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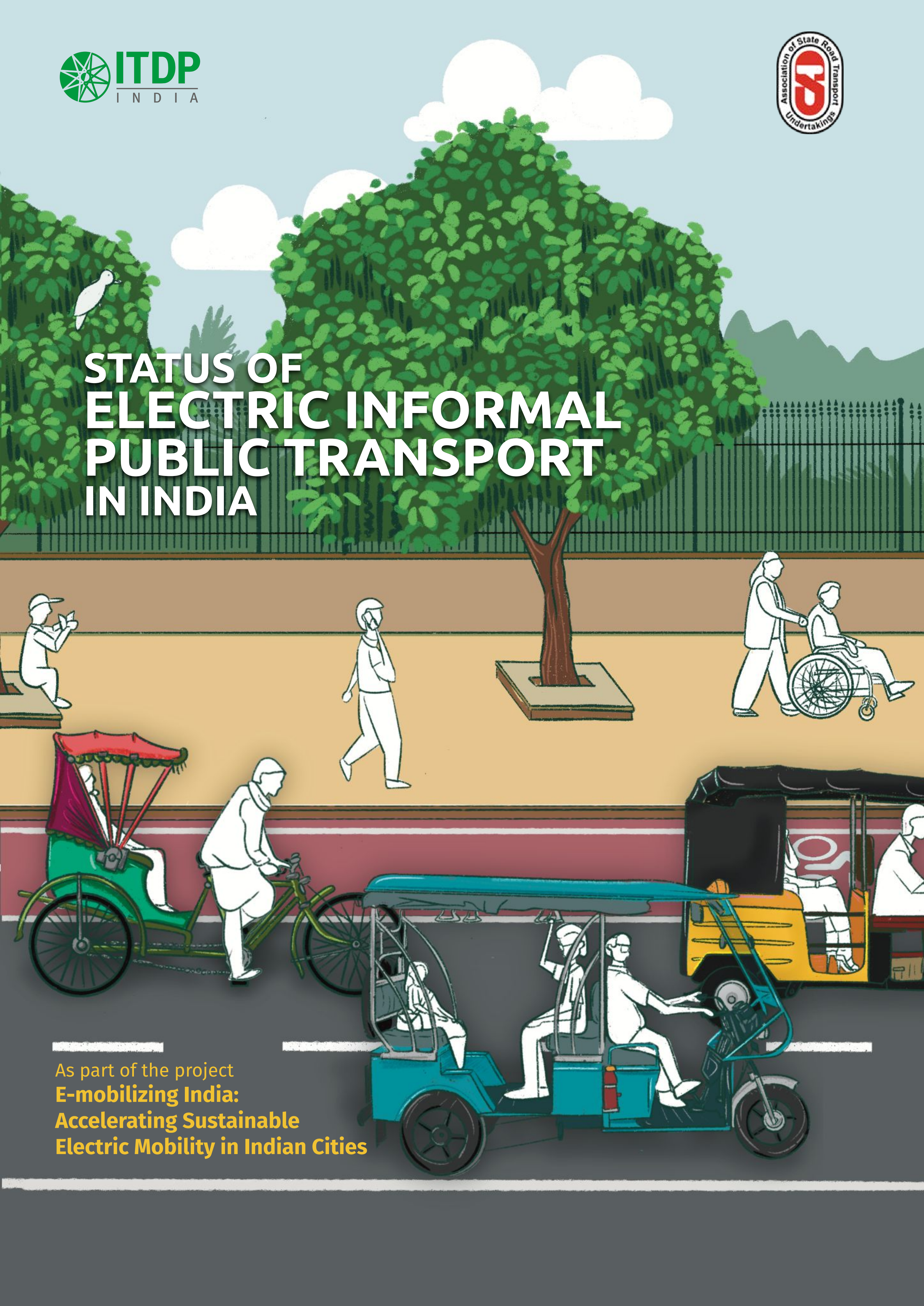

STATUS OF ELECTRIC INFORMAL PUBLIC TRANSPORT IN INDIA

As part of the project

E-mobilizing India: Accelerating Sustainable Electric Mobility in Indian Cities

June 2022

Prepared by

ITDP INDIA

ITDP India is a service provider for the Institute for Transportation & Development Policy—a non-for-profit organisation that works with cities worldwide to promote transport solutions that reduce traffic congestion, air pollution, and greenhouse emissions while improving urban liveability and economic opportunity.

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Preface

The transportation system in India has seen significant growth in the last decade. India plans to adopt electric vehicles to address rising fuel prices and poor urban air quality. Many Indian cities rely on informal public transportation systems (IPT), which serve as feeders to mass transit and fill gaps. IPT contributes about 4% to 6% of mode share across the states in India. India has around 15 lakh e-rickshaws, of which only 1.5 lakhs are found to be registered. The organized OEMs sell about 1,500-2,000 vehicles a month, while the unorganized sector sells nearly 10,000 e-rickshaws per month. The price of e-rickshaws ranges anywhere between Rs. 0.6 to 1.30 lakhs, while ICE-based rickshaws cost 1.5 to 3 lakhs. The cost to run an e-rickshaw is only Rs 0.4/km, while ICE-based rickshaws cost Rs 2.1–2.3/km. E-rickshaws are simple to operate and have low maintenance expenses. In addition, e-rickshaws have received support from Faster Adoption and Manufacturing of Electric Vehicles (FAME 2), the Smart City Mission, the Pradhan Mantri Mudra Yojana, and state EV programmes. Therefore, the Indian government aims to scale-up e-rickshaws to meet the Sustainable Development Goals (SDGs-11).

In several cities, IPT services are believed to be accessible and economical transit solutions for the urban poor. IPT provides last-mile connections, has flexible schedules, and occupies prime spots in the city. However, due to idiosyncratic and city-specific stakeholder uncertainty, IPT policymaking is challenging. There is a need to strengthen stakeholders, and decisions must be made by consensus at the centre, state, and local levels. In addition, the urban planners, regional transport officers, municipalities, the IPT unions and NGOs play a key role in scaling up e-rickshaws.

The report aims to provide the current status of IPT e-rickshaws and addresses the role of stakeholders in promoting sustainable IPT practices. The report also examines growing vehicle technology and IPT developments, as well as the rules and frameworks governing IPT e-rickshaws in several Indian cities. The case studies from various cities in India draw attention to the policies that must be prepared at the micro-level. Overall, the study provides a detailed investigation of the current status of e-rickshaws across the stakeholders.

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01

Introduction

1.1. Current Scenario

Mobility is one of the major areas that is experiencing problems due to rapid urbanisation. The use of personal motor vehicles is expanding rapidly in Indian cities, leading to congestion, air pollution and deteriorating road safety. About 86% of the total vehicle population in India constitutes two-wheelers and cars[1]. Organised public transport services in the form of buses and railways are present in only 65 of the 7935 cities and towns in India[2].

Most cities largely depend on Informal Public Transport (IPT) modes for their travel needs due to the unavailability of formalised public transport systems. IPT includes e-rickshaws, shared vehicles, cycle rickshaws, and other four-wheeled passenger vehicles. The IPT system is not only addressing the last-mile connectivity needs of the commuters but is also bridging the demand gap due to insufficient capacity of the public transport services.

IPT services are considered to be accessible and affordable transport systems for the urban poor (Centre for Public Policy Research, January 2015)[3]. It is estimated that about 4 to 16 auto-rickshaws serve every 1000 people in Tier I and II cities in India (EMBARQ, 2013)[4]. IPT contains three potential features:

- They act as feeder service to the formal public transport and ensure last-mile connectivity,
- They act as pseudo-public transportation in tier two cities, notably where formal city bus service is missing,
- They provide flexible, convenient and easily available transportation services.

Table 1 categorises five important stakeholder groups and highlights their roles in the IPT sector. Numerous studies have emphasised the lack of cooperation between these five groups and the need to incorporate them into policies relating to sustainable development goals[5].

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[1] *Ministry of Road Transport and Highways. Road Transport Year Book 2015-16*
[2] *Moving India to 2032, National Transport Development Policy Committee report (NTDPC), 2014.*
[3] *Intermediate Para-Transit (IPT) systems: A case of private players in a sector of government monopoly. CPPR, 2015.*
[4] *EMBARQ. (2013). Sustainable Urban Transport in India, Role of Auto Rickshaw Sector.*
[5] *Improving and Upgrading IPT Vehicles and Services: A study.reterived from https://smartnet.niua.org/sites/default/files/resources/Intermediate%20Public%20Transport.pdf*

Table 1: Details of IPT stakeholders

User	IPT users are typically captive and have the least say in the operation of informal public transport. Frequently, their comfort and convenience are neglected.
Drivers	Drivers are primarily responsible for operating the IPT services. The vehicles are either owned or leased from the owners.
Owners	Individuals who own the vehicle and rent it out daily. They are also responsible for maintenance and other recurrent expenses.
Unions	A group composed of drivers and vehicle owners that operates as the city's chief agent for informal public transport operations.
Government	The government has a significant role in regulating IPT services in the city. It includes, among others, the traffic police, the Road Transport Office/District Transport Office, the local government, and the Transport Department.

IPT occupies a prime spot in urban transport in Indian cities. With a wide range of vehicles and different operational models across the country, they provide mobility to urban residents in the absence of adequate public transport. However, the sector has been inadequately regulated, leading to passenger overloading, accidents, congestion, pollution, irrational fares, etc.

The National Transport Development Policy and Committee (NTDPC, vol. 1, 2014) emphasizes the need for a "closed permit system" and an "open permit system" for the IPT transportation system, as well as the need for a policy with stringent and maintenance-oriented standards. The IPT mode share in Ranchi, for example, is 12% according to the Census 2011. However, a primary study[6] conducted by ITDP in 2014 revealed the mode share for IPT to be 28% — more than double the figures in three years. Similar dissonances can be seen in studies conducted to analyze mode share figures across cities (NTDPC, 2014). Nevertheless, experts from the field suggest that the actual share of IPT usage in the country is much higher than the reported numbers. As shown below in Figure 1, major urban cities like Bangalore, Ahmedabad, Mumbai, and Chennai contribute a higher share of light passenger motor vehicles. It is evident that the vehicular registration figures also provide a sense of the scale of IPT in urban India.

[6] *With a sample size of 9000 citizens, the study was conducted to understand the mobility patterns amongst residents in Ranchi.*

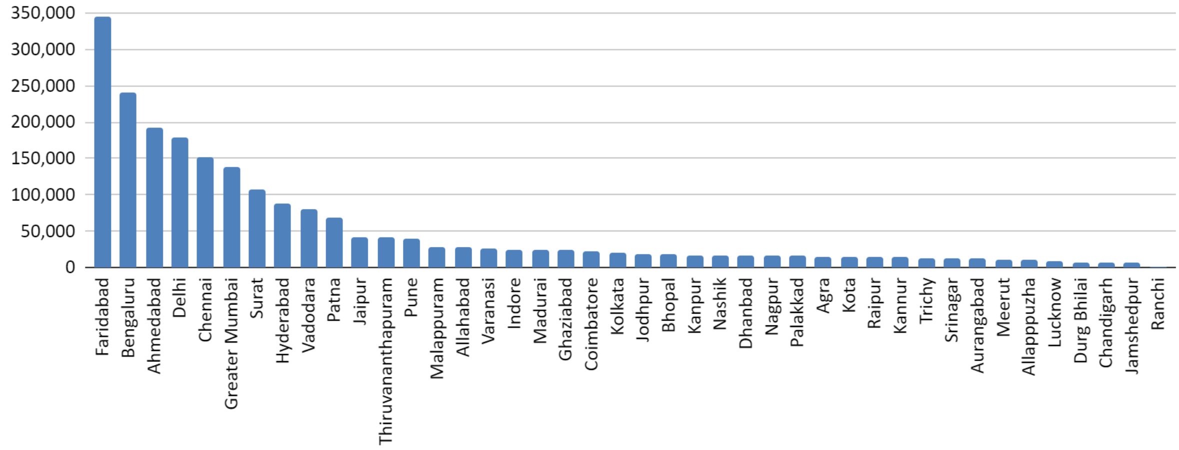

Figure 1: Number of registered light passenger motor vehicles in India, 2019[7]

In addition to the lack of regulation in the sector, there is not enough data to quantify the true scale of usage of IPT across the country. This also affects any understanding of its impact on urban mobility and the environment. Figure 2 presents the mode share in urban India and the share of IPT users ranges between 4-6 per cent across the states in India (Census, 2011).

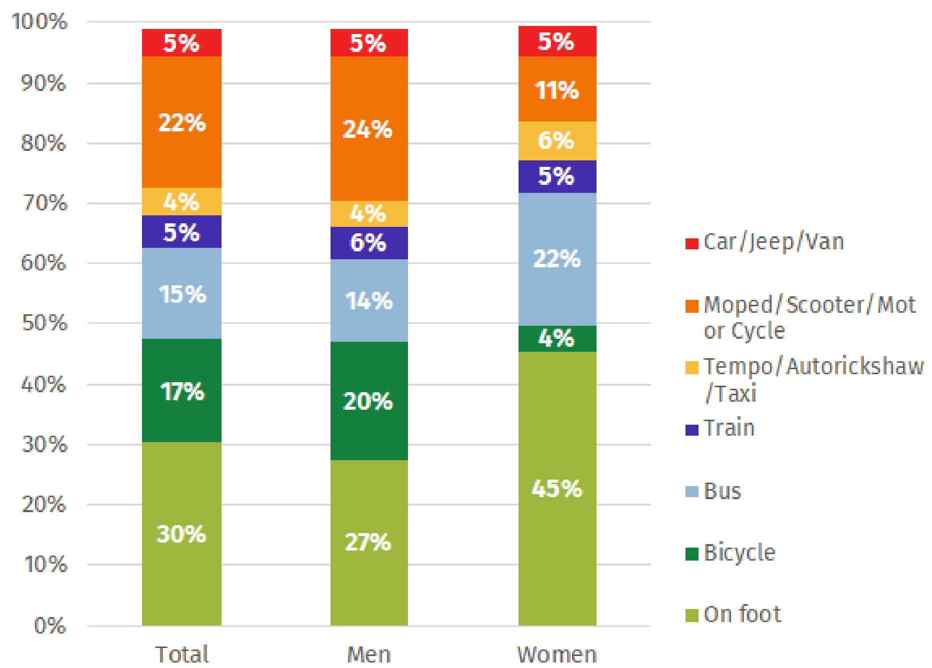

Figure 2: Mode Share in Urban India (Census 2011)

Data from the MoRTH shows that there are about 6.8 million registered passenger light motor vehicles in the country as of 2019. Of these, 2.4 million (35%) have been registered in 50 million-plus cities (with an approximate population of 160 million).

[7] *Road Transport Yearbook, Ministry of Road Transport and HIghways (MoRTH), 2019*

With an average daily run of 100 kilometers, IPT would be responsible for approximately 50 billion vehicle kilometers traveled annually in these 50 cities. Although estimating the veracity of such ballpark figures would be an onerous task, it helps to provide a sense of scale. However, potential savings from fossil fuel purchase, reduction in carbon emissions and air pollution can be estimated from this initial figure.

1.2. Evolution of e-IPT system in India

In the mid-'90s, e-IPT was born out of attempts to improve upon the existing cycle-rickshaw. However, it picked up steam in the late 2000s. Older designs of cycle-rickshaws were very inefficient, placing a great deal of physical stress on rickshaw pullers. It was to improve upon this situation that the first attempt at designing electric rickshaws in India was made. One of the initial successful models was created by Nimbkar Agricultural Research Institute in Maharashtra in the late 1990s.

Before the start of the Commonwealth Games hosted by Delhi in 2010, the Delhi government introduced e-rickshaws in the country. The vehicle was powered by lead-acid batteries and could carry 2-3 passengers at a time. The simplicity of the vehicle caught the public eye as did the extremely low fares that operators charged. However, in its initial days, e-rickshaws operated in a regulatory vacuum.

Most of the e-rickshaws on the road remain unregistered. India has around 15 lakh e-rickshaws in 2021; till 2019, only 1.5 lakh were registered. As a result, drivers do not hold valid licenses and the safety of passengers is compromised. While organized players sell about 1,500-2,000 vehicles a month, the unorganized players sell 10,000 e-rickshaws a month[8]. The e-rickshaws sold by the unorganized sector are of poor quality and operate on lead-acid batteries that need to be changed after every six to eight months. The replacement cost per battery is Rs 25,000-Rs 28,000. The lead-acid batteries usually weigh close to 80 kilograms, which reduces vehicle mileage. Used batteries are often disposed of carelessly, harming the environment. The growth of e-rickshaws was fuelled by the import of parts from Chinese suppliers which were locally assembled and are usually non-standardised. As of November 2021, nearly 28,304 e-rickshaw (including e-Rickshaws & e-cart) were sold[9]. Most of the e-rickshaws are lead-acid based. This has been mainly due to the lower upfront cost of lead acid-based e-rickshaws compared to their internal combustion engine (ICE) counterpart-based auto-rickshaw.

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[8] *https://www.downtoearth.org.in/blog/air/why-e-rickshaws-have-emerged-a-winner-in-transition-to-electric-mobility-race-75767*

[9] *Details of electric vehicle manufacturers/ original equipment manufacturers (OEMs) registered under phase-ii of fame India scheme. Retrieved from: https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1778962*

The initial cost of an e-rickshaw is anywhere between Rs 0.6-1.30 lakh, whereas the cost of an ICE-based auto-rickshaw is Rs 1.5-3 lakh. The total running cost for an e-rickshaw is only Rs 0.4/kms as compared to Rs 2.1-2.3/km for ICE-based rickshaws[10]. E-rickshaws incur less maintenance costs and are easy to handle. It has also received support through Faster Adoption and Manufacturing of Electric Vehicles 1 (FAME 1), Smart City Mission, Pradhan Mantri Mudra Yojana and state EV policies.The FAME-1 subsidy support for lead acid batteries for e-3 wheelers is ₹55,000. However, the strategy could not adequately ease the purchase of e-3 wheelers. However, the FAME 1 subsidy for lead acid-based e-rickshaws was discontinued in October 2019.

Over time, a robust domestic manufacturing industry arose. Major traditional IPT manufacturers such as Mahindra have also entered the segment, although their vehicles are based more on auto-rickshaws than cycle rickshaws. Increasingly, manufacturers are also coming out with e-rickshaws with lithium-ion batteries rather than lead-acid batteries[11].

The primary difference between e-autos and e-rickshaws is in the vehicle design w.r.t the battery size, motor power and performance of the vehicle in terms of maximum speed, torque and range and passenger capacity. India has the largest electric rickshaw fleet in the world. Currently, the e-3wheeler market is dominated by e-rickshaws, where unorganized players have 80%-90% of the market share. Therefore, there is an urgent need to regulate the e-rickshaw sector to ensure that benefits are maximized for both users and operators.

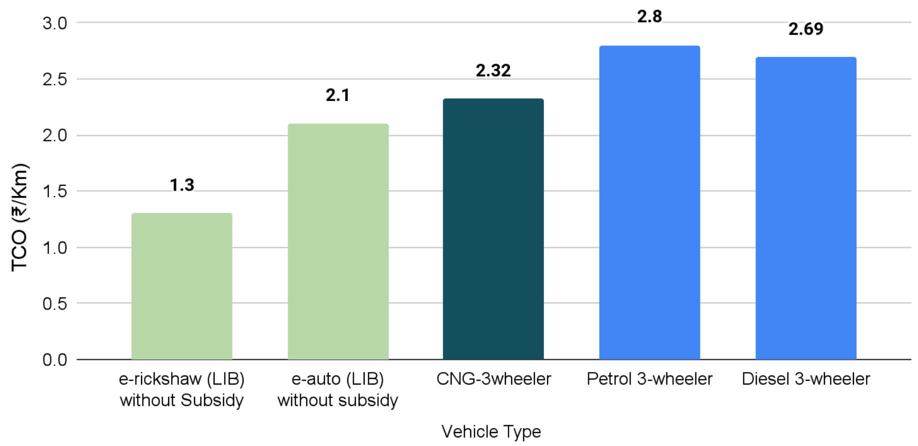

Figure 3: Comparison of TCO per KM of e-rickshaw (without subsidy) and e-auto (without subsidy) with CNG-3W, Petrol-3W and Diesel-3W at an average daily travel distance of 100km[12].

[10] *https://www.downtoearth.org.in/blog/air/why-e-rickshaws-have-emerged-a-winner-in-transition-to-electric-mobility-race-75767*

[11] *This has also led to a differentiation between e-rickshaws and 'e-autos' with the latter having advanced batteries. However, this report does not make this distinction and has used the term e-rickshaw to refer to all e-IPT vehicles.*

[12] *WRI India Analysis, 2020. https://wri-india.org/blog/busting-cost-barrier-why-electric-three-wheelers-make-business-sense*

Comparison of TCO per kilometer of e-rickshaw (without subsidy) and e-auto (without subsidy) with CNG 3-wheeler, petrol 3-wheeler and diesel 3-wheeler at an average daily travel distance of 100 km. Here, the purchase cost of e-rickshaw (Lithion-ion Battery (LIB)) and e-auto (LIB) is ₹2,02,552 and ₹3,66,906 respectively. The cost of a CNG 3-wheeler, petrol 3-wheeler and diesel 3-wheeler is ₹2,40,000.

Some major inputs and assumptions used to calculate the annual operating cost include:

- cost of electricity ₹6/ kWh, cost of petrol ₹72/liter, cost of CNG ₹46/kg, cost of Diesel ₹67/liter.
- resale value 10%, discount rate 10% and vehicle holding period of 10 years.
- mileage of e-rickshaw, e-auto, CNG-3wheeler, petrol-3wheeler and diesel-3wheeler are 13 km/kWh, 17 km/kWh, 30 km/kg and 30km/liter respectively.

As per WRI India's analysis at an average of 100 km per day usage, the TCO per km of e-rickshaws (₹1.30/km) and e-autos (₹2.10/km) is lower than the corresponding ICE variant (CNG 3-wheeler, petrol 3-wheeler, and diesel 3-wheeler). This highlights the viability of e-3wheelers for typical commercial applications. Additionally, with a FAME-II subsidy of ₹37,000 for e-rickshaws, the TCO per km of e-rickshaws (₹0.99/km) become even more economical[13].

[13] *WRI India Analysis, 2020*

Source - Bloomberg.com

02

Operation of Informal Transit

In India, the operation of informal transit was first introduced in the form of electric cycle rickshaws in early 2000. The informal transit operation is classified under two broad categories (a) contract carriage - flexible, demand-based and point-to-point service and (b) informal public transport - shared fixed routes with intermediate stops.

I. Contract carriage

The most commonly seen form of IPT operations is in the form of autorickshaws which provide point to point service to passengers. In cases where the door to door travel is involved, IPT acts as a substitute for a personal motor vehicle, and therefore, their proliferation is not particularly desirable. A key drawback that was faced by operators till recently was the lack of dispatch services. However, the entry of aggregators such as Ola has shown that improved service delivery was quickly possible; even though the question of sustainable business models and fair returns for drivers remained to be solved.

II. Informal Public Transport

In this form of operation, vehicles operate on fixed routes and fares, ensuring a modicum of reliability for commuters. In most cities, such forms of operations would be regulated by the Regional Transport Office, which sets a cap on the number of vehicles, allocates routes to operators and regulates fares. However, the lack of enforcement, fixed schedules and severe competition amongst operators leads to inefficient outcomes.

2.1. Permit structure

A permit is a document issued and regulated by the Regional Transport Offices (RTO), established by the state government entitling vehicles to be used as a transport vehicles within its jurisdiction. There are two types of permits issued by authorities which may vary from city to city: open and closed permits.

- **Open Permit:** There is no restriction on the number of permits issued by the transport authority within their jurisdiction, thus allowing uncapped and free movement of IPTs. While this scheme effectively manages the demand and pricing of the service to some extent; on the other hand, issues such as congestion and jams do arise due to a large number of vehicles.

- **Closed Permit:** In the closed permit system, the numbers are regulated and capped by the transport authority. It also restricts the unchecked entry of IPTs into the market in an attempt to control the supply and congestion on the roads (CPR, 2016).

2.2. Legal concerns and need for regulation

Although e-rickshaws became widespread in Indian streets quickly in 2010, they remained unpopular with the governments for multiple reasons. Several high-visibility accidents involving e-rickshaws increased the perception that the vehicles were unsafe, and that their operations need to be regulated. In 2013, a writ petition was filed in the Delhi High Court for the same citing the issues of safety and the lack of regulation in the form of registration, insurance and fitness certificates for these vehicles.

The court asked for responses from the city authority, state transport department and Delhi traffic police. The city authority responded that its powers of regulation were limited only to cycle rickshaws. The state transport department submitted that e-rickshaws were operating illegally as they were not defined under the Motor Vehicles Act. It also pointed out the lack of standardization and regulation and its negative effects. The study also put forward the importance of e-rickshaws, pointing out that their sudden rise reflected unmet latent mobility needs within the city. The traffic police also agreed that e-rickshaws were operating illegally and banned their operations.

The central government put forward its view that although they were operating illegally, given a large number of households dependent on the same for their livelihoods and mobility needs, the court granted leniency. However, the Delhi High court refused to accept this argument and banned the operations of e-rickshaws in Delhi in late 2014. It asked both the central and state governments to amend the Motor Vehicles Act (MVA) and the Central Motor Vehicles Rules (CMVR) to ensure that e-rickshaws were included, defined and regulated sufficiently. One month after the High Court verdict, an amendment was made to the MVA and CMVR to include e-rickshaws and provisions for their operation and licensing. Despite this, many of the e-rickshaw manufacturers in Delhi (which has about 340 manufacturing units) still do not comply with the ARAI / ICAT standards.

2.3. Need for regulation

There is an obvious need for regulating the informal public transport sector in Indian cities. Although they provide a critical public service, current, inefficient systems of operation have led to a situation where IPT modes contribute significantly to traffic congestion, accidents, air pollution and resultant carbon emissions.

TERI's study on Bangalore showed that nearly 10%[14] of road traffic is composed of IPT modes such as autos, and contributes to approximately half a million tons of CO_2 and 165 tonnes of PM_{10} annually in the city[15]. With other cities across the country having similar (or more extensive in the case of smaller towns with no formal public transport systems) figures for the mode share of IPT, the necessity of regulation for the IPT sector is evident. It can lead to significant gains in terms of efficient mobility, cleaner air and reduced carbon emissions. In this context, electrification has been suggested as a panacea for the IPT sector.

Electrification of the IPT sector can potentially be effective in mitigating local air pollution and carbon emissions. However, India's high dependence on coal for providing electricity means that electric vehicles would lead to more carbon emissions than conventional Internal Combustion Engines (ICEs). Switching from a traditional IPT fleet to an electric fleet does not reduce the growing congestion on the roads either. Therefore, electrification cannot be seen as the only goal for the IPT sector.

However, electrification offers an opportunity to create a practical regulatory framework for the IPT sector across cities in India. For this, action needs to be taken at three levels: local, state, and central. These actions should span across multiple domains: the registration process for vehicles and licensing for drivers, on-route allocation, and traffic. At the local level, cities need to identify what type of services are currently being provided by IPT. In larger cities, they both supplement and complement the formal public transport system, while in smaller towns, in addition to the above, they also act as proxy public transport services with fixed routes.

The routes operated by IPT in most cities have evolved from market demand and usually cover only parts of the city with adequate demand for ridership. This provides financial viability for IPT operators but leads to lesser coverage across the city. When cities have tried regulating IPT routes, poor implementation and enforcement have led to the failure of these efforts. These results have been seen in locations and contexts as wide and varied as megalopolitan Delhi or Tier three city- Ranchi.

In Ranchi, a set of routes spread across the city was drawn up by city officials. As drivers found out that only a few routes in the central commercial district of the city had sufficient demand, they left operations on their unprofitable routes leading to increased congestion in the commercial district aided by weak enforcement by the city's traffic police.

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[14] *Comprehensive Traffic and Transportation Plan for Bengaluru, 2011*
[15] *TERI (2018). Replacing Bengaluru's auto fleet with electric autos will clean up the air and save LPG*

In Delhi, various forms of IPT such as the Gramin Sewa service and e-rickshaws have dedicated routes allocated to them by the Transport Department and the traffic police. However, violations have occurred to the extent that parties have had to access legal recourse.

It is necessary, therefore, that at the city level all concerned stakeholders come together and identify solutions which are acceptable to all and provide positive externalities. The following principles should be put in place as a guide:

- IPT operators need to be able to run a profitable operation.
- Commuters need to be able to access reliable, safe and convenient IPT services.
- Cities need to reduce their carbon emissions, local air pollution and traffic congestion.

2.4. Concerns and Opinions of IPT drivers

According to a recent survey conducted by the Ministry of Urban Ministry of Housing and Urban Affairs (Mohua), IPT drivers show concern about several issues. As shown in Figure 4, the primary concerns of IPT drivers are the “competition for passengers” and experience “traffic jams and inconvenience for parking”. Therefore, there is a need for addressing IPT drivers' concerns and form an adequate policy. Figure 5, draws attention to IPT drivers' difficulties in making a trip. The majority of the drivers face competition from other autos, taxis, and e-rickshaw or buses. While few experience problems related to “time lost in traffic”, and “restriction due to corona”.

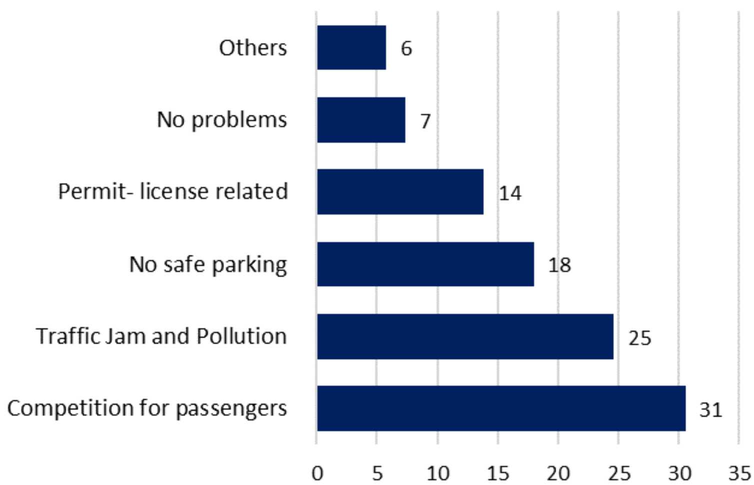

Figure 4: Primary concern of IPT drivers

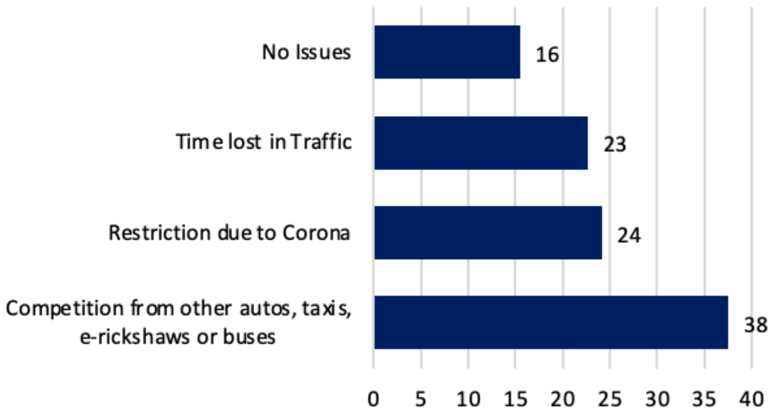

Figure 5: Difficulties in finding passenger trips

The majority of older age groups are less likely to opt for cashless payment, as shown in Figure 6. The figure also shows that people below the age of 30 are more likely to switch to cashless payments.

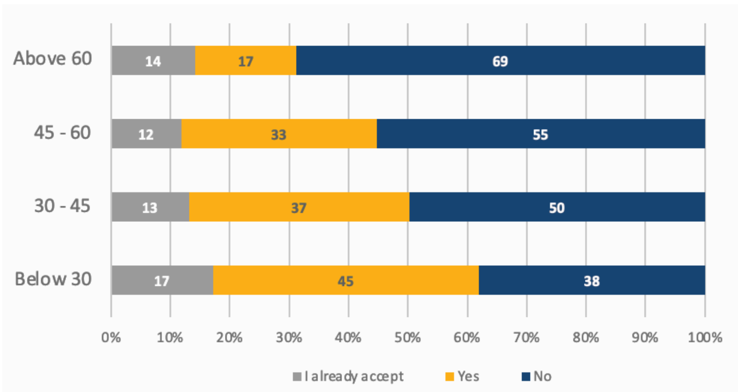

Figure 6: Age-wise willingness to access cashless payment by IPT drivers

In Figure 7, the proportion of individuals willing to utilize cashless payment varies by vehicle type. The majority of respondents were non-cashless payment users across all IPT transport systems. The majority of e-rickshaw drivers prefer cash payments and are less likely to switch to cashless payment methods.

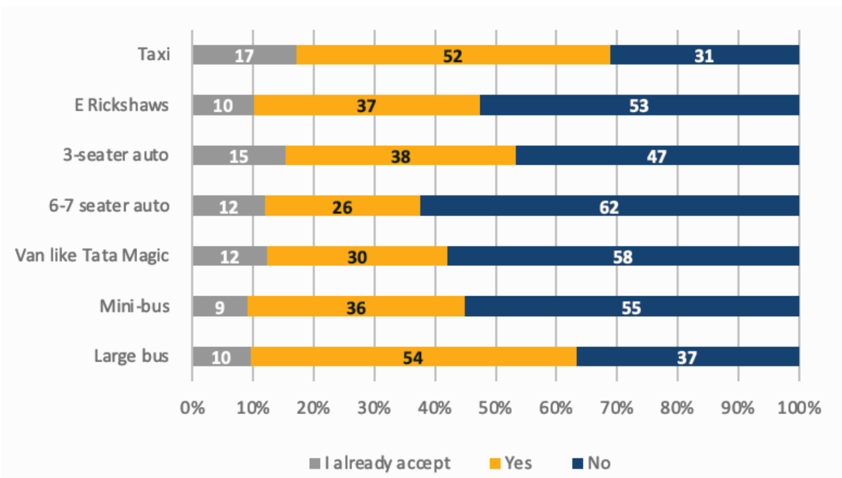

Figure 7: Vehicle type-wise willingness to access cashless payment

2.5. Driver behaviour of IPT electric vehicles

IPT drivers typically respond to changes in customer demand by altering their timetables and picking up and dropping off passengers wherever is most convenient. Therefore, the actions of drivers are determined by their response to passenger demand. The IPT driver behaviour also varies with respect to types of IPT vehicles, i.e electric and non-electric vehicles. Electric IPT vehicles are mainly classified as three-wheeled pedal rickshaws and three-wheeled autos. The drivers' willingness to procure e-rickshaw is majorly associated with the socio-economic profile of the drivers. Most e-rickshaws drivers either own or rent their vehicle. A study by Rahim et al. (2013)[16] explored the socio-economic and environmental impacts of e-rickshaws in Bangladesh.

It was discovered that after moving from traditional fuel-type IPT vehicles to e-rickshaws, drivers were able to boost their income, social status, level of comfort, and employment rates. The operating expenses for an e-rickshaw are only Rs 0.4 per kilometre, compared to Rs 2.1-2.3 per kilometre for ICE-powered rickshaws. In general, IPT drivers' behaviour is largely influenced by OEM schemes and market strategy.

An organization like Three Wheels United[17] provide subsidy to consumers to purchase e-rickshaw. Additionally, consumers' environmental consciousness and acceptance of technology products will influence their behaviour towards e-rickshaw. Further, several original equipment manufacturers (OEMs) report a decline in ICE rickshaw sales as a result of e-rickshaw advertisements highlighting its technological features and services[18].

Prakash et al. (2014)[19] collected IPT three-wheeler electric vehicles from eleven cities in India and examined the social aspects and the role of gender on their preference for electric vehicles as an alternative for personal and public use. It was revealed that male respondents were more inclined toward influential factors like fuel efficiency, safety, vehicle power, and early availability of the vehicle in the market.

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[16] *Rahim, M. A., Joardder, M. U. H., Houque, S. M., Rahman, M. M., and Sumon, N. A. (2013). Socio-economic & environmental impacts of battery driven auto rickshaw at Rajshahi city in Bangladesh. In International Conference on Mechanical, Industrial and Energy Engineering 2012.*

[17] *https://www.livemint.com/news/india/bengaluru-s-three-wheels-plans-to-raise-25-million-to-scale-up-funding-evs-11594885972519.html*

[18] *https://auto.economictimes.indiatimes.com/news/commercial-vehicle/lcv/3ws-in-spite-of-ice-segment-recovery-electrification-makes-rapid-strides/92122168*

[19] *Prakash, N., Kapoor, R., Kapoor, A., and Malik, Y. (2014). Gender Preferences for alternative energy transport with focus on electric vehicle. Journal of Social Sciences, 10(3), 114-122.*

Harding (2014)[20], in their study related to e-rickshaws in New Delhi, found that there is a shortage of accurate quantitative information on e-rickshaws operators, and technology. Few researchers in India have investigated the elements that motivate IPT drivers to purchase electric rickshaws.

Priye et al. (2021)[21] noted that the absence of amenities such as designated parking and fixed charging stations, as well as a lack of fare regulation, is viewed as a significant obstacle to e-rickshaw services. The paper also highlighted the need for enforcement and driver training and licensing policies to create a sustainable and organized IPT system in urban India.

Figure 8: IPT drivers survey as part of Transport4all Challenge

[20] *Harding, S. (2014). The Battery Rickshaw Crisis in New Delhi. Journal of Indian Law and Society, 6, 74-88.*

[21] *Priye, S., Manoj, M., & Ranjan, R. (2021). Understanding the socioeconomic characteristics of paratransit drivers and their perceptions toward electric three-wheeled rickshaws in Delhi, India. IATSS research, 45(3), 357-370.*

Source - Honda

03
Technological Aspects of e-IPT Vehicles

Electrification has brought out a plethora of technological changes in urban mobility. However, before adoption, it needs to be considered whether the technology would help to address the concerns of equity and sustainability. In the case of IPT as well, any technological introduction should be preceded by these questions:

- Will the technology be accessible to all?
- Will it help to improve urban mobility by reducing congestion and improving road safety?
- Will it help the environment by reducing local air pollution and help rein in carbon emissions?

3.1. Vehicle Technology and Design

The design of an electric three-wheeler is similar to its ICE counterpart in its design except for the drive train. These rickshaws have mild steel tubular chassis to keep the body weight low, and three wheels with a differential gear transmission at the rear wheels. The chassis provides structural strength and support for mounting components.

The Chassis should be designed for uniform stress and weight distribution while keeping the overall weight of the vehicle light. The body of the vehicle is made up of sheet metal or fibre with a hard or a soft rooftop. The figure below shows the schematic of the powertrain of an e-rickshaw.

Brushless DC electric motor

The motors in electric e-three-wheelers are BLDC motors, brushless DC synchronous motors with a power rating between 600W to 1400W.

These motors have

(a) high power-to-weight and volume;
(b) high-speed operation;
(c) low maintenance;
(d) high efficiency;
(e) reliable construction.

This makes them highly suitable for lightweight applications such as three-wheelers. The motor has a permanent magnet rotor, stator field coils and controller circuit integrated into the stator assembly, eliminating difficulties of supplying current to moving parts.

BLDC motors can be further classified into two types:

i. Out-runner type BLDC Motor where the rotor of the motor is present outside and the stator is present inside.

ii. In-runner type BLDC Motor where the rotor of the motor is present inside and the stator is outside like conventional motors. Many three-wheeler manufacturers in India use the runner-type BLDC motors.

Basic selection criteria for motor selection and design

Motor selection for the e-3wheeler is determined based on the peak power and torque demands. They have to be lightweight, low cost, high reliability and generate low noise and vibration. For urban driving conditions with frequent stop-and-go traffic, constant torque at low speeds is a primary requirement. Cruising at high speed on long roads will require constant power operation with high speed and low torque. For lightweight vehicles such as auto rickshaws, motors with a high power-to-weight ratio are preferred to keep the size small while having high power output.

Compared with other types of motors such as the brushed DC motors, switched reluctance motors and induction motors, Brushless DC motors have the highest power-to-weight ratio and hence are preferred for electric auto rickshaws.

Gross Weight of the Vehicle

Certifying agencies in India defines the category of auto rickshaws with a Gross Vehicle Weight of < 1500 Kg. For all the models of the e-autos, the GVW is less than 1500 kg hence they are considered safe

Battery Considerations

Various batteries used in electric vehicles are Valve Sealed Lead Acid (VRLA) battery, LiFeP04, Nickel-Metal Hydride batteries etc. Generally, lead acid-based batteries are commonly used for three-wheeler auto-rickshaws due to cost constraints and safety. Due to the higher benefits such as higher energy density, weight density, larger life cycles, faster recharge time, longer replacement time frame etc., backed by strong research, Lithium-ion batteries are becoming widely accepted in the industry.

Table 2: Comparison of Lead-acid and lithium-ion batteries[22]

	Lead Acid	Lithium Ion
Specific energy Wh/kg	40-50	150
Number of cycles	200-500	1000-4000
Usable capacity	50%	80%
temperature sensitivity	degrades above 25	degrades about 45
Fast charging time	4-8 hrs	2-4 hrs
Nominal cell voltage	2 V	3.2V
Maintenance frequency	every 3 months	annual

Battery pack size is selected based on the range requirement and the motor power demand. In India, the voltage rating of the batteries is 48V -72V. The average electrical consumption for a three-wheeler in an Indian city under real-time driving conditions is 61 Wh/km. The battery pack size can be calculated if the distance travelled, and the energy consumption is known.

$$\text{Distance Travelled (km)} = \frac{\text{Battery Pack Size (Wh)}}{\text{Energy Consumption (Wh/km)}}$$

Table 3: motor and battery requirements as per Indian Driving cycle for electric auto rickshaws with Lithium-ion batteries[23]

As Per India Driving Cycle Requirements		Li-ion based EV	
		Direct Drive	Geared Drive
Motor	Continuous Rating	2.07 kW, 66 N.m, 300 rpm	2.12 kW, 16.8 N.m, 1200 rpm
	Short Time Overloading Capacity (for 30 s)	4.15 kW, 130 N.m, 500 rpm (max)	4.24 kW, 33.6 N.m, 2000 rpm (max)
Battery	Nominal Pack Voltage (V)	48	48
	Ah Rating (Ah)	80	80
	VA Rating (VA)	4.882	5.007
	Max. Current Rating (A)	101.71	104.31

[22] *https://www.altenergymag.com/content.php?post_type=1884*
[23]*https://www.researchgate.net/publication/311908063_An_Insight_into_Motor_and_Battery_Selections_for_Three-Wheeler_Electric_Vehicle/link/5a45c210aca272d2945dbc74/download*

Battery Placement Location

The battery pack as well as the electrical and electronics components must be securely placed and packed inside the vehicle, to avoid electrical issues during rainy seasons and flooded roads. The electrical components must also have an efficient cooling system, as the temperature in summers can soar to high magnitudes. The bulkier battery packs are best placed at the center of the vehicle for a lower Center of Gravity and weight distribution.

3.2. Compliance Standards for e-3wheeler

The primary difference and the point of technological innovation between e-rickshaws and regular rickshaws lie in the battery. The simplistic technology required, therefore, has made e-rickshaws much less complicated to manufacture, assemble, operate and maintain in comparison to a regular autorickshaw. This was the primary reason for its impressive growth in its initial years as entrepreneurs started importing the parts from China and informally assembling and selling the vehicles. Coupled with the lack of regulatory action, this resulted in e-rickshaws with poor design and safety standards operating on the street in the technology's early days.

Realising the necessity for quick action, the Ministry of Road Transport and Highways (MoRTH) amended the Motor Vehicles Act (MVA) and its accompanying Central Motor Vehicle Rules (CMVR) to include e-rickshaws under the Automotive Industry Standards (AIS)[24]. The standards provide detailed guidance on the specifications for vehicle technology.

The 2014 amendment SO 2590(E) lists the safety standards for e-rickshaws. Five AIS standards are in place for battery-operated vehicles, while AIS guidelines have been created for retrofitting, batteries and charging infrastructure as well.

These documents are listed in the table below.

Table 4: Safety standards for e-rickshaws

Sector	Title	Reference Standards
Electric powertrain vehicles	Construction and functional safety requirements	AIS 38
	Measurement of electrical energy consumption	AIS 39
	Method of measuring the range	AIS 40

[24] *AIS are created by the Automotive Industry Standards Committee (AISC), which is housed in the Automobile Research Association of India (ARAI), an autonomous body affiliated to the Ministry of Heavy Industries and to the automotive industry.*

	Measurement of net power & maximum 30-minute power CMVR type approval for electric powertrain vehicles	AIS 41 AIS 49
Retrofitting	CMVR type approval of electric propulsion kit intended for conversion of vehicles for purely electric operation	AIS 123
Battery	Safety requirements of traction batteries	AIS 48 (Part 3)
Charging standards	EV conductive AC charging system EV conductive DC charging system	AIS 138 (Part 1) AIS 138 (Part 2)

3.3. Developments in battery technology and battery swapping

As noted in earlier sections, nearly all current e-IPT vehicles in India run on lead-acid batteries. The technology surrounding these batteries has been around for more than 150 years with few improvements made in the recent past; the popularity of the battery lies in its low costs and therefore, market penetration and availability. The specifications of the lead-acid battery, and its comparison with lithium-ion batteries, are very important in identifying the characteristics of e-IPT vehicles.

Lead-acid batteries have a lower energy density as compared to lithium-ion batteries. This leads to lead-acid batteries being of a much higher mass and volume. At the same time, the lesser efficiency of the batteries also impacts the life of the batteries, efficient charge window and temperature sensitivity.

The lead-acid battery provides an operating range of 80-100 kms[25] in a single charge. However, the battery has a limited lifetime- and on average battery lasts between twelve to eighteen months, after this period this range was found to have halved, only reaching between 50-60 kilometres[13].

In comparison, advanced lithium-ion batteries have advantages over lead-acid batteries in all the categories mentioned above. They last anywhere between three to five years, need lesser maintenance and can operate in a wider variety of climatic conditions. Their lesser mass and higher energy density also contribute to their portability.

[25] *Real World Energy Efficiency Calculation for e-Rickshaws - A Comparative Study (Lead Acid Vs Lithium Ion Battery Vehicles), 2019*

In addition, the improvement of technologies such as fast charging can potentially reduce the charging time significantly as compared to lead-acid batteries. However, the steep cost of lithium-ion batteries has been extremely problematic, with most operators lacking financial sufficiency. The cost of the lead-acid battery was found to be nearly Rs 24,000, whereas the cost of Li-ion is around Rs 65,000 on average[26].

The lead-acid batteries used in e-rickshaw get discharged quickly due to their low quality. It also raises concerns about the lack of proper infrastructural support for e-rickshaw services.

As noted above, the two main challenges facing battery-powered vehicles are capital costs and charging time. While both of these issues can be addressed for personal motor vehicles, a sector such as IPT - where operators have limited time and financial resources - could find scaling up especially difficult. Innovations around battery swapping are a potential way around this roadblock. In India, the pilot initiative was done by Ola in Nagpur, Namma Auto in Bangalore provided several insights regarding both battery technology and battery swapping.

For individuals who do not have access to charging points at their residence or workspaces, battery swapping points are a welcome convenience. For commercial operators – especially those performing last-mile deliveries battery swapping allows for minimum downtime for their vehicles. Battery swapping involves removing a drained EV battery from the vehicle and replacing it with a fully charged one. The technology is now being employed for a variety of EV categories, including e-3wheelers and e-autos. Battery swapping helps in decoupling the initial cost of the vehicle, thus making it economically viable for fleet operation and also helps in addressing any range difficulties.

[26] *Based on stakeholders' interaction*

Source - Twitter @ArvindKejriwal

04

Central & State Government's Initiatives to Promote Uptake of Electric IPT Vehicles

4.1. FAME scheme

Although launched with a focus on promoting all sectors of electric mobility, the major focus of the Faster Adoption and Manufacturing of Electric Vehicles (FAME) I scheme was on pushing the adoption of personal electric motor vehicles. At the end of the first phase of the scheme, State Transport Undertakings (STUs)- the agencies responsible for operating public buses, were provided funding for bringing in electric buses in major cities; however, even at this stage, e-IPT did not gain from FAME I.

Realizing that an active market is in place currently, the second phase of the FAME scheme has included e-IPT under its ambit. In fact, one of the major objectives of FAME II is to provide purchase subsidies for 500,000 e-rickshaws. So far, five OEMs have 18 models listed under FAME II, with incentive amounts ranging between ₹25,000 and ₹60,000. Total subsidy support of ₹2,500 crores is provided to scale up the IPT electrification. A Convergence Energy Services Ltd. (CESL), a fundraiser for the state-owned Energy Efficiency Services Limited (EESL), has issued an invitation to bid for the purchase of 100,000 electric three-wheelers under a subsidized scheme. Electrification of three-wheeled vehicles will be aided by the likely price reduction that will result from aggregated procurement.

The listed OEMs are Kinetic, TVS, Mahindra, Electrotherm and Kalinga Ventures. However, given the growth rate of the sector, more OEMs should be joining the list. FAME-II proposes to provide purchase subsidies for half a million e-rickshaws, with an incentive of up to 20% of the vehicle cost. The average incentive given to an e-rickshaw is approximately ₹45,000. It can be seen that this is the average cost differential between e-rickshaws and regular autos currently. Since the launch of the FAME-II scheme in April 2019, only around 20,000 thousand electric three-wheelers and rickshaws have availed the subsidy till December 2021[27].

The reasons for such a slow uptake of the incentives need to be explored in detail. One of them could be that to avail incentives; operators require a valid permit from a government agency stating that the vehicle will be used only for public transport purposes. OEMs, meanwhile, are hedging their bets, producing vehicles powered by lead-acid and lithium-ion batteries alongside ICE.

The deployment of e-rickshaws in Udaipur, Delhi and Siliguri — through the 'CapaCITIES' project supported by the Swiss Agency for Development and Cooperation — highlighted the need for an enabling framework along with the financial assistance being provided under FAME I and II schemes.

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[27] E*lectric two-wheelers sale rise after remodelling of FAME -II scheme, says govt. 23 December 2021. Economic Times*

The absence of a framework for pricing electricity for charging, high charging time, frequent breakdowns, few charging stations and high battery costs were some of the critical concerns raised after the pilot.

Recently, Ahmedabad has also issued a work order to deploy 166 e-rickshaws to provide last-mile connectivity within 5 km of BRTS stations. The city is planning to use the annual license fee from e-rickshaws to improve Janmarg BRT operations. In general, the government of India aimed to support the electrification of IPT three-wheeler vehicles through

- Establishment of a network of charging infrastructure.
- Provision of incentives to all categories of electric three-wheelers vehicles
- Maximum number of vehicles to be supported is 500,000 vehicles

4.2. Financing for E-rickshaws

One of the structural reasons behind the current mode of functioning of IPT in Indian cities is the lack of access to formal financing channels. Currently, most established formal banks do not provide adequate access for financing individual operators, due to measures such as lack of credit history, stringent conditions, lengthy procedures and the need for collateral. This pushes the entrepreneurs and vehicle owners towards informal financing channels. Although they find it easier to access financing, the exceptionally high rates of interest ensure that the foremost concern on the mind of the operator is to maximize his earnings to pay off his loans. Recent surveys conducted by the Ministry of Housing and Urban Affairs under the Transport 4All Challenge show that 77% of the IPT vehicles are financed through loans from the bank or private finance. While more than ~30% of IPT drivers across all the modes are renting their vehicles as they cannot afford to purchase their own vehicle[28].

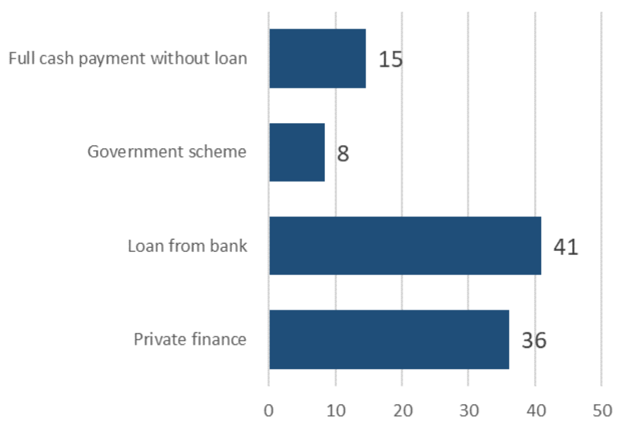

Figure 9: Mode of Financing of the Vehicle (%) by IPT Drivers

[28] *Analysis of Public Transport Needs in Indian Cities, June 2022, Transport4All Challenge*

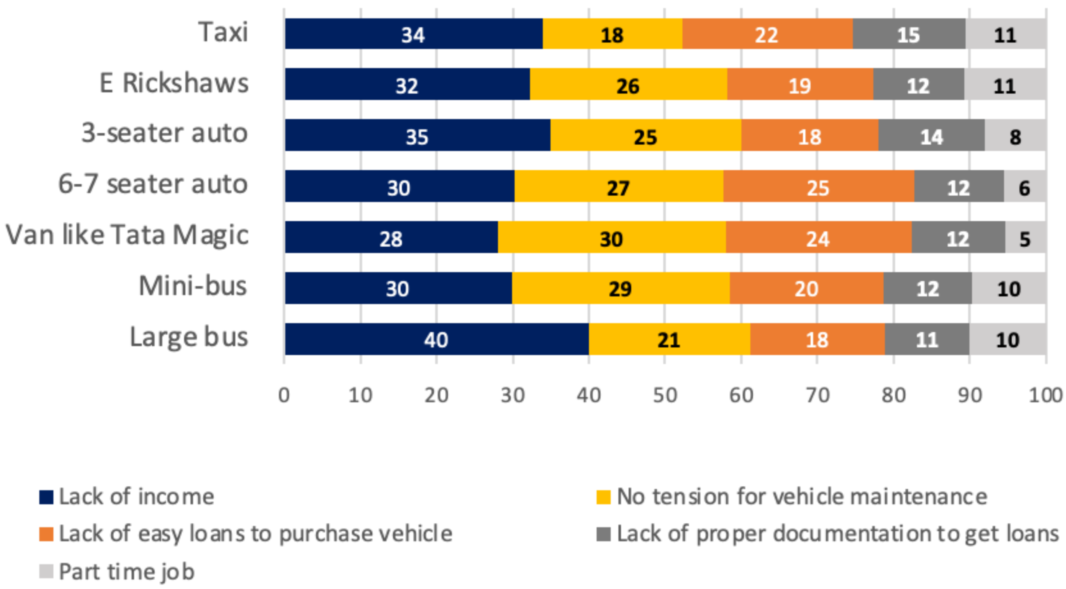

Figure 10: Reasons for Renting the Vehicle by Vehicle Type(%)

With the majority of operators facing the same issue, this leads to a situation where IPT operators compete with each other to maximize their earnings, leading to reduced road safety due to unsafe driving practices. Commuters also face a dip in the quality of service as the focus on maintenance of the vehicle lowers.

Easing access to formal financing options can therefore boost the IPT ecosystem. It can ensure that the debt burdens of operators would be significantly reduced, leading to greater financial security for households. With this concern removed, operators could turn out to be amenable to regulatory measures and newer operating models such as the Gross Cost Contract.

One of the most significant reasons for the growth of e-rickshaws across northern India has been the disparity in cost between them and regular autorickshaws. With an average price between 1- 1.5 lakh rupees, the e-rickshaw powered by a lead-acid battery is nearly half the price of an autorickshaw. However, lithium-ion batteries have gained sustainability and gained popularity in the performance of three-wheeler vehicles. The banking institutions have rarely planned policies or protocols for supporting battery technology. Access to financing for e-rickshaws was minimal due to the traditional unwillingness of conventional banking institutions to finance IPT.

The governments have realized that this lack of financial access hampers the growth of the IPT sector, and a few have responded to rectify the situation. State governments such as Delhi and Jharkhand have provided subsidies for purchasing e-rickshaws.

The Delhi government offered purchase subsidies to the tune of ₹30,000 for nearly 6,000 operators. However, in Jharkhand, even with a 75% purchase subsidy, operators found it difficult to gather the remaining amount. While state governments have been pushing for commercial banking institutions to improve access to financing for e-rickshaw, this approach has not been very successful.

Ministry of Road Transport and Highways (MoRTH) recently permitted[29] the sale of electric two and three-wheelers without batteries which can bring down their cost by 30-40%. This notification could further push battery swapping technology and make e-IPTs more affordable and accessible to operators. However, there are still some obstacles that need to be removed. Electric vehicles are taxed at 5% GST while purchasing batteries separately attracts a GST of 18%.

High capital cost, low range and high charging time have become major roadblocks for e-IPT expansion in India. However, financial assistance and upcoming innovations in battery technology and battery swapping can help in expanding the current pilots to state/city-wide projects.

[29] *Vide notification number RT-11036/72/2017-MVL dated August 12, 2020.*


Source - Republic news India

05
Case studies

The implementation and technological aspects of e-rickshaws in Asian cities and India vary substantially. A detailed review is explored to understand the status of e-rickshaws

5.1. Case Study of Thailand

Thailand approved a roadmap for EV development, the Electric Vehicle Promotion Plan, under its Alternative Energy Development Plan 2012-2021 and created the Electric Vehicle Association of Thailand to build infrastructure (charging stations) for both public transport and personal vehicles and to scale up the use of EVs. EVs are incorporated in the draft National Energy Efficiency Action Plan as a means of reducing the use of petroleum-based transport fuels.

In February 2022[30],Thailand released new government incentives for its electric vehicles (EV) industry as part of its ambitious plan to transform 50 per cent of its total auto production into EVs by 2030 and become a production base for cleaner vehicles in Southeast Asia. As on 31st December 2021, there is a total of 263[31] electric tuk-tuk (3-wheeler) which are registered in Thailand. The Thailand government offered generous tax incentives to automakers producing plug-in hybrids and EVs in the country for applications submitted by the end of 2018. The new incentive package includes significant exemption in import duty and excise tax for a wide range of EV models & important electrical components. The Thailand Board of Investment (BOI)[32] exempted corporate income tax (CIT) for 3-10 years and exempted import duties on machinery for electric 3-wheeler in the roadmap of the national electric vehicles policy committee.

In 2017, the Thai government began a pilot[33] to convert 100 internal combustion engine (ICE) autorickshaws (tuk tuks) to electric. In this pilot program, the first 10 owners will be granted a 100% subsidy, while the other 90 owners will be granted an 85% subsidy. The Thai government set aside nearly US $2.2 million for the subsidy programme to help the rickshaw business owners to leap conversion. The plan is to convert the country's 22,000 existing LPG (liquid petroleum gas) powered tuk-tuks to electric-powered by 2025.

In 2016, Thailand's Energy Policy and Planning Office (EPPO) set up a subsidised scheme to establish 100 charging stations nationwide for infrastructure readiness and to increase public awareness of EVs. There are currently 693[34] public charging stations & 2285 outlets deployed in Thailand.

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[30] *https://www.aseanbriefing.com/news/thailand-issues-new-incentive-package-for-electric-vehicle-industry/*
[31] *http://www.evat.or.th/attachments/view/?attach_id=258855*
[32] *https://www.rvo.nl/sites/default/files/2021/10/E-Mobility%20in%20Thailand.pdf*
[33] *https://coconuts.co/bangkok/news/thai-ministry-announces-plan-convert-gas-powered-tuk-tuks-electric-vehicles/*
[34] *http://www.evat.or.th/attachments/view/?attach_id=258855*

5.2. Case Study of Delhi

As per Vahan dashboard[35], 1,04,559 passenger e-rickshaws & 9,638 goods e-rickshaws are there on road in Delhi as on Feb-2022. Only 5,891[36] e-rickshaws are registered out of these one lakh e-rickshaws.

Delhi government announced their comprehensive Electric Vehicle policy in the year 2020[37]. Under the Delhi electric vehicle policy, 177[38] three-wheeler models are available and eligible for purchase and scrapping incentives across 68 manufacturers. Currently, there is a cap of one lakh on the number of autorickshaw permits issued in Delhi. Delhi is set to issue 4,261[39] new electric auto permits for the city.

The Delhi state government has reserved a quota of 33% (1,406 slots) for women to drive e-autos. The scheme to allot e-auto permits was launched and successful applicants will be required to purchase the three-wheeler and apply for registration on the single window portal of Convergence Energy Services Limited (CESL). Special features such as the single window system of subsidy disbursement and interest subvention along with a provision of co-ownership with fleet aggregators will make the whole process of registering and owning an e-auto extremely simple. To provide visibility to these vehicles, and to ensure compliance and prevent the misuse of the scheme, the transport department has also notified a special colour scheme for e-autos -- those driven by men will be blue and e-autos driven by women will be lilac.

Delhi Government is also running the Switch Delhi campaign focused on generating awareness of the benefits of e-autos along with benefits offered under the Delhi EV policy.

Within the Delhi EV policy, there is a provision for incentives for e-3wheelers in the form of road tax and registration fees exemption. There are also incentives in the form of capital subsidies and loan subventions, including, a capital subsidy of ₹30,000 available per new e-auto purchased and an interest subvention of up to 5% available for loans or hire-purchase schemes to finance an e-auto. ₹7,500 is available as a scrappage incentive for the replacement scheme if the owner can show proof of receiving the funds from the OEM and a deregistration certificate for the ICE vehicle.

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[35] *https://vahan.parivahan.gov.in/vahan4dashboard/vahan/view/reportview.xhtml*
[36]*https://www.downtoearth.org.in/blog/air/why-e-rickshaws-have-emerged-a-winner-in-transition-to-electric-mobility-race-75767*
[37] *https://transport.delhi.gov.in/sites/default/files/All-PDF/Delhi_Electric_Vehicles_Policy_2020.pdf*
[38]*https://timesofindia.indiatimes.com/city/delhi/3-wheelers-emerge-as-top-ev-choice/articleshow/81130221.cms*
[39]*https://www.hindustantimes.com/cities/delhi-news/draw-of-lots-for-over-4-000-e-auto-permits-in-delhi-1-3rd-reserved-for-women-101644861372686.html*

Delhi government has started scrapping[40] its old petrol and diesel vehicles and procuring electric ones. According to a National Green Tribunal (NGT) order 2021, the use of diesel and petrol vehicles older than 10 years and 15 years respectively is banned in Delhi. With the retirement age for autos set at 15 years, new permits being issued in Delhi have now been reserved for electric autos only.

Figure 11: A battery-operated rickshaw on Rajpath in New Delhi, Source - The Hindu

As per Switch Delhi[41], Delhi has 169 charging stations & 377 charging points. The lack of authorised e-rickshaw charging facilities leads to power theft. Several unorganised setups in Delhi provide bulk charging at night by doing power theft. The e-rickshaw owners pay fixed money (Rs 100-150) for parking and charging facilities[42].

For setting up Public Charging Stations/Battery Swapping Stations (PCS/BSF), Delhi Government will provide land at highly concessional rates, the electrical infrastructure of up to 100kW on each site, and a subsidy of ₹6000/charging point for slow chargers. In the first phase of the policy, Delhi Government will set up close to 500 PCS/BSF across 100 Locations provided by different land-owning agencies in Delhi.

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[40] *https://auto.economictimes.indiatimes.com/news/industry/delhi-govt-replacing-its-old-diesel-and-petrol-vehicles-with-electric-ones/89691181*
[41] *https://ev.delhi.gov.in/charging-station*
[42] *https://www.downtoearth.org.in/blog/air/why-e-rickshaws-have-emerged-a-winner-in-transition-to-electric-mobility-race-75767*

The Delhi government has also set in place a single window process to install EV charging points on their premises. The end-to-end process of selecting EV chargers/vendors, obtaining a new electrical connection, installing charging points, and availing subsidies for chargers will be accomplished through this single unified system.

YC electric, Mahindra electric mobility, Saera electric auto, Champion poly plast, Dilli electric, Bestway, Unique International, Best way agencies, Mini metro, Terra motors & Vani electric are the major players in e-rickshaws. Oye! Rickshaw is the largest e-rickshaw aggregator with a fleet of over 6,000 e-rickshaws in Delhi NCR & Karnal. Battery Smart, Lithion Power, ChargeUp & Okaya power group are also providing battery swapping solutions in Delhi. ElectriVa[43] is planning to install over 50,000 electric vehicle charging stations across the country.

Delhi Metro Rail Corporation (DMRC) has called for an Expression of Interest in the operation of the E-rickshaws from the Delhi metro stations. The E-rickshaws will be plying from 6 am to 11 pm daily and providing last mile connectivity to the nearby localities. The tariff shall be Rs 10/- for the first two Km and Rs 5/- for each subsequent Km or part thereof. One consortium that has been shortlisted is ETO Pvt Limited and Goenka Electric Motor (GEM) Vehicles Private Limited. The commuters can book vehicles through the ETO app and pay digitally. Presently, over 300 e-rickshaws are already providing last mile connectivity service from 36 Metro stations spread across the network and plans are afoot to increase this number to 1000. In its continued efforts to boost last mile connectivity, DMRC will be further introducing e-rickshaw services from 15 more Metro stations.

5.3. Case Study of Amritsar

The smart city governing body of Amritsar city aims the electrification of three-wheelers through subsidies and the key initiative considered is the financial assistance provided in the form of subsidy on vehicle costs and the low-interest loans facilitated by the State Bank of India to owners replacing old Bharat Stage (BS) III emission standard diesel three-wheelers. As of March 2021, 50,000 auto-rickshaws are plying in the city, but only 8,479 of them have been registered with the RTO. Among the registered vehicles 6,747 run on diesel, 1,076 on petrol/CNG, 596 use petrol/LPG as fuel, 54 runs on CNG and only six are electric.

Amritsar has recently launched the RAAHI (Rejuvenation of Auto-Rickshaw in Amritsar through Holistic Intervention) project to transition the city's three-wheeler-based informal public transport system to electric vehicles.

[43] *https://www.livemint.com/companies/start-ups/startup-electiva-wins-contract-for-electric-vehicle-charging-stations-in-delhi-11642081409571.html*

The project is implemented by the Amritsar Smart City Limited (ASCL) as a part of the Ministry of Housing and Urban Affairs (MoHUA) - City Investments To Innovate, Integrate and Sustain (CITIIS) Program.

The e-rickshaw program under RAAHI provides a subsidy of up to Rs 75000 per vehicle. An amount of Rs 15000 is provided upfront to the operator, while the other 60,000 is provided from the back-end into the loan. Through the RAAHI program, Amritsar Smart City Limited[44] has tied up with the State Bank of India to provide loans to e-auto buyers at easy rates of 9.9%, for a maximum loan period of 4 years. A Co-op society has been set up to formalize the many auto unions operating in the city. This Co-op acts as the permanent body for welfare schemes, providing auto operator's families with soft-skill training, and providing technical assistance to auto-rickshaw owners.

Figure 12: E-rickshaws launched under the Smart City Project in Amritsar - Tribune India

Several skilling initiatives for EV ecosystem development have been initiated including short-term technical courses and training and the establishment of skilling centers. Punjab Skill Development Mission (PSDM) in collaboration with Automotive Skill Development Council (ASDC) is planning to introduce courses related to the maintenance and manufacturing of electric vehicles. SkyRide Automotive is one of the pioneers in manufacturing e-rickshaw in Amritsar.

[44] *https://www.smartcityamritsar.com/files/downloads/file-33.pdf*

Punjab EV policy[45] has been developed with the following objectives, designed for direct and indirect impact on multiple UN Sustainable Development Goals (SDGs). Through the EV policy, a special drive for mandatory free registration of existing e-rickshaws will be organised by the Department of Transport. There will be a 100% waiver on permit fees and registration fees and motor vehicle tax during the policy period. Additionally, for vehicles manufactured in Punjab, this waiver shall be applicable for 10 years. SkyRide Automotive is one of the pioneers in manufacturing e-rickshaw in Amritsar

The Punjab policy aims to provide easy access to a public charging facility in 'Target cities', including Amritsar, and major highways over the first 3 years of policy notification. This shall be extended to the entire state over the complete duration (5 years) of the policy implementation.

5.4. Case Study of Hyderabad

As of Jan 2022, there are 4,40,125 rickshaws in the state of Telangana, with 226 e-rickshaws registered, as per Government of Telangana State Transport Department[46]. With appropriate financing support mechanisms and access to permits for electric autos, this is expected to grow thirty times (nearly 20,000) in the next few years. Given the stringent regulation of only the L5 category allowed to ply on roads, deployment numbers have been limited in Hyderabad.

The 'Telangana Electric Vehicle & Energy Storage Policy 2020-2030'[47] builds upon the FAME II scheme being implemented in April 2019 by DHI where it also suggested States offer fiscal and non-fiscal incentives to further improve the use case for the adoption of EVs, including electric 3 wheelers.

The policy proposes a 100% exemption of road tax & registration fee for the first 20,000 Electric 3 Wheelers purchased & registered within Telangana. There is a retro-fitment incentive at 15% of the retro-fitment cost capped at Rs. 15,000 per vehicle for the first 5,000 retrofit 3-seater auto rickshaws in Telangana and finally, financing Institutions shall be encouraged to provide a hire-purchase scheme at discounted interest rates.

The Telangana EV policy aims at a time-bound mandate to be pushed for all auto rickshaws within Greater Hyderabad Municipal Corporation to switch to EV. It will permit corporate ownership of e-auto rickshaws/ to enable entrepreneurship and create local jobs for the economically marginalised segments.

[45] *https://www.transportpolicy.net/wp-content/uploads/2019/12/Punjab_Draft_EV_Policy_20191115.pdf*
[46] *https://www.transport.telangana.gov.in/html/statistics_vehicles.html*
[47] *https://tsredco.telangana.gov.in/Updates_2020/Telangana_EVES_policy_2020_30.pdf*

Ride-hailing services will be encouraged to commercially operate electric 3-wheelers through incentivisation. ETO Motors Pvt Ltd, in coordination with Trinity Group, has launched the ‘Own your ETO’ scheme to support woman drivers in Hyderabad. Under this scheme, women with a license can drive the ETO Motors’ electric three-wheelers from metro stations to passenger destinations and can earn Rs 15,000 every month. Women drivers who ride the EV three-wheelers for three years can purchase the vehicle by paying Rs 50,000 against the actual cost of Rs 3 lakh to ETO Motors. The state government has granted permission to ETO to deploy 250 electric three-wheelers.

Piaggio Vehicles Pvt Ltd (PVPL) launched Ape-E-City, an electric three-wheeler passenger auto vehicle, in Hyderabad. These electric autos can run for 100 km after 4 hours of charging. Skyride is manufacturing electric rickshaws in Hyderabad. Gayam Motor Works, a Hyderabad-based company is providing electric autos to IKEA for its delivery fleet since 2018 and has also been exporting the vehicles. ERide, an EV manufacturing company headquartered in Hyderabad has been chosen to custom make 200 electric loaders as part of a prestigious initiative called “The Livelihood India Project” put forth by the Government of Telangana and Vijaya Dairy.

Figure 13: ETO Motors deploys three-wheeler EVs’ at the ‘Statue of Equality’ inaugurated by Prime Minister, Shri Narendra Modi in Hyderabad. Source - EMobilityPlus

Night-time community parking with charging facility in the PPP mode to be established for e-autos and other shared mobility services. Further to this, land belonging to Government Agencies within Hyderabad will be offered to private players on a long-term lease at subsidised rates and a 2-year moratorium period on rental payment for setting up charging/swapping stations, through a transparent and inclusive bidding process. Provision for charging spots will be made mandatory in all commercial buildings such as hotels, shopping malls and technology parks. In addition, 75% of SGST paid on the fast-charging equipment/machinery procured by any entity for setting up private/public/institutional charging stations will be reimbursed.

5.5. Namma Auto, Bengaluru

The case of the ‘Namma Auto’ intervention in Bengaluru and Chennai offers insights into innovative financing methods for IPT vehicles in the absence of strong initiatives from the government and the banking sector. The intervention is a spin-off of the work done by the social enterprise- Three Wheels United (TWU). The enterprise was started initially as an intermediary to help bring in financing opportunities to operators.

In particular, TWU approached operators who drove rented or aged vehicles and lacked adequate credit history, and who were more likely to be rejected by banking institutions. More critically, apart from providing access to loans, TWU also engaged in building a community around operators. It adopted the joint liability group model to bring together operators into self-help groups to encourage savings, take up insurance policies and enact behaviour change using training and capacity building. Since its inception in 2014, TWU has been reported to have brought together over 15,000 operators across the country, most of them in Bengaluru. It has also grown from being an intermediary linking operators to banks to itself being a non-banking financial institution.

The Namma Auto intervention is a European Union (EU) sponsored project with TWU entering into a consortium to accelerate and scale up their work. Under the intervention, electrification has received significant attention. TWU planned to provide financing for about 500 e-rickshaws and has also engaged with OEMs to build an ecosystem. Apart from Bengaluru, it has expanded its scope to Chennai, Hyderabad and Pune. Under the intervention, a pilot project was launched at the beginning of 2019, where e-rickshaws would-be providers of last-mile connectivity and feeder services to the metro system. State support has also come in the form of Chennai Metropolitan Rail Limited (CMRL) providing free parking and charging facilities for the duration of the pilot, a necessary step in scaling.

The ‘Namma Auto’ model provides an innovative way forward for financing the IPT sector, particularly in the use of self-help groups (SHGs). Collectives and cooperatives provide an opportunity for the sector to organise itself, reducing the risks involved in raising financing as well as improving its bargaining power with the State. The investment in time, expertise and resources was a major cause for the success of TWU and the intervention, demonstrating that quick scaling up might not be possible.

Figure 14: Electric autos in Bengaluru. Source - Citizen Matters, Bengaluru

5.6. Ola’s multi-modal mobility initiative in Nagpur

Ola is one of the top two ride-hailing service providers in India alongside Uber. It started as a taxi-aggregator service and expanded to include motorbikes and auto rickshaws. Ola conducted a year-long pilot study in Nagpur between July 2017 and August 2018 to assess the potential of electric mobility. Touted as a multimodal mobility project, Ola deployed both electric cars and rickshaws. Throughout the project, they claimed to have served 350,000 trips, operating 7.5 million ‘clean’ kilometres, reducing 570,000 litres of fossil fuel and 1230 tons of CO_2 emissions[48].

The utility of Ola is in the provision of dispatch services, thus potentially increasing efficiency for both passengers and operators. However, Ola autos should not be considered as IPT as they continue to operate as a contract carriage substitute for a personal motor vehicle. Even then, Ola’s pilot project is essential for the insights it provides into leasing models.

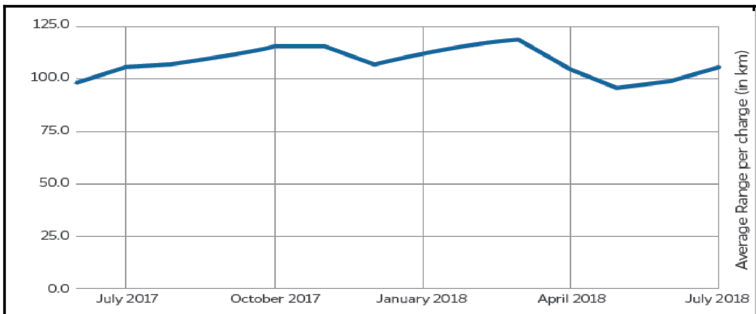
[48] *Beyond Nagpur: The promise of Electric Mobility, 2019*

Ola leased out their vehicles to operators daily at 10% of the cost of an ICE vehicle. Their experience confirmed results from other contexts that due to the current economics of electric vehicles, i.e. high capital costs, lower operations and maintenance costs and the requirement for stable charging infrastructure, private users may hesitate in investing whereas fleet operators can potentially be the early adopters of electric mobility. Due to the low operating costs, Ola reported that the upfront costs would be recovered in five years for a shared vehicle as opposed to 11 for a private vehicle. These figures would be undoubtedly even lower for an IPT vehicle as opposed to that of a cab aggregator.

The project set up a total of 22 public charging points (11 fast chargers and 11 slow) across three locations in the city, including the airport as well as slow charging points at operators' homes. Additionally, they also provided free charging in the first month of the project and charging at 50% rebate afterwards.

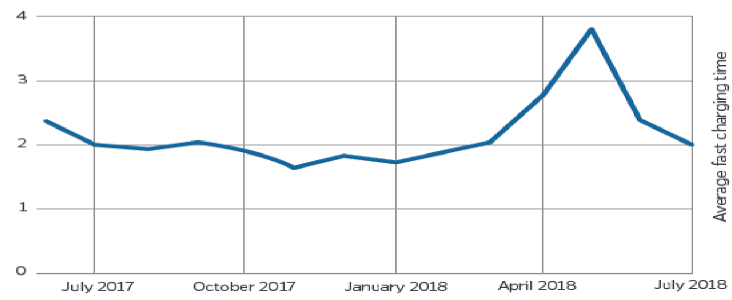
Performance of batteries

The pilot project studied the efficiency of batteries in detail, especially the effect of temperature and weather on the efficiency of charging and battery operations. The key results from the pilot for electric cars, describing the changes throughout all seasons of the year, are presented in the figures below.



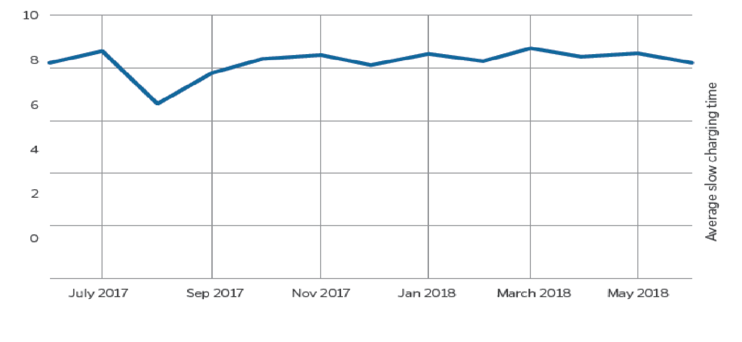
Average range per charge

Differences up to 15% were seen in the range offered by the battery between winter and summer.



Average fast charging time

The seasonal variations were much more apparent in fast chargers, with the temperatures hitting over 45°, above which lithium-ion batteries start to degrade quickly. The electricity consumed for charging during summer was 1.5 times that of winter.



Average slow charging time

Unlike fast chargers, slow chargers provided much more stable performance over the year

Figure 15: Performance of batteries. Source: Ola Mobility Institute, 2019.

For e-rickshaws, Ola used portable slow chargers as well as fast rack chargers. Slow chargers took six hours to charge the 2.8 kWh battery while the fast charger would take only two hours. However, Ola reported that fast charger utilization was just 25% of the installed capacity. It is attributed to the high charging costs as well as a limited fleet size for the same. It became evident during the project that operators of EVs had a running time of 20-25% lesser than ICE vehicles. For e-rickshaws especially, this translated to lower earnings, despite the presence of fast chargers.

The average range per charge was 100 kilometers in summers; it increased to 110-115 kilometers in winters. In summers, when temperatures rose to over 45 C, the charging time increased from 90 minutes to over 200 minutes for a full charge. Considering these factors, Ola considered battery-swapping technology for e-rickshaws a success in Nagpur.

Cost of electricity

A critical insight that the pilot provided was the impact of the cost of electricity on the project’s success. Ola reported two principal concerns, the actual cost of electricity as well as the cost of land to set up the charging infrastructure. At the start of the project, these two components contributed to 62% of the total operating costs with electricity being charged at commercial rates (₹18/kWh). After a special EV tariff was implemented following the publication of the Maharashtra state Electric Vehicle (EV) policy, the electricity cost went down to ₹8/kWh, helping improve the viability of the project.

As multiple other studies have recommended— to have a successful e-IPT infrastructure in place, the cost of electricity will also need to be factored in. Special tariff rates, like Maharashtra and several other states, have put forward in their EV policies, which are very important to ensure that operators can find viable margins from e-IPT vehicles.

Ola reported significant difficulties in renting land for charging infrastructure. Apart from Ola, other organisations and e-rickshaw operators themselves have expressed similar views. It, therefore, becomes imperative for the state to address this issue.

Delhi, in its state EV policy, aims to develop robust public charging infrastructure, with key locations such as bus terminals and depots and metro stations to be covered. Such a move is welcome and should be encouraged as it would be most beneficial for e-IPT, as well as ensuring that it continues to supplement formal public transport systems.

The Ola pilot claims to have saved over half a million litres of import-dependent fossil fuel and reduced CO_2 emissions by over 1,230 tons. However, significant difficulties in renting land for charging infrastructure — are an issue that still needs to be addressed through a robust policy and regulatory framework.

Figure 16: Ola electric three-wheelers. Source: Auto Futures

5.7. Other Initiatives

In Bengaluru, OEMs such as ETO Bukle Plus have been designed to carry logistic loads and personal use with a 148-kilometre travel range. It utilizes a lithium-ion battery with a recharge time of 3.5 to 4 hours and the capacity of the battery is 9.4 kwh. ETO has signed an agreement with Uber where their vehicles are onboarded on the Uber platform and run for a specific number of hours per day[49].

E-Rickshaw, eBlu – operated by Godawari E-mobility Private Limited, a Raipur-based company – has been offering the vehicles with a refundable down payment of Rs 15,000/- and daily rent of Rs 350/- for three years after which the ownership will be transferred to the driver[50]. The e-Rickshaw comes with a 1000-day warranty, can go up to a maximum speed of 25 Kmph and its 90AH Li-ion battery gives mileage of 90 km per charge and can be charged up to 2000 times. It has also designed delivery vans based on the same base chassis to diversify into segments like cargo delivery as well. The company is making inroads into the Tier-2 and Tier–3 cities of Chhattisgarh, Madhya Pradesh, Bihar, Uttarakhand, Delhi-NCR, Haryana, Maharashtra and Punjab and is eyeing further expansion to South India. As of October 2021, the company has onboarded around 1,100 vehicles and the plan is to bring on an average of about 150 vehicles per month which is expected to go further up to 200 - 250 vehicles. [51] The company is developing manufacturing facilities in India given the increasing demand.

Another reputed battery maker Exide Industries has made a foray into e-Rickshaw by introducing its product Exide Neo which has a capacity for 4 passengers and can run up to 120 Km per charge. The battery is presently Lead Acid based one while the company plans to develop the Li-ion battery-based e-Rickshaws as well.

5.8. Upcoming Innovations

In the realm of e-mobility, participation from the private sector, especially from start-ups, is accelerating. The majority of innovations have focused on battery and charging technology; however, several stakeholders are attempting to develop an ecosystem for electric vehicles. Two-wheeler manufacturers such as Ather motors have diversified and moved on to building charging infrastructure to drive the adoption of EVs. In the case of e-IPT manufacturers, OEMs such as Mahindra and Kinetic have prioritized the development of smartphone applications that aim to provide the operator with trip and battery performance data.

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[49] *https://ces.asci.org.in/resources/stakeholder-driven-solutions-for-financing-electric-mobility/*

[50] *https://www.eblu.in/article.html*

[51] *https://economictimes.indiatimes.com/industry/renewables/godawari-e-mobility-to-invest-up-to-rs-150-cr-by-2023-for-setting-up-ev-manufacturing-unit-in-raipur/articleshow/87235822.cms?from=mdr*

E-rickshaws are more sustainable than motor-powered three-wheelers because they are powered by lead-acid and lithium-ion batteries that can be recharged using clean energy. In recent times lithium-ion batteries have gained attention in the market due to their longer travel range. However, lithium-ion batteries are costlier than lead-acid batteries. A Sri Lankan manufacturer has designed a Vega ETX three-wheeled electric vehicle with a solar roof, which is one of the emerging inventions[52]. The vehicle is powered by an electric motor that draws energy from Lithium Iron Phosphate (LFP) battery packs to maintain affordability. The manufacturer anticipates that a battery can travel approximately 64 kilometres per day.

SmartE, another notable private participant, has created an application on the model of Ola and Uber, but exclusively focused on connecting commuters and e-rickshaws as the last mile connectivity service. SmartE has also tied up with the Government of NCT Delhi to create an ecosystem for e-rickshaws and building charging stations. For operators, the mobile application helps to book a spot at the charging location, thus ensuring efficiency and time savings.

My Safar, Kinetic's Android application for the Safar e-rickshaw

Smart E e-rickshaw charging station in Dwarka, Delhi

Figure 17: Innovations in e-rickshaws

The impact of these apps has not been significant due to the low proliferation of EVs on the streets. Lessons from other examples around the world show that this could be quickly rectified, which has been demonstrated by Gogoro in Taiwan. The success of Gogoro lies in its creation of an extensive network of battery swapping stations for e-scooters, with one station present within 1.3 kilometers of a customer. The company is utilizing artificial intelligence (AI) and advanced algorithms to help ensure the availability of batteries to the riders.

[52] *https://www.rushlane.com/vega-etx-electric-rickshaw-with-solar-roof-12410727.html*

Source - Honda

06 Way Forward

Indian cities are witnessing rapid urbanization and trying to serve the growing mobility needs. In the absence of formal public transport, IPTs have evolved as a substitute in most Indian towns. Ironically, even though IPT ensures connectivity and accessibility, they are perceived as a cause of congestion and nuisance by the city administration— highlighting the need for regularization. While efforts have been made by a few cities to regularize the operation of IPT vehicles, weak enforcement has led to inadequate results.

The new push by the government and market forces toward electrification of vehicles provides the city government with an opportunity to regularize the sector by facilitating a transition of IPT towards electric mobility. Cities need to engage with the stakeholders to improve the policy and regulations and streamline the current operations of auto-rickshaws/e-rickshaws. This can help the city create a robust transportation system with integration across different transportation modes.

Right now, there is a disparity in the cost between diesel/CNG rickshaws and electric rickshaws. As seen in the case of Jharkhand, lack of access to financial resources became a roadblock to a large-scale shift to electric mobility. Easing access to formal financing options can therefore boost the IPT ecosystem. It can ensure that the debt burdens of operators would be significantly reduced, leading to greater financial security for households. With this concern removed, operators could turn out to be amenable to regulatory measures and newer operating models such as the Gross Cost Contract.

A significant issue with IPT is also a heavy reliance on cash transactions after most journeys. To mitigate this, as a next step, the mechanisms to integrate the fares and provide digital payment solutions such as standard mobility cards, QR-based payment methods etc. can be explored by the authorities.

Electrification of rickshaws provides an opportunity to develop a practical regulatory framework for India's IPT sector across cities. The stakeholder's actions needed to be taken at the three levels local, state, and national. Additionally, there is limited consensus in framing the policies among the urban & transportation planners, regional transport offices, municipalities, and the IPT unions. There is a need for a comprehensive study of individual departments' roles in IPT sectors.

The electrification of the IPT sector has the potential to reduce local air pollution and carbon emissions. However, due to India's reliance on coal for electricity generation, electric vehicles would emit more carbon dioxide than conventional internal combustion engines (ICEs). The latest battery technologies enabling the reduction of coal use could enhance environmental sustainability. Switching from a traditional IPT fleet to an electric fleet has no effect on reducing road congestion. As a result, electrification cannot be viewed as the sole goal of the IPT sector.

There is a need for research into financial models associated with a total cost of ownership and high down payments that prevent people from purchasing electric vehicles. Furthermore, case studies from India show that subsidies, incentives, and regulations for e-rickshaws vary. The geographical location could have different outcomes in planning e-rickshaws demands, charging facilities, operational costs, licensing, and regulations. Therefore further research is required on inequalities and common agendas to drive e-rickshaws forward.

07
Annexure

Table 1: Specifications of a 3 seater and 4 seater electric three wheeler[53] [54]

Parameters	3seater e-3wheeler	4 seater e-3wheeler	
	Mahindra Treo	E-Trio	Treo
Dimension L xWx H (mm)	2769 x 1350 x 1750	2980 x 1450 x 1890	2769 x 995 x 1750
Wheelbase – mm	2073	1955	2073
Ground Clearance -mm	142	180	142
Turning Radius – m	2.9		2.9
Vehicle Kerb Weight - kg	377	490	276
Top Speed – km/h	55	50	24.5
Certified Range- km	141	NA	125
Driving Range- km	130	85	85
Gradeability – degree	12.7	7	7
Battery Type, Voltage	Li, 48V	Li, 48V	Li, 48V
Battery Capacity – kWh	7.37	7.6	3.69
Charging Time	3 h 50 min	5 h 30 min	2 h 30 min
Peak Power – kW	8	8	1.95

[53] *https://www.mahindraelectric.com/vehicles/treo-electric-auto/*
[54] *https://www.etrio.in/touro.html*

Table 2: Specifications of 6 seater electric three wheeler

Parameters	Lovson	Vidyut	Bajaj
Dimension L x W x H (mm)	2960 x 1470 x 1850	3250 x 1530 x 2000	3020 x 1200 x 1950
Wheelbase – mm	1900	2270	
Ground Clearance -mm	135	140	250
Turning Radius – m		3.5	
Maximum GVW - kg	1130	Not Specified	600
Top Speed – km/h			25
Certified Range- km			
Driving Range- km	80	189	100
Gradeability – degree		7	20
Battery Type, Voltage	Li, 48 V	Li, 72 V	Li, 60 V
Battery Capacity – kWh	7.3	16.2	7.2
Charging Time	3-4 hours	8-9 hours	6-8 hours
Peak Power – kW	9	5.9	

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