigali, the implementation of the pilot project led by SolutionsPlus enabled to train 35 women to operate electric motorbikes. The training conditions were adapted to women needs and constraints, considering for instance the schedules related to children's care, the possible experience of harassment, the fear to pass exams publicly etc. Training was provided by female drivers and among

other female participants and allowed them to operate both for passengers or goods deliveries. Such initiatives and training are essential to understand the existing barriers to enter the sector and to overcome those, with the ultimate goal to spread this type of initiatives to other related occupations such as mechanics, assembly and swaps attendants, etc. A similar project was implemented already in the early 2010 in Kathmandu, were the Safa tempos (electric 3-wheelers) became operated by a growing number of female drivers. The Danish cooperation allowed the training of about 200 women drivers, some of whom also became owners of the vehicles.

Source: SolutionsPlus and Espelia-Codatu (2022).

Support from the national and local authorities could also manifest through the capacity to protect operators, especially small-scale operators, whose interests might not be equally considered or respected in confront to major stakeholders such as energy providers, ride-hailing companies, EVs renting and leasing companies. Authorities should therefore ensure that a basic level of information – and accessible information – is disseminated among operators, and that they are aware of their rights.

Box 6. The FAME programme in India: the case of an ambitious transition towards electromobility led at the national level

Due its scale, its ambition and its unprecedented objectives, the FAME programme (Faster Adoption and Manufacturing of (Hybrid) and Electric Vehicles) conducted in India deserves specific attention. This programme, led by the Ministry of Heavy Industry and Public Enterprises, enacts a proactive and voluntarily transition towards e-vehicles supported by massive investments and support from the national State, the federal States and the cities. Initially, the programme was set to run from 2015 to 2019, with the priority set on the transition of 2, 3 and 4-wheelers towards electrification, as well as bus electrification. To reach this goal, the government offered massive fiscal rebates and measures to support the development of a local manufacturing industry. The success of the programme explained its extension from 2019 to 2023 (FAME II), with a focus on public transportation and the provision of electric equipment such as charging stations (10 % of the total funding scheme). The objectives allocated to the programme are clear: by 2030 India should reach 50 % of its fleet to be electric, and all electric vehicles manufactured in the country.

Source: Espelia-Codatu (2022).

4.5. Conclusion and recommendations

The magnitude of the changes required to introduce e-mobility and the necessity to align it with trans-sectoral policies to reach the objectives set by the NDC's and climate change agenda call for the elaboration of a consistent strategy at the national level. At this level, the national policies should create the rightful environment to foster the development of e-mobility, facilitate the setting of a national e-mobility industry and elaborate an ambitious strategy considering the interests and obligations of the various stakeholders involved in the e-paratransit sector.

In this regard, four main types of policies are identified, namely technical policies, regulatory policies, economic and financial policies and social policies. The last set of policies directly result from the responsibility of the national and local authorities and represent the cornerstone of any just transition. Based on international experiences and observations, specific attention should be drawn towards the following aspects: first, the elaboration of a new regulatory framework and strategy regarding e-mobility should be articulated in line with the existing documentation and orientations among the different sectors, and consistency between the national and local level should be carefully considered. Second, the coordination of stakeholders at a trans-sectoral level is crucial in order to set realistic and ambitious goals, and to achieve them. This also entails coordination between the different Ministries involved in the e-mobility transition. Eventually, in the context of Global South cities, sustainable strategies and policies rely on the emergence of a e-mobility manufacturing industry, to prevent full dependence from foreign markets and technology transfer. Only at the national level these aspects can be tackled.

Based on these conclusions and observations, the following recommendations are suggested:

- To ensure the national homogeneousness of all previous actions dedicated to the transition of paratransit towards electrification and consistency between policies, it will be necessary to set up entities in charge of the coordination and the deployment of such measures over the country, who could also be responsible for the development of capacity building programmes. Such entities could be identified or created within the National Urban Mobility Plan, or a similar national mobility plan.
- The coordination of actions and measures at the national and local level may be entrusted to a national "agency for e-paratransit", which could as well counsel and advise operators on technical, financial or regulation aspects and monitor the transition, through the collection and exploitation of data and/or surveys addressed to the stakeholders. The agency could monitor the implementation of e-paratransit projects and ensure the objectives of a just transition are respected and provide the necessary feedback to engage in an iterative process in case of a project scale up.
- Capacity building programmes shall be dealt with by education institutions. A global program could be designed at the national level to address all levels of education and all types of stakeholders, from the drivers or maintenance officer to fleet managers or executives within large-scale operating companies. Training and courses could be promoted and implemented either by institutions in charge of continuous and professional training like Chamber of Commerce in many countries or 3FPT in Senegal (Fonds de Financement de la Formation Professionnelle et Technique), or eventually by schools and universities for higher educational levels. The elaboration of a wide training programme embracing the various fields and competences involved in the e-mobility sector could foster the development of a local e-mobility industry.

5. E-paratransit and local policies

Local policies on electromobility shall be elaborated according to the national policies such as National Urban Mobility Plan (NUMP) and similar strategies regarding the electromobility and energy transition. Although the capacities of the national authority exceed the mandate of local authorities in areas such as incentives, permits, imports…they might reinforce them considering the local transport context and set up concrete and practical actions to facilitate the deployment of electromobility and more specifically of e-paratransit.
National stakeholders (electricity distribution and/or production companies, vehicles' manufacturers, …) might also impose constraints at the local level for the transition of the paratransit sector.
Paratransit electrification must be part of the e-mobility strategies at the urban level which should be included in the SUMP or in any other local e-mobility master plan both for passenger transportation and urban logistics. This issue shall also be considered jointly with the policies dealing more generally with the integration of paratransit services in the urban mobility system and with the strategies, goals and concerns of the local paratransit stakeholders.

To ensure the success of the deployment of e-paratransit services, local authorities should envision how to include paratransit operators and stakeholders all along the electrification process, and set-up a trustful and ongoing dialogue with the representatives of the sector.

In this perspective, the main policies to implement at the local level regard:

- The **definition of the governance framework**, to organise the local ecosystem, to consider the role of transport authorities and stakeholders in the design and operations of e-paratransit.
- The **motivation of stakeholders**, to encourage their participation in the electrification of paratransit and more generally in the public transport decarbonisation.
- The **deployment of e-paratransit** services and operations, to enable the implementation of e-paratransit services and facilitate the operations.
- The **training and capacity building of stakeholders** on e-paratransit, including decision-makers, experts and planners, practitioners, officials and officers, as well as operators.

5.1. Governance of paratransit activities

As part of the urban mobility system, the e-paratransit sector is influenced by the governance framework, the measures and actions implemented by other actors and regarding other types of services. Depending on the position of the e-paratransit sector within the urban mobility system, different set-ups exist:

- If paratransit activities and organisations are not integrated into the urban mobility system, actions to promote electrification of the vehicles will be similar as the ones elaborated for other use, such as private individual use or for commercial fleet (for instance for logistics). In this case, the involvement and regulation of operators will be minimal.
- If paratransit is integrated into the urban mobility system, specific actions could be taken to facilitate the electrification of vehicles in line with the electrification strategy of other modes.

For instance, charging stations could be shared by the different modes, connections to the grid could be considered jointly, infrastructures could be shared, … In this set-up, operators are likely to be more involved in the transition process and the design of the services.

As the involvement of paratransit operators is a critical aspect to ensure the success of e-paratransit, several types of actions are presented to facilitate the interactions and dialogue between the local authorities and the operators. These actions consider:

- The global evaluation of electromobility feasibility.
- The organisation of the relations between local authorities and stakeholders.
- The possible collective actions.
- The monitoring of the process.

5.1.1. Global evaluation of electromobility feasibility of the paratransit sector

The objective of this first action is to identify the main challenges regarding the feasibility of electrification of paratransit and to estimate the opportunity to go in more detailed analysis.
Prior to any action or strategy regarding electrification, it is essential for the local authorities to have a correct and updated understanding of the paratransit operations and the operators' governance.
This knowledge may be obtained either through a detailed diagnosis of the paratransit (see Box), or through a survey especially oriented towards electrification addressing mainly operational, technical, economic or traffic organisation aspects which are the main criteria to get a first broad overview of these challenges and evaluate the possible quantifiable difficulties. The criteria refer more specifically to:

- Operational criteria are related to the utilisation of the vehicles, essentially the daily distances, the organisation in depot, the sizes of the fleet, ….. These criteria inform on the capacity to satisfy the travel demands with electric power train (for instance, estimation of the number of recharging needed during a day, compared to the average performance of available e-vehicles).
- Technical criteria rely on the actual vehicles (their types, the number of passengers or weight of deliveries) compared with (possible) same criteria with the available e-vehicle in the country and depending on the quality of the energy mix, its supply and its possible evolutions (towards renewable energies for instance). It is also important to assess the consequences on infrastructure (charging points and required power).
- Economic criteria would globally evaluate the possibility for operators to purchase electric vehicles.
- Traffic organisation criteria aim at evaluating the distribution of trips according to the size of operators, the spatial distribution of the paratransit flows, etc. For instance, a relevant indicator would be the pareto analysis of the percentage of operators versus the percentage of travels or distances.

This survey may be facilitated in cities where electric vehicles are already used for paratransit or have been experimented for this purpose.

Based on this first evaluation, it would then be possible to decide whether it would be relevant to engage an electrification process of the paratransit sector prior to any approach or engagement with

paratransit stakeholders. Another decision resulting from this survey would be to consider alternatives to electrification, such as the transition to gas or bio diesel, as it has been done in some cities. For instance, in Casablanca a first step was made towards the renewal of the "white taxis" fleet by supporting the transition to new power trains to reduce the fuel consumption by 60 %. in May 2023, 75 % of the “grand taxis” vehicles (33 250 vehicles) have been modernised (according to "Comptes spéciaux du Trésor" included in the "projet de loi de Finances 2024 du Maroc"). The next step will be to move towards electromobility within the next few years.

Box 7. Methodology to conduct a diagnosis of the paratransit sector, based on MobiliseYourCity Paratransit Toolkit.

Conducting a diagnosis of the paratransit sector is a delicate exercise, at various levels: the relationship between local authorities and the paratransit sector is, in many cities, complex if not conflictual. Besides, as mentioned above, there is a lack of data regarding the paratransit sector, and it is not uncommon that operators themselves only have a partial understanding or knowledge of the sector. Also, different sources shall be mobilised and cross-checked, and the data collected shall be shared with the various stakeholders to get their feedback.

The objectives of the diagnosis are multi-fold:

- The collection of information regarding the fleet, the operations and the stakeholders are essential to gather data on the paratransit sector, which is often very scarce and/or not updated. Information on the operations and the business models of operators are crucial to design sustainable services. This data is even more important to be able to assess, monitor and review the implementation of the project;
- The stakeholder mapping is a strategic tool to identify all the stakeholders involved in the sector and ensure the just transition by considering all the possible impacts for each of them. Besides, the mapping allows to identify the possible representatives to involve within the implementation of the electrification project;
- Ultimately, developing a SWOT matrix for each stakeholders facilitate the identification of common objectives and to ensure the participation of the majority of stakeholders into the transition process. These tools are also useful to create a dialogue with the industry and to build a common understanding of the expected outcomes of the transition.

Eventually, the diagnosis shall make sure that all operators are included and considered in the process and pay specific attention to incumbent operators.

5.1.2. Organisation of the relations between local authorities and stakeholders

Based on the result of the previous action, a strategy for paratransit electrification can then be elaborated in line with the local electromobility context (mobility plan, Sustainable Urban Mobility Plan). From the strategy elaborated, an action plan can then be set.

As mentioned previously, stakeholders must be associated to this process. However, this principle may be difficult to implement in specific context. In some cities, most operators are organised and consolidated through associations, syndicates or private companies. In other cases, the paratransit ecosystem remains fragmented and transport services are provided by individuals or small enterprises

(2 or3 vehicles). The role of transport authorities and the appropriate measures to undertake are then quite different according to the situation:

- In the case of a high-level of fragmentation with no objective of consolidation of the sector, the electrification process will mostly rely on individual commitment and actions. The role of authorities will mainly concern the allocation of financial incentives and technical support for the operators. Authorities will also determine a global management scheme for charging and/or battery-swapping stations addressing all potential electromobility customers including paratransit actors.
- In the case of an already structured sector, transport authorities may elaborate together with the (main) representatives the transition process towards electrification and determine collective actions which will benefit from the synergy between all operators. This can be formalised in a specific e-paratransit master plan which will be the framework for the transition.
- Between these two situations the strategy might be to improve the structuration by encouraging the constitution of associations, cooperatives, operating companies, … This strategy may be triggered or encouraged by the objective of electrification but must be initiated long before its deployment since it requires very deep modification of the paratransit sector and changes in the relations between them.

5.1.3. Collective actions and co-design of the operations and services

The objective is firstly to identify the synergies that might exist regarding electromobility in order to optimise the deployment of e-paratransit, and secondly to elaborate a master action plan for this deployment with the representatives of the stakeholders of this sector.

Several domains can be examined, such as:

- Procurement: local authorities can organise grouped purchase of vehicles, batteries or components in order to get commercial discounts. Apart from a reduced cost, such policies are also beneficial as they enable to elaborate common technical specifications or terms of reference.
- Financing: as access to financial institutions is one of the key obstacles for paratransit operators to purchase the vehicles, implement the required infrastructure, and in general to improve their operations thanks to electromobility. The role of local authorities could be to advocate and facilitate the access to specific loans and payment facilities.
- Best practices: local authorities are in the rightful position to identify relevant expertise and tools which can be shared between operators. These best practices can eventually turn into the elaboration of guidelines for activities such as planning charging procedures, optimising runs' routes, etc. or the basis for training sessions on different domains such as maintenance of vehicles, fleet management (for instance charging, fleet renewal, drivers training, etc.) or technical specifications for the construction or management of infrastructures.
- Developing common resources: from the discussions between operators, specific equipment or tools could be specified and developed to be used and/or shared by all stakeholders such as:

- Buildings or specific spaces (public or private) can be shared by several stakeholders, for instance proximity storage for goods delivery (see 5.3.4. for instance)
- Operational or software tools, fleet management tools, ride hailing apps, traffic planning, GPS, …

- Education and training: the coordination and implementation of training and capacity building on e-paratransit might be a strategic approach for the local authorities to ensure all stakeholders share a common understanding and vision of the topic, to bring together all the stakeholders involved, and to assert its authority as the regulator and coordinator of the urban mobility system.
- Data collection and accuracy: electrification of paratransit requires a very detailed knowledge of the characteristics of the vehicles and activities. Local authorities can enhance and oversee regular collection of:
  - Technical date, to ensure the correct match between vehicles' performances and their use, considering powertrain, battery autonomy etc., to design and localise the charging stations, adapt charging procedures, …
  - Usage-related data, to have in-depth information on the operations (km/day, number and duration of trips, number of delivery runs and their length), and the maintenance of the vehicles.

5.1.4. Monitoring and review of the action master plan

As any planning process, the action master plan established for the e-paratransit services development shall have a periodic follow up both to analyse its outcomes and to adapt to the evolution of the context, usages or technologies.

Paratransit stakeholders should participate to this monitoring both to identify the relevant indicators and measurement methods to be used, and to analyse and provide feedback of the progress and the corrective actions which must be undertaken.

Indicators should be quite simple and related data should be collected automatically (which is possible with electric vehicles), such as distances, working time, speed… The indicators can be transmitted to the entity in charge of the central data base directly or periodically, and to the operators and monitoring services if any.

This data collection and regular surveys will allow global analysis of the deployment of e-paratransit and will constitute the basis to assess the corrective actions that could be undertaken to improve the deployment and further steps.

To elaborate the master plan and to follow up its progress, it is recommended to set-up:

- A Steering Committee, gathering the main stakeholders (operators) to approve the paratransit electrification strategy and validate the main phases of the deployment in line with the planning framework.
  This Committee could also consider any adaptation linked to the evolution of the technologies and other connected factors (technical, social, financial..).
- A Technical Committee, to co-design the actions, to follow the progress of the vehicles and charging infrastructure (e.g. charging and battery-swapping stations, hubs, …),

implementation, as well as the technical evolutions of the e-mobility to inform the Steering Committee of any evolution that should be considered in the related strategy.

5.2. Motivation for electrification of paratransit stakeholders

Electrification of vehicles represents a drastic change for paratransit operators and several barriers need to be overcome to convince them to make the transition to new vehicles, such as financial barriers (higher purchase costs) technical barriers (new power train, battery management) and operational barriers (driving, fleet management, routes, …). However, the success of the transition and in some cases, even the development of electromobility at the scale of the city, might rely on their enrolment and active contribution.

Obviously, the actions to mobilise the paratransit stakeholders (not only the operators) regarding a transition towards electromobility depend on the local context and on the degree of fragmentation of the local paratransit operators.

The first step to set up the motivation strategy is to identify all stakeholders involved in the transition and to characterize the interest and challenges regarding electro mobility for each stakeholder and define target groups of stakeholders based, for instance, on a power/interest matrix.

The second step will aim to determine the actions to be undertaken to mobilise and motivate the different members of the target groups. This will lead to a communication plan to support the deployment of e-paratransit. A corollary step will be to determine capacity building actions for members of some of the target groups so that they can really be proactive regarding the transition towards e-paratransit.

In parallel, continuous actions aiming to raise awareness among stakeholders will be especially useful to identify and convince incumbent operators. Raising awareness thus aims at sharing knowledge regarding the electrification of vehicles and in the paratransit sector in particular, and convincing operators who might still be reluctant.

Dissemination of information might be undertaken during workshops, shows, exhibition or demonstrations coordinated by the local authorities. Reports and informative publications enable to share further details on the technology, the progress of the transition or possible sources of funding for instance.

5.2.1. Characterisation of stakeholders' target groups

The first step is to get a clear vision of all the stakeholders which might be involved in the paratransit sector transition and to make sure that they get a basic and common understanding on electromobility and the possible consequences of a transition towards electric power trains. All stakeholders do not have the same interest in the transition or the same influence to make the changes happen. Therefore, determining the appropriate communication content and actions as well as the level of involvement that could be expected from them is important. To do so, it is necessary to characterise their position, activities, estimated requirements, interests and challenges. This analysis can be realised through a interest/power matrix, as shown below.

The first target group includes the most interested and most influential stakeholders regarding the development of e-paratransit. As expected, this group gathers the existing paratransit operators and the representative and related institutions, including owners and drivers as well as sharing companies, associations, syndicates, repairing and maintenance companies,….

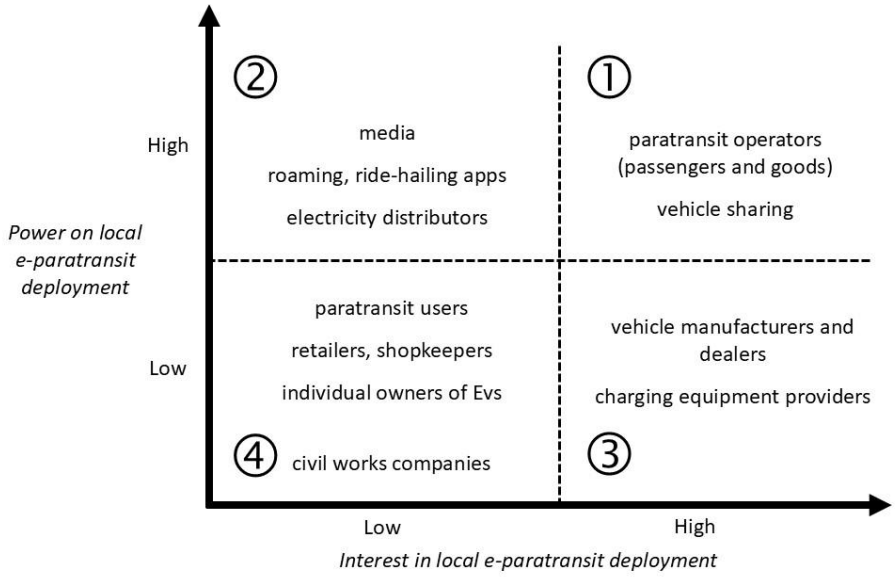
The second target group relates to the stakeholders showing a strong influence on the deployment of e-paratransit, but a low interest as paratransit is not their main activity. Are part of this group the media involved in the communication and dissemination of information related to the electrification transition, the apps provider (when not also operators), the electricity distribution companies, etc.

The third target include the stakeholders contributing to the deployment of e-vehicles, such as:

- Vehicle dealers, who can promote and explain the advantages of the vehicles;
- Manufacturers or assembly companies of e-vehicles
- Companies producing or/and installing charging equipment (stations), or electricity integrator (for depot for instance).

The fourth target group gathers the numerous users of these vehicles, who could be:

- Retailers or passengers who could request that their travels or services are provided by electric vehicles.
- Users, and in this case, the best way to convince them is to showcase the various advantages of the vehicles by enabling them to use the e-vehicles through vouchers distribution, pilot demonstration, …
- Private drivers : they require specific awareness campaigns, especially if the deployment of e-vehicles comes with the implementation of access zones or low emissions zones to push the urban population towards capacitary modes.



Example of power/interest matrix

5.2.2. Communication actions

Local authorities should play an active role in the promotion of e-paratransit among the various stakeholders. This promotion could also be part of a global promotion of electromobility and contribute to demonstrate the advantages of EVs for passengers and other drivers.

To ensure the relevance of the messages based on the targets identified in the communication strategy, local authorities should determine a common basis for communication and promotion and then adapt actions according to each target group.

For the first target group, a strong communication strategy must be elaborated to convince them to move towards electromobility. This strategy depends on the local context and should point out the advantages (and the limits) of turning to electric vehicles in different domains such as economy (total cost of ownership, incentives, …), technical (driving, charging, maintenance), environmental (access to low emission zones), security, gender issues ….

Communication actions are quite diverse and may concern:

- General information, through leaflets, publications in media, social networks, newspapers…
- Targeted information to specific actors like 2-3 wheelers and minibuses operators, maintenance/repair officers, through dedicated media or workshops, conferences,….
- Tangible vision through the organization of events to showcase the performances and capacities of e-vehicles.
- Testing schemes, by lending vehicles for a short period so that drivers get familiar with them.
- …..

These actions can also be completed with training activities (see 5.2.3.).
The second and third target groups include stakeholders who require a long-term vision on the deployment of e-paratransit. Communication actions should aim at providing them with future-oriented information on objectives and actions planned to meet these objectives.

Regarding the fourth target group, the objective is rather to raise awareness on EVs as the majority of actors either do not know much about electromobility or are reluctant to use e-paratransit services. Thus, the main objective shall be to increase their confidence in such vehicles and drivers in terms of reliability (autonomy range), security, performances, …

The main actions to reach this objective are :

- General information through large audience media.
- Shows and demonstration events to give a real experience on the vehicles.

5.2.3. Capacity building actions

In many cities it is common that neither operators, officials as well as urban planning and mobility experts do not have specific knowledge and competence on electromobility, and therefore cannot master the associated technologies or practices.

Also, complimentary to the initiatives implemented at the national level, capacity building activities might be designed and provided at the local level.

These trainings can be either organised with local educational institutions for students or working professionals, or with the human resources department of large companies (such as buses companies) involved with the deployment of electromobility.

These trainings may concern:

- General information on the advantages and constraints related to electric vehicles.
- Technical knowledge on the components of the power trains, charging equipment.
- Economics, to learn how to optimize the utilization of EVs, and how to evaluate its own total cost of ownership.
- Operational management, for traffic planners to optimize the organisation of the delivery runs, of the passenger routes or of the charging of vehicles.
- Strategy addressing decision-makers on long-term decisions like fleet renewal, depot adaptation to electric vehicles, fundings and financial aspects, …

5.3. Deployment and operating support

Once strategies have been elaborated and priorities given, practical decisions should then be taken concerning the deployment and the operations of e-paratransit services.
Several sets of actions may be undertaken to help the stakeholders realise an efficient energy transition concerning:

- Funding and financing
- Traffic regulation
- Charging
- Urban planning
- Energy supply

5.3.1. Funding and Financing

Stakeholders are often not aware of the financial supports and sources existing at the national and international level. The role of local authorities is to disseminate among the stakeholders the possible funding sources, to help them to apply for it and to identify the required partners or consortia.

The economic aspect is a key factor for operators to move from ICE towards electric vehicles. Although main incentives are rather provided at national level, several actions, permanent or temporary, may be launched at the local level such as:

- Costs reduction on tolls, electricity, local taxes, licences, …
- Management of e-hubs or other shared spaces
- When possible, short-term incentives or loan guarantees
- Implementation of charging stations nearby mass-transport
- …

Besides direct funding opportunities at the local level, specific economic facilities may be proposed to the start-ups willing to innovate in the field of electromobility and paratransit, especially those aiming to design, manufacture or assemble vehicles. Among the facilities, offering manufacturing equipment or design software, experts' advice, financial support are relevant options. Support can also be

provided by the local authorities in hosting or facilitating the creation of fablabs and co-working spaces, by lending equipment, directing grants, giving access to space at a minimum rent, …

Box 8. Supporting the development of the e-mobility manufacturing industry in India

In the context of the FAME programme implemented in India (see Box 6 above), one main objective has been to encourage the manufacturing of electric vehicles nationally to reach the goal of 100 % of electric vehicles being manufactured on the national ground by 2030. Whereas massive fiscal rebates were offered by the National government, incentives directed towards manufacturers and industrial stakeholders have been mostly led at the State level and the city level, as exemplified in the Box XXXX. Besides these examples, dedicated programmes and projects have also been designed and implemented at the local level: the CITIIS programme for instance aimed at providing technical and financial support to 15 Smart Cities, with a focus on sustainable mobility, among other topics. In Jabalpur, a pilot project was set to transition 5 000 fossil-fuel rickshaws towards e-rickshaws, correlated with the construction of 9 solar-powered charging stations. Besides these local initiatives, it is noteworthy to emphasise that in India, the innovation and industrial sector benefit from strong connections between universities, research and technical institutes, as well as manufacturers. However, observers also commented on the limitations of the projects undertaken at the city level, mostly due to their lack of consistency with the national policies.

Source: Espelia-Codatu (2022).

5.3.2. Regulation

The deployment of e-paratransit must rely on regulatory measures to facilitate its integration in the urban mobility system. There are three main types of regulation, which could be implemented at a different pace and independently:

- Standards for the vehicles regarding:
    - the frame and performances of the vehicle (dimensions, speed, maximum load, …).
    - the batteries (especially for swapping), from their assembly (or importation) to the end of life of batterie.
    - charging protocols, especially interoperability between providers and equipment since it is important to install powerful charging stations to minimize the charging time.
- Standards for the charging equipment to guarantee the interoperability on all aspects (technical/plugs, payment, accessibility…) and the accessibility.
- Access to the urban space: ICE vehicles could be prevented to access specific areas of the city or have more specific restrictions regarding their traffic to prioritize the use of e-vehicles with dedicated lanes for e-vehicles, low-emission zones, restricted delivery hours, etc… These measures shall be conceived and implemented in accordance with the Sustainable urban Mobility Plan, and in relation with traffic management.
- The ban of ICE vehicles, which can start with the prohibition to import and sale ICE vehicles, and by taxing the spare parts.

In some cities where the local authorities show a limited capacity, the emergence of new actors such as ride-hailing companies and EVs providers (mostly for 2 and 3-wheelers) might be a lever to introduce a basic level of regulation through a partnership. The access to EVs and the platform might be correlated to the obtention and verification of the driving licence, as well as other regulatory documents.

Box 9. The role of ride-hailing companies providing electromobility services in the regulation of the paratransit sector.

Among the major cities in India, e-rickshaws are particularly widespread in Delhi, where they were introduced in 2010 during the Commonwealth Games. Nowadays more than 100 000 vehicles are registered; and the number of vehicles rose rapidly over the past few years with an increase of 935 % in the number of registered e-rickshaws between 2016 and 2018. Among the operators, 81 % own their vehicle (81 %), with few operating on rent (29 %). A large part of the offer is provided through RHA, with Ola and Uber, as well as a local RHA named Smart-E. It was developed in 2015 by Treasure Base Venture, with the specific goal to deploy e-rickshaws in Delhi area. Beyond the app, Smart-E provides paid infrastructures facilities (charging and parking) and training for drivers in partnership with other organisations and vehicles equipped with GPS and CCTV to address the issue of commuter safety. E-rickshaws help more than 6,3 million passengers to commute each day (Shandilya et al., 2019), providing mainly first and last mile connectivity, as among these trips, 88% are short trips.

Source: Espelia-Codatu (2022).

5.3.3. Charging facilities

Access to charging facilities is a priority for operators to plan their service, and an important signal to mitigate their anxiety and facilitate the transition towards electromobility. Even though battery performances and autonomy range are improving quickly, it is necessary to provide adequate charging infrastructure, information about availability of charging equipment as well as interoperability between charging providers and between vehicles and charging monitoring.

There are 4 main options regarding the charging facilities, that should be considered according to the vehicles' specifications, the characteristics of the paratransit services and practices of operators and users, and in line with the urban planning strategy:

- **Charging in depot**

For paratransit fleet, charging at depot when the vehicles are not used is the easiest solution since all electric facilities can be gathered and connected to the grid. This option also enables to mutualise some depots by hosting fleets belonging to several operators. The management of the depot could be realised by local authorities (or a private mandated company) and cover several functions according to the context, from renting parking spaces to park vehicles (with charging facilities) to more sophisticated functions such as booking charging times, plugging vehicles, repairing,).

- **On street Charging**

The implementation of "on street" charging equipment for paratransit vehicles must be analysed and its opportunity evaluated, especially if these are deployed in the framework of an urban e-mobility

plan. On street charging of paratransit vehicles must be as quick as possible since it takes place during working hours:

- For 4-wheeler vehicles, this requires high-powered equipment (minimum 150 kw/h) and of course powerful batteries (minimum 70 kw) in the vehicle. Either such equipment is available in public charging stations, and paratransit drivers can book in advance the charging, and if not, dedicated stations must be implemented, the best location being close by electrified mass transport lines to take advantage of the availability of high power.
- For 2 and 3 wheelers, fast charging does not require high-powered equipment. However, if such charging facilities are not made available in "public" charging stations, more powerful equipment should be added to existing stations or dedicated ones shall be implemented.

- **Battery swapping**

When on street charging is not possible or difficult to set up for 2 and 3 wheelers paratransit, battery swapping is an efficient alternative. It can be organised in dedicated places (for instance e-hubs) with a renting or subscribing scheme. The infrastructure shall be organised in such a way that drivers can change battery in a few minutes, without losing time during their working day.

The main constraints are the interoperability between swapped batteries and the management of the stored ones. To avoid these obstacles:

- Homogeneity between batteries of different 2 and 3wheelers should be agreed between operators during the preliminary phases.
- Management should be coordinated either by local authorities or a private consortium grouping the concerned operators.

- **E-hubs**

Usually e-hubs are created to promote and facilitate electromobility globally. Nonetheless, they can facilitate the deployment of e-paratransit regarding the management of battery swapping, and by offering tailored advising for the operators (especially incumbent operators) on the characteristics of 2 and 3 wheelers, and on aspects related to the maintenance and repair of vehicles.

Box 10. Charging stations at stake in the e-mobility strategy in Rwanda

In 2021, the Government of Rwanda enacted a national strategy to support the adoption of e-mobility solutions, including fiscal incentives and other measures. One goal identified in the strategy regards the facilitation of charging points implementation and operation, as it is a crucial lever to foster e-mobility adoption. A set of measures have thus been introduced, including reduced electricity tariffs at charging points, exemption from VAT and rent-free land for charging stations located on government land. These measures led to the integration of e-mobility as one of the components of the Kigali master plan which since identifies prioritized parking spaces for electric vehicles and EV charging stations shall be integrated in the building code and the city planning rules.

Source: SolutionsPlus.

5.3.4. Urban Planning

The main challenge regarding urban planning relates to the facilitation of the circulation for e-paratransit services, for passengers or goods, the provision of charging stations and the allocation of dedicated parking spaces and possibly dedicated traffic space.

As previously mentioned, charging stations can be located on-street, in parking areas, in e-hubs, ... The location shall be carefully integrated or coordinated with the urban mobility plan and planning documentation. Parking and users' waiting spaces need to be clearly identified in the urban space, and located depending on the potential users' demands, the operators' needs and the technical constraints regarding electricity accessibility. When possible, e-paratransit parking spaces and waiting spaces should be easily identifiable by the users' and obtain primacy in the urban space. Ideally public authorities could preempt a land reserve in the perspective of long-term development strategy of the e-paratransit services.

Services offered in these spaces may be different according to the physical situation (e.g. BRT or metro exit, commercial centers), to the characteristics of the transport demands (business, shopping, ...) or electromobility users' needs (charging/swapping, repairing, ...)

Depending on the typology of the stops or spaces, different types of location can be considered:

- Basic: specific secured parking bays or waiting spaces for passengers; these could be used by people taking a collective mass transport or by or taxis' drivers waiting for customers coming out mass transport or other attractive places; these spaces should prioritize e-bikes for instance areas quite near of attractive places or entry of collective transport.
- Intermediate: the "simple ones" equipped with charging facilities, with storage of batteries for swapping, including secured parking or access. Such hubs may also comprise e-bike sharing stations/facilities for different operators.
- Complete e-hubs as mentioned above including also services such as vehicle's maintenance/ repairing, advice on driving, charging and ownership…. Eventually e-hubs might be equipped with charging stations for cars or vans.

Prior to the implementation of such spaces, the following items should be identified and/or collected:

- Definition of the guidelines to determine the most suitable locations to integrate 2 and 3 wheelers in the urban mobility system.
- Identify key locations for paratransit activities, their surfaces and their facilities.
- Engage land-owners from the private or public sector whose property would be suitable for the deployment of these locations and encourage their involvement.
- Chose the sites with highest probability of success, and define their implementation, financial plan, management, governance and pilot deployment according to the passengers' demands.

Regarding urban logistics, the deployment of e-cargo 2 and 3 wheelers also requires tailored actions to improve the spatial organization:

- Include dedicated delivery bays, equipped with charging facilities.
- Define guidelines to determine the most suitable spaces and streets for goods delivery with 2 or 3 wheelers.

- Identify proximity storage areas where logistic compagnies can deposit their parcels or goods before the transfer to their end destination (e-hubs for instance).
- Engage land-owners in the private or public sector who own land in sites that are suitable for the deployment of these locations and encourage their involvement.
- Choose the sites with highest probability of success, and define their implementation, financial plan and pilot deployment according to deliveries criteria, shop keepers experience and consumers habits.

Box 11. Making charging stations part of city planning in India.

To ensure the achievements of the goals set within the FAME programme, the Government of India decided in 2016 to make it mandatory to set up electric vehicles charging stations in residential and commercial buildings, and up to 20 % of available spaces in parking. A maximum fee was also established regarding the tariffs asked within a public charging station. In 2017, a complementary policy was enacted with the Draft National Energy Policy, which established the development of charging stations as a component of city planning.

Considering the limits identified during the FAME I programmes, i.e. barriers to the adoption of electric vehicles due to the limited access to charging stations, emphasis has been made within FAME II on the development of charging equipment in Indian cities. Thus, a target of 2 700 charging stations to be implemented in cities of 4 million inhabitants and above was set, and fast-charging stations are expected to be implemented along major highways at a maximum distance of 25 kilometers each, and ultra-fast charging stations every 100 kilometers.

Source: Espelia-Codatu (2022).

5.3.5. Ensure the local energy supply

Local authorities must guarantee that all stakeholders will have electricity in quantity and quality to pursue their activity. This must be dealt with electricity distributors which are among the stake holders to involve in electromobility projects, and with service providers such as roaming apps which indicate the availability of charging stations.

As many cities experience challenges with electricity availability and distribution, ensuring access to the local energy supply should be a priority of the electromobility masterplan for e-paratransit.

5.4. Conclusions and recommendations

At the local level, the challenges regarding the policies related to e-paratransit deal with the alignment with the national strategies and policies, and the capacity of the local authorities to set up a dialogue with the various stakeholders involved. Indeed, besides the technical aspects, a large part of the feasibility of any project involving paratransit operators rely on the capacity to engage with the sector and create a trustful relationship.

Also, at the local level, the policies identified in the paper regard four main aspects. A first set of measures deals with the identification and consolidation of the e-paratransit stakeholders' ecosystem. Second, once identified it is possible to target dedicated measures aimed at each of them to ensure their motivation and adherence in the paratransit sector transition process, while considering their

interests and limitations. Third, the implementation of e-paratransit projects and their integration within the urban mobility system implies the elaboration of a local regulation and strong coordination at the urban planning level. Fourth, training and capacity-building at this level shall ensure the transfer of technical skills among operators and related occupations, as well as technicians, officials and decision-makers involved on the side of the local authorities. This aspect is crucial to ensure the mutual understanding of the stakeholders and create a local know-how regarding electromobility. A corollary consideration eventually regards the transfer of skills and means from the national to the local level, which are critical to undertake policies enactment.

The challenges at the local level are multifold, and mostly deal with stakeholders' engagement and satisfaction. Indeed, the outcomes of any e-paratransit project will be tangible at this level, and return on investment will be quickly expected from all parties involved. Due to the social embeddedness of the paratransit sector and the historic antagonist relationships between local authorities and paratransit operators, a strong emphasis should be placed on building a qualitative dialogue between stakeholders. However, due to the uniqueness of each local set-up and the specific features of the paratransit sector and institutions in each city, bespoken and adapted policies, processes and objectives should be designed.

Based on these conclusions and observations, the following recommendations are suggested:

- Due to the complexity of the paratransit sector and the electromobility transition, the collection of data at the local is essential to ensure the feasibility of an e-paratransit project. As each ecosystem of stakeholders is different, even within the same country the relevance of e-paratransit projects might not be the same depending on each city. The data collection process could be undertaken in the context of a Sustainable Urban Mobility Plan, and ultimately contribute to feed a local Mobility Observatory.
- To oversee the data collection, engage with paratransit stakeholders and monitor a transition programme, a dedicated unit could be set up within the institution in charge of the urban transport planning and regulation. This unit could be in responsible of the consistency of local projects with the national policies, ensure the coordination with the local urban planning documentation and strategies and become the focal point for paratransit and external stakeholders (such as banking institutions for instance). In the context of the e-mobility master plan, members of the unit would be part of the Steering committee and the Technical committee and would as well be the main recipients of capacity building programmes within the public institutions.
- Eventually, setting-up a consultation platform with the paratransit stakeholders could be a lever to engage with the paratransit sector in the context of an e-mobility project while consolidating the relationship with the paratransit sector in general, in the perspective of other types of reforms. Even though the on-going dialogue with the paratransit operators is essential to ensure the rightfulness of the sector's transition, users should also be associated to the discussions at the various stage of the project, as they would be the main beneficiaries of the e-paratransit services.

6. Operational impacts of e-paratransit for stakeholders

A set of financial and technical barriers persists that are constraining the uptake of private initiatives, such as high upfront investments costs in vehicles and infrastructure (Amedokpo, 2024). Moreover, interrogations still exist on the capacity of EVs to provide similar uses compared to current fossil fuel vehicles in terms of road conditions, carried weight, range and speeds. These barriers should decrease in the next years due to the evolution of technologies such as batteries capacities (and costs), improvements of performances of vehicles and the growth of the production of electric vehicles, which could be manufactured locally at lower costs.

Impacts and barriers on stakeholders depend on many factors such as the types of vehicles, their use, the organisation of the paratransit structures, the local context and mobility culture, the relations with transport authorities, etc.

It is then quite difficult to elaborate specific recommendations for each category of actor; however, some generic key issues can be pointed out as they must be considered by any operator of paratransit. They relate to:

- Economics, and more specifically the adaptation of business models.
- Agility to introduce new technologies and/or to adapt organizations.
- Openness to the environment and more specifically to the local transport authorities.

6.1. Economics and Business models

One of the most important impacts for stakeholders is the business model change. Indeed, while the purchase costs (CAPEX) are high, the operational costs (OPEX) are much lower than those of internal combustion vehicles.

First of all, regardless of any financial aid, the total cost of ownership (TCO) of vehicles used for paratransit is constantly decreasing and depending on the type of vehicle. Experience led within the context of European funded projects such as ELLIPTIC and ASSURE showed that the TCO of electric vehicles is lower than the TCO of internal combustion vehicles after 3 years for paratransit vehicles, 2-3 and maximum 5 years for minibuses or vans.

Several reasons explain this decrease:

- The cost of batteries is steadily decreasing while their performance is increasing.
- Production (or assembly) can be relocated, which leads to lower production and transport costs.
- Fewer spare parts are needed, and fewer maintenance operations.
- Electrical energy is (or will be) possibly produced by renewable energy, often at a lower fare.

Secondly, the economic impacts of the paratransit electrification must be analysed with a broader view and considering all the components of this new transportation system. The following factors should then be examined:

- The charging equipment and operations: in some cases they will be installed in depots and financed by the depot's owner with or without subsidies, or in the framework of a public-

private partnership with local authorities or private partnership with energy supplier. In other cases, charging will be done on street, in public charging stations or swapping will be organised in private or public e-hubs. These are different solutions for charging vehicles which must be envisaged to analyse the financial impacts of the transition.

- The vehicle availability for operations, which depends of course on its reliability (normally quite good with electric power trains) but also on charging time, and autonomy range. These parameters are critical to dimension a fleet and charging equipment to match the demand, especially for 4-wheelers vehicles. All these "non productive times " have to be considered in the financial analysis.
- The economy of scale, which can be realised either in the fleet dimensioning (optimising the infrastructure and human resources costs) or in cooperation with other operators (pooling or sharing resources).

6.2. Agility for the energy transition of paratransit

Together with the economic aspects, the ability to introduce electromobility in the operators' fleet depend also on the competences of the operational or managerial actors and decision-makers in different domains such as:

- Fleet management, from the scheduling of vehicles renewal to the planning of their charging.
- Infrastructure improvement, from the upgrading of electricity supply to the physical organisation of charging equipment/parking spaces which must be positioned differently from parking/fuelling spaces of conventional vehicles.
- Operational management to adapt the runs or the lines/routes to the performances of the vehicles and/or the availability of charging equipment or to organise the swapping of the batteries.
- Maintenance and repairing which require good knowledge in electricity and mechatronic with new tools and methods.

To success in this transition, actions are required in several domains:

- Capacity building of all operating actors, from drivers to decision-makers in order to get the right knowledge to be efficient in their activity. As mentioned previously, it is recommended for the national and local authorities to set up adapted training courses and funding for these courses, but it is also necessary that operators are proactive to contribute to the definition on the contents and templates of these courses and by being willing to participate to these training sessions.
- Agility of the operator's organization to progressively adapt its processes and practices to the introduction of EVs in various domains such as human resources (with impact on the operators' working hours, security aspects, …), management of spare parts, relations with suppliers (energy of course, as well as for the vehicles and other components), etc. These changes must also consider the evolution of the technologies.
- Innovation in operations and vehicles, to be more adapted to the passengers' requirements (for instance regarding the design of the vehicles to be adapted to women's needs) or to

propose new services. The driving easiness of EVs is also an opportunity to open jobs to new categories of drivers, such as women as it has been done in Nepal or Rwanda (see Box 5).

6.3. Openness to the environment

As mentioned above, the introduction of electric vehicles must be envisaged according to a holistic approach of the transport system. In this perspective, operators shall take into consideration their environment, i. e. not only the passengers, but also other parameters which lead to synergies between the actors of the transport system. Ensuring the openness of the urban transport system relies on:

- Active participation from paratransit operators to elaborate the paratransit electrification master plan or to the collective actions organised by the local authorities.
- (Improved) Intermodality between public and private operators. Optimization of the existing modes can be implemented through better integration between mass-transit services and paratransit services (minibus, mototaxis, etc.) as feeder services or complementary modes, the introduction of e-bikes or e-mototaxis for the last mile and cargo cycles dedicated to the urban logistics.
- Coordinated promotion and sensitization regarding the new e-paratransit services and new vehicles in order to favour a positive image of EVs and build a common narrative among stakeholders.
- Association with other operators to pool or share some resources (garages, maintenance, equipment, software, …) or to manage some common activities and infrastructures such as e-hubs, depots or warehouses.
- Creating platforms of discussions between all stakeholders engaged in the paratransit electrification to foster innovation, synergies and feedback. Dedicated workshops and events might be organized, as well as call for projects and research or once-off initiatives such as hackatons.

Box 12. The critical role of private actors in the development of the e-mobility sector in Kenya and Rwanda.

Over the past years, the number of private actors involved with electromobility projects increased substantially in cities of Kenya and Rwanda. From e-safari vehicles to e-bikes and e-minibus, these projects relate the diversity and ambition of the companies investing in the sector; from multinational firms to local start-ups, from pilot projects to larger-scale initiatives. A common feature lies in the involvement of such companies in the shaping of upcoming regulations and policies in the e-mobility sector. The discussions might take place during events and workshops organized by the public authorities themselves, or by third parties such as NGO's or International Funding Institutions. These events are often opportunities for these private actors to express their constraints and frustrations regarding the development of electromobility, and by doing so they also have a role to play in the elaboration of the national e-mobility framework. In many countries, such dynamics within the private sector do not exist, and e-mobility projects are mainly led and conceived by public authorities.

Source: Galuszka J. et al (2021).

6.4. Other Stakeholders

Of course, other stakeholders can be impacted by the development of e-paratransit. The increase of EVs in a relatively short period may raise concerns among:

- Energy providers, who need to adapt the distribution to the demand increase and improve the network.
- Manufacturers of charging equipment (on street or in depots), since they will have to swiftly deploy all the facilities. However, this investment should be beneficial over the long-term, since the equipment should last many years.

Box 13. Emergence of new stakeholders in the e-paratransit sector, the case of Spiro in Togo.

Regarding the development of electric 2-3 wheelers, the Togolese market is largely occupied by the company Spiro (previously known as M-Auto Electric Mobility or M-Auto) which started its activity in 2019. Spiro belongs to the Equitane group, a conglomerate at the intersection of industrialization, innovation, and sustainability. Rooted in Africa with a global vision, Equitane serves as the parent company to a diverse portfolio of subsidiaries, including leaders in renewable energy, agribusiness, healthcare, and technology. The company currently accounts for 506 employees, half of which are women.

Present in Benin, Togo, Uganda and Rwanda with nearly 10 000 motorcycles, Spiro will soon extend its service to Uganda and Kenya, with an additional 15 700 motorcycles. Most operators are paratransit taxi drivers (90 %), with a few exceptions for private users or public institutions.

The company offers two models of electric motorcycles in Togo: the "chap chap" and the "commando". Commando is the manufacturer's first model, a 125 electric motorcycle powered by a 6,5 kW electric motor, which has a maximum speed of 80 km/h and is powered by a pair of removable batteries that can travel up to 75 km on a single charge. Capable of travelling up to 65 km/h, chap chap is a 125 cc electric scooter which allows up to 90 km of range. Chap Chaps are more specifically designed for women.

Both vehicles are built in India, and since the beginning of 2024, they are assembled in Togo in a manufacturing center where 85 local staff are employed. According to Spiro, the plan would be to manufacture more vehicles in Togo to create up to 2 000 jobs in the transport sector.

Regarding the operations and business model, Spiro offer the following services:

- operators receive a scrapping allowance when returning their ICE vehicles, some of the parts being then either recycled or sold by Spiro.
- battery swapping according to a quite affordable weekly fee. Several swapping stations are implemented around the city (85) and outside (20), and the first charging station has been opened in February 2024.
- electric motorcycles are leased based on a "work and pay" system according to various schemes: leasing from 1 to 3 years, weekly or monthly repayment, … in case the operator would not repay Spiro, the vehicle would be blocked thanks to the GPS located within. In case the operator would not be able to pay, the vehicle can be brought back.
- to get ownership of the vehicles, operators shall run about 20 000 km per month and do about 150 000 km in total.
- guarantee regarding the procurement of spare parts and the maintenance of the vehicle, included in the leasing contract.
- a training is offered for the operator when buying the vehicle.

Several limitations have been identified by the current operators of Spiro, the most important being the location of the maintenance center dedicated to Spiro motorbikes, in the outskirts of Lomé. The distance and restricted availability to bring the vehicle impose a substantial vehicle immobilization which impacts operators' business model. Also, the scattered location of charging stations has been initially identified as a limiting factor. To overcome these limitations, Spiro recently improved its offer by proposing unlimited battery swapping (whereas prior the number of battery swapping was set depending on the leasing contract) and vehicle replacement to make up for long downtime.

So far, Spiro developed its activity in Togo in connection with the Ministry of Promotion and Investments. to ensure the rightful integration of these services and the activity of Spiro operators in Lomé, discussions with the Ministère des Transports Routiers, Aériens et Ferroviaires and with the Ministère de l'Environnement et de la Ressource Forestière would be helpful.

Parallel to the development of Spiro activities, another operator called "Piki piki" recently started its business. Similar to Spiro, Piki piki rents and leases e-motorbikes and proposes services to transport passengers and goods. It is far less developed than Spiro, and most of the vehicles offered by Piki-piki are made by Spiro. The main difference relates to the services offered: as Piki piki operators do not have access to the Spiro maintenance center, they are offered a parts daily guarantee of 200 FCFA, which enables them to have they faulty parts replaced at no cost.

Sources: SolutionsPlus, Amedokpo (2024).

These stakeholders should normally be involved in the electromobility master plan at the national and local levels, and more specifically in the definition of the actions regarding the electrification of paratransit.

For the others, impacts are rather related to the development of electromobility in general, and not directly connected to the electrification of paratransit services specifically:

- e-paratransit market shares are likely to remain limited for vehicles manufacturers and assembling companies compared to the potential of electromobility, as most vehicles are not specifically designed for these activities (except for 3 wheelers).
- Services like ride-hailing apps or travel assistance are already developed with existing paratransit and should not have difficulties to integrate e-paratransit services in the case it would be deployed (example of Ola, in India).

6.5. Conclusions and recommendations

The development of e-paratransit services remains still rather exploratory, with very few initiatives and pilot projects implemented worldwide and limited available feedback and recommendations yet. Also, this section suggests considering the potential resisting barriers to the deployment of e-paratransit fleet and services, and their possible outcomes on the stakeholders.

Regarding the barriers identified, they either deal with technology aspects, such as the capacity to adapt to a fast-changing environment with regular improvements regarding the battery autonomy or their size for instance, which impact in return the business models of operators as well as vehicle and battery providers. The barriers also regard the behavioral implications on the operators' side, users'

side as well as investors' and manufacturers' side. These are difficult to predict still and are also largely correlated to the local practices, social patterns and cyclical events.

To mitigate these uncertainties, public policies could be instrumental to introduce safeguard measures. The first priority would be to introduce protective parameters in the operators' business models to consider the technology changes, or to enable operators to refine their business plans at different stages. Second, the capacity of the stakeholders (operators, managers, officials) to adapt to a changing environment will be key to ensure the responsiveness and attractiveness of the services. Third, the introduction of e-paratransit services locally could become a momentum to gather a broader range of stakeholders and consolidate interests from various actors that could then materialize into innovations and local growth. Local authorities thus have a role to play in maintaining the openness of the sector and making it as inclusive as possible.

In terms of recommendations, several suggestions are made that are not completely specific to the e-paratransit sector.

- To mitigate the economic uncertainties related to the introduction of new technologies, the consolidation of the paratransit sector appears to be even more desirable that it would minimize the risk by distributing it among a broader range of individuals, or directly towards the professional organization (association, syndicate, companies, …).
- The data collection process is another strategic component: collecting and analyzing data on the existing services and the new e-paratransit services will position stakeholders in a more agile position to react to the technological changes and market evolutions.
- Eventually, the existence of a platform of discussion gathering operators from the paratransit industry as well as related occupations and sectors could be useful to foster innovations but also to monitor the transformation of the industry in terms of labor, to identify possible measures to facilitate professional retraining.

Eventually, rather than introducing risks and uncertainties among precarious operators, the electrification of the paratransit sector should be considered an opportunity to increase its resilience. In this regard, the multiplication of uses and spaces enabled by electrification could be a relevant lever, may it be through the shared use of charging facilities with other transport operators as well as urban dwellers, or the possibility to train operators and to use vehicles either for passengers' or goods' deliveries. On the governance side, resilience could be facilitated through coordination units and trans-sectoral dialogue, which would eventually contribute to consider paratransit not just as a localized transport component, but rather as a transversal matter in urban societies, economies and environments.

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