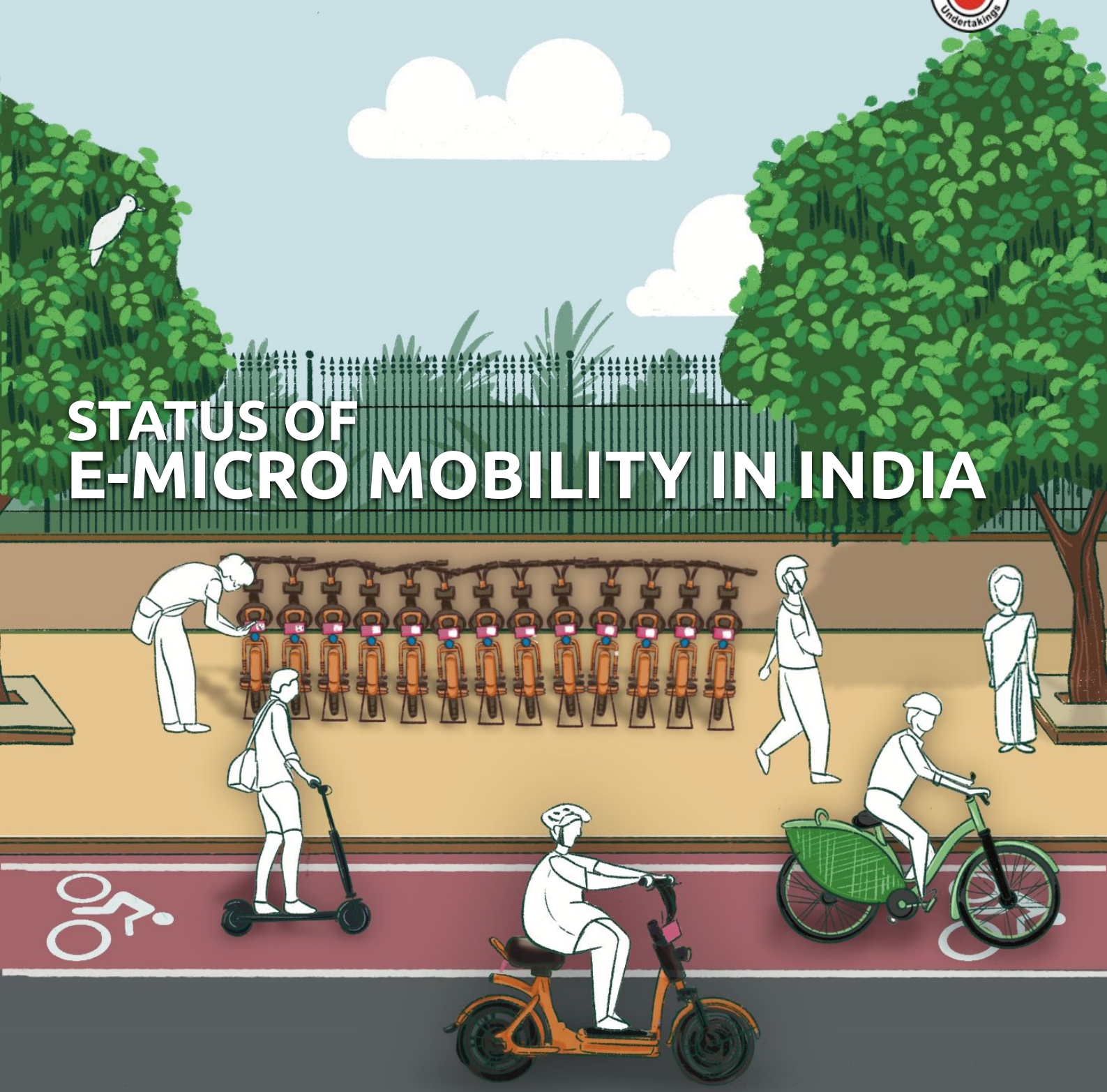
ITDP INDIA

Association of State Road Transport Undertakings

STATUS OF E-MICRO MOBILITY IN INDIA



As part of the project

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

June 2022

Prepared by

The Institute for Transportation & Development Policy (ITDP) is a global 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. ITDP is represented in India by ITDP Pvt Ltd and works with governments, multilateral agencies, and civil society to make visible, on-the-ground improvements by providing technical expertise, policy solutions, research publications, and training programmes.

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Preface

Micromobility solutions such as bicycles and scooters - electric as well as non-electric - offers a great alternative to address the first and last mile connectivity, air pollution, noise pollution and congestion. Micromobility devices have potential to reduce the reliance on motorized two-wheelers in the Indian cities; and in turn reduce the demand of the petroleum products. In many of the cities of the world, the number of micromobility devices is starting to outnumber the number of cars.

This report discusses the Electric micromobility technology and the various vehicles available in the market. It talks about the micro-mobility market around the world. Though the COVID-19 pandemic caused many of the micromobility companies across the world to shrink or shut down their operations, the micromobility services have bounced back more quickly than other modes of transportation, mainly because of the safety it provided to the users for commuting, resulting in surge in direct-to-consumer demand.

Since the micromobility vehicles are emerging segment, governments across the globe are coming up with their rules and regulations, regarding the classification of the micromobility vehicles based on their power, maximum speed and other criteria, requirement of registration and use of personal protective equipment and allocation of road space. This is of utter importance as the safety of the rider as well as other road users like pedestrians is concerned. The report also talks about the policies and initiatives to promote the e-micormobility in India.

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Source - WorldBankGroup

01

Introduction to Micro-mobility

As a recent trend still in the nascent stages of use in most countries around the world, micro-mobility lacks a standard, agreed-upon definition. The mode has either been described in terms of vehicle specifications - dimensions, number of wheels, weight, payload capacity, power train, range, the availability of a seat (Zarif, 2019), or in terms of usage - passengers per vehicle, typical distances covered per trip, etc. The latter is particularly common in the media coverage of micro-mobility, or the operation of dockless, ride-sharing services in cities using electric variants of bicycles, push scooters and motor scooters.

Regulations, meanwhile, have focused more on vehicle specifications. In the United States, for instance, two or three-wheeled electric vehicles

- equipped with an electric motor with an output of less than 750 watts, and functional pedals
- not capable of exceeding a speed of 20 miles per hour (32 km/h)

are called 'low-speed electric bicycles'[1]. Minus the functional pedals, they are termed 'electric two-wheeled vehicles'[2]. In India, these vehicles are called 'Battery Operated Vehicles'[3], so long as the motor output is less than 250 watts and the speed of the vehicle does not exceed 25 kilometres per hour. Singapore refers to e-bikes and e-scooters as 'power-assisted bicycles' and 'personal mobility devices' respectively[4].

While micro-mobility in the United States and Europe is more synonymous with electric variants of bicycles (e-bikes) or push scooters (e-scooters), the mode also includes electric versions of motor scooters in a few countries including India. As such, this report uses the terms 'low-speed electric two-wheelers' and 'micro-mobility vehicles' interchangeably to generically refer to these vehicles, which are shown in Figure 1. Where the context may be specific to a particular vehicle, the terms 'e-scooter' or 'e-bike' have been used. This report is concerned only with the shared usage of micro-mobility vehicles and not their private usage.

The number of micro-mobility vehicles is starting to outnumber the number of cars in many countries. China has over 300 million electric bicycles (e-bikes) in use, Japan has about 72 million e-bikes, Brazil has 40 million e-bikes and the US has over 100 million e-bikes. With electrification, this largely unmeasured category is gaining a significant modal share and impacting the way we travel.

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[1] *US Code 2085: https://www.law.cornell.edu/uscode/text/15/2085#b*
[2] *NHTSA, 2009: https://www.nhtsa.gov/interpretations/08-002289as*
[3] *Central Motor Vehicles Rules, 1989*
[4] *Road Traffic Act, Chapter 276, Government Gazette, 2018*

One global estimate indicates that the market size for e-bikes and e-mopeds in key markets like Europe, the USA, China and India to be 120 million units by 2035[5]. Given the growing number of brands and models in electric kick-scooters and electric bicycles as well as rental and sharing services using these vehicles, the micro-mobility market size is expected to surpass around ₹15.4 trillion ($198.03 billion) by 2030, growing at a CAGR of 17% from 2021 to 2030.

Figure 1: Shared micro-mobility vehicles around the world

1.1. Existing scenario and need for micro-mobility in India

Road-based transport contributes about 87% of the total transport emissions[6] which include carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O), and pollutants such as carbon monoxide (CO), Non-Methane Volatile Organic Compounds (NMVOCS), sulphur dioxide (SO2), PM and oxides of nitrate (NOx)[7]. On-road diesel vehicles were responsible for nearly half of the health impacts of air pollution from vehicles worldwide in 2015, and two-thirds of the impacts in India[8].

[5] *CB Insights and Trucks*
[6] *Sharma, S., et al. "India-California Air Pollution Mitigation Program (ICAMP)." (2013)*
[7] *Task Force on National Greenhouse Gas Inventories of the Intergovernmental Panel on Climate Change (IPCC), 2006*
[8] *A global snapshot of the air pollution-related health impacts of transportation sector emissions in 2010 and 2015, ICCT*

Studies suggest that the most vulnerable population, including children, and the elderly are exposed to higher levels of pollution.[9] Cities well serviced by public transport tend to have lower per capita emissions improving air quality and overall public health.[10]

Micro-mobility solutions in India such as electric bikes, scooters and bicycles address air pollution problems at a low level. India is currently the world's fourth-largest consumer of energy, trailing China, the United States, and Russia (with a total energy consumption of 638 million tons of oil equivalent). Most of the country's energy demands are met by the production of coal and the import of crude oil[11]. These energy sources pose a serious threat to environmental conditions across the countries.

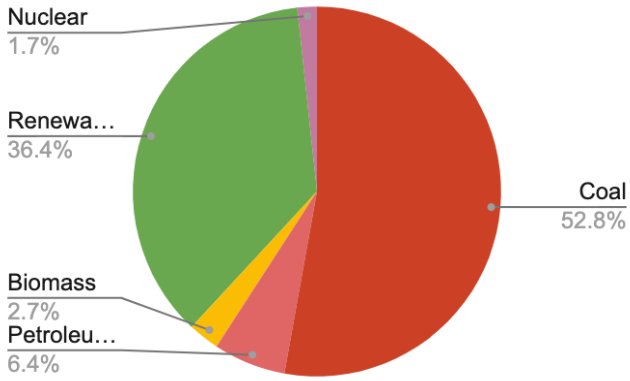

Figure 2: Percentage bifurcation of energy sources in India[12]

Cities like Delhi, Mumbai and Kolkata are already suffering from excessive pollution due to the burning of coal and petroleum in vehicles. Over 40% of the oil and oil products are used up in the running of vehicles[13]. An analysis of 14 cities in India by Delhi-based CSE (Centre for Science and Environment) found that urban commuting is one of the most intensive pollution contributors.

[9] *Royal College of Physicians. Every breath we take: the lifelong impact of air pollution. Report of a working party. London: RCP, 2016; The toxic school run, UNICEF, 2018; Air pollution and child health: prescribing clean air, WHO, 2018*
[10] *CSE – Urban Commute, 2018*
[11] https://techstory.in/facts-electric-scooters-india/
[12] https://powermin.gov.in/en/content/power-sector-glance-all-india accessed on 6th July, 2022
[13] https://www.cseindia.org/the-urban-commute-8950

The study reveals that cities with high population, higher vehicular travelled kilometers (VKT) and higher vehicular stock are facing major pollution challenges and require drastic measures to integrate sustainable urban mobility strategies with clean fuels to mitigate these effects.

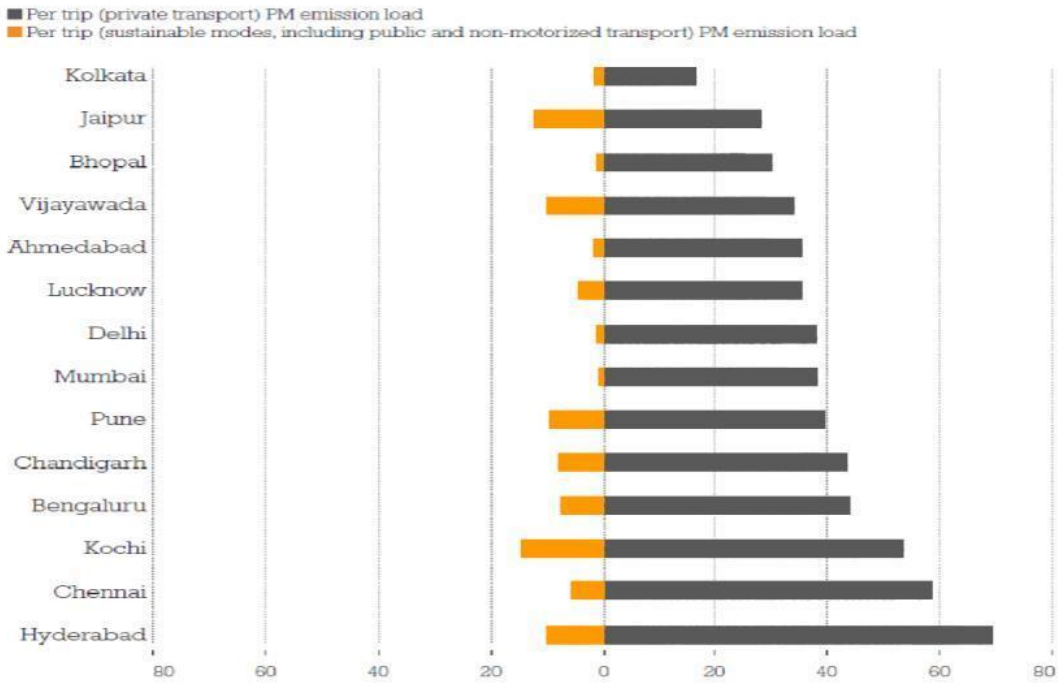

Figure 3: Particulate emission load per trip from private and public modes of transport (gm/year)[14]

The issues of air quality and transit deserts are common in Indian cities as well, as understood from major national initiatives promoting public transportation and clean vehicle technology. Currently, the transport sector in India is a major consumer of crude oil for daily commuting. Though cities have responded with investments in public transport - metro rail networks, in particular - several issues, including poor last-mile connectivity and reliability of bus systems, remain major concerns affecting public transport patronage.

[14] Who pollutes and guzzles more from urban commute? (CSE, 2018)

1.2. Benefits of micro-mobility

1.2.1. Reducing India's dependence on two-wheelers

45% of all trips by two-wheelers and cars in Urban India are less than 5 km[15], which can be easily shifted to electric micro-mobility and IPT. These are distances typically covered sooner and more conveniently on two-wheelers than by using public transport in most Indian cities. The motorized mode share of two-wheelers in major Indian cities is very significant, as shown in Figure 4, which will have an immense impact on fuel consumption and tailpipe emissions correspondingly if replaced by micro-mobility options. With electric micro-mobility, Indian cities can reduce conventional two-wheeler usage, owing to its lower costs of ownership and usage. The starting price of an e-scooter in India is as economical as ₹37,000 ($474) which makes it very competitive compared to conventional two-wheelers running on petrol[16]. Under the Indian scenario, micro-mobility devices can act as the preferred mode of travel in cities for rides up to 5 kilometers, and act as a potential mode to replace two-wheelers.

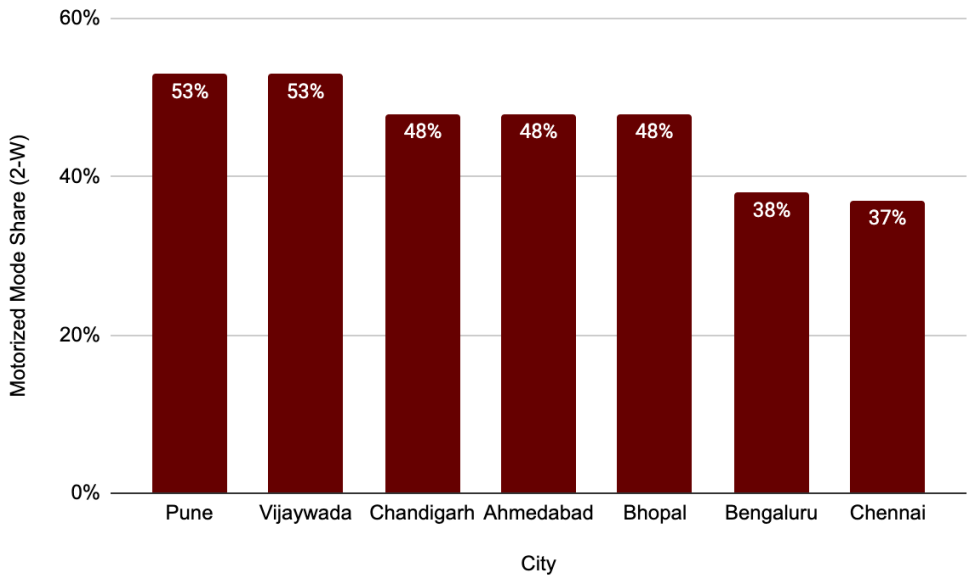

Figure 4: Mode share of Motorized Two-wheelers in Indian Cities (2017)[17]

[15] 2011 Census
[16]https://www.themobileindian.com/picture-story/top-20-cheapest-electric-scooters-available-in-india-1292-14018
[17]The Urban Commute, Centre for Science and Environment, (Anumita Roychowdhury and Gaurav Dubey), 2018

When powered with electric motors, micro-mobility devices also have an advantage over two-wheelers in terms of tailpipe emissions, any potential reduction of which could significantly improve air quality in most of our polluted cities. According to a Greenpeace study, air pollution costs India ₹11.7 trillion ($150 billion) a year[18], two-thirds of deaths from air pollution in India can be attributed to exhaust emissions from diesel vehicles, which were responsible for nearly 385,000 deaths in 2015[19].

1.2.2. Aiding the Mobility of Persons with Disability

Micro-mobility devices are capable of being operated on the roads as well as indoors and could make lives easier for persons with special needs and disabilities. Research has found that these devices, already in use in Japan and some other countries, are essential in providing an active life to those with declining abilities. This makes them essential in a country where most public transportation modes are not suitable for use by people with special needs. The Department of Empowerment of Persons With Disabilities, in its 2017-18 Annual Report, found only 9.1% of all buses in the country were "provided with accessibility features". It should be noted that 'accessibility features' here may not necessarily mean a ramp or wheelchair harness and could instead indicate the presence of audio announcements and other amenities accessible only upon boarding the vehicle[20].

Figure 5: Access for disabled. Source - Swachhindia NDTV

[18] *https://www.livemint.com/news/india/air-pollution-costs-india-150-billion-a-year-11581533636013.html*
[19] *https://economictimes.indiatimes.com/news/politics-and-nation/majority-of-air-pollution-deaths-in-india-linked-to-diesel-vehicle-emissions-study/articleshow/68184315.cms?from=mdr*
[20] *https://www.itdp.in/micro-mobility-devices-what-could-they-mean-for-india/*

1.2.3. How micro-mobility is replacing other modes of transportation

Figure 6: Innovations by Yulu that changed daily commute. Source - YULU

A new study[21] conducted in Zurich, Switzerland in 2020, shows that shared micro-mobility vehicles are more likely to replace public and shared transport for the daily commute, followed by trips on bikes, and cars. Micro-mobility modes are least likely to replace walking trips. The micro-mobility substitution rates derived from the study are summarized in Figure 7.

OSTARA ADVISORS	% of substitution by Owned e-Bike	% of substitution by Shared e-Bike
	9%	9%
	29%	43%
	48%	19%
	14%	29%

Figure 7: Transport modes that micro-mobility replaces

[21] *https://www.sciencedirect.com/science/article/pii/S1361920921004296?via%3Dihub*

Source - iStock

02

E-micro-mobility Technology

2.1. Technology required for the operation of electric bikes

An e-bike is powered by an electric motor, attached to the bottom bracket or front wheel. E-bike uses the same designs, geometries, and components as any other bicycle, but also includes an added electric motor. It is fueled by a rechargeable battery, which gives an extra boost of power and ultimately provides a smoother, more convenient, and less strenuous cycling experience[22]. There are four key parts to an electric bike: the battery, the motor, the sturdy frame and spokes, and the brakes[23].

2.1.1. Batteries

The batteries are the most important parts of an e-bike because they contain all the power that will drive the vehicle along. Typical electric bike batteries make about 350–500 W of power (35–50 volts and 10 amps). Lightweight lithium-ion batteries, similar to those used in laptop computers, mobile (cellular) phones, and MP3 players, are used in e-bikes. The batteries are capable of delivering a range of 15-65 km between charges (depending on the terrain) and a top speed of 25 kmph (maximum speed allowed in India as per standards).

Figure 8: Batteries are generally placed at the down tube

[22] *https://evelo.com/blogs/ebike-buyers-guide/an-introduction-to-electric-bikes*
[23] *https://www.explainthatstuff.com/electricbikes.html*

2.1.2. Electric motor

Electric bikes have compact electric motors built into the hub of the back or front wheel (or mounted in the center of the bike and connected to the pedal sprocket) which is much fatter and bulkier than on a normal bike. It is generally integrated into the rear or front wheel. When engaged, it pulls or pushes the wheel along[24].

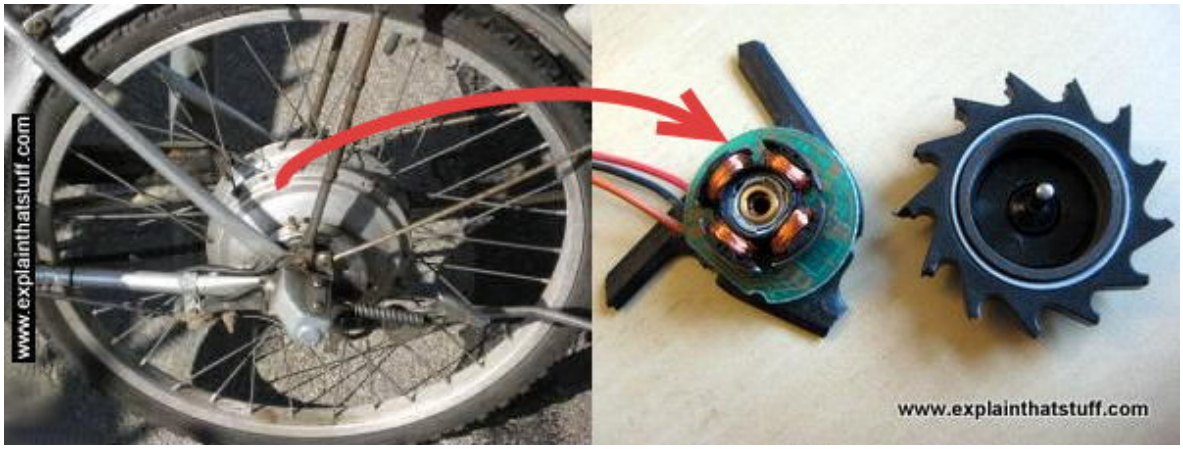

Figure 9: The hub motor of an electric bike

There are two main kinds of electric cycles, broadly known as full-power and power-assist, and they differ in the way they're powered by the electric motor:

- **Full-power**: These bikes are designed for minimal pedalling over relatively short distances. They have large batteries and powerful hub motors and they tend to be big, sturdy, and heavy.
- **Power-assist / Padelecs**: They have a pedal assist mode which supplies power from the electric motor while pedalling, giving an extra push to the rider. The electric assistance starts to help the user only when pedalling starts. The motor is mounted near the rear wheel and the amount of power supply can be selected based on different levels of power assist. Unlike full-power bikes with minimal or no pedalling, these bikes require the riders to pedal while receiving power from the motor, however, the pedalling efforts required are minimal.

[24] *https://evelo.com/pages/electric-bikes-101*

2.1.3. Frame

The frame of an electric bike is slightly different from conventional bikes. The main part of the frame (that supports weight) is usually made from lightweight aluminium alloy: the lighter the frame, the lighter the weight of the bike overall, and the further it can travel without charging. The spokes on the wheel are also stronger than the thin spokes on a traditional bicycle so that the electric motor in the hub spins the wheel with a lot of turning force (torque).

2.1.4. Brakes

In recent times, many electric bikes work on regenerative braking. Under this technology, when pedalling the bicycle or going downhill, the spinning wheels turn the electric motor in the hub in reverse and start charging up the batteries. In practice, regenerative braking is nowhere near as useful on an electric bicycle as it is on an electric car or bus since the energy captured depends directly on the kinetic energy and in turn the vehicle mass and speed and battery capacity. Though small, it can still provide an added advantage by giving an added range of up to 5%[25].

Figure 10: E-Bike Brakes. Source - Area13

[25] *https://electrek.co/2018/04/24/regenerative-braking-how-it-works/*

Source - ggwash.org

03

Micro-mobility Market Around the World

3.1. Introduction

The presence of electric bicycles and electric scooters in major cities dates back to the 1980s in China, where the high cost of ownership affected their popularity for a decade until incentives were announced by national and regional governments. The adoption of electric two-wheelers in China can be divided into three phases:

Phase 1: In the 1980s, high costs undermined the mass usage of these devices. The quality of batteries available during this time was poor in terms of performance and lifetime, and added to the cost of owning an electric vehicle, making it more expensive than a conventional motorbike.[26]

***Phase 2*:** In the early-1990s, e-bike usage was encouraged as part of the Chinese government's push for energy efficiency. E-bikes were more affordable as a result but failed to gain popularity as people continued using conventional motorbikes that they had relied on for decades.

Phase 3: Major cities including Shanghai and Guangzhou subsequently banned the usage of motorbikes, thus leading to the mass adoption of electric two-wheelers in China.

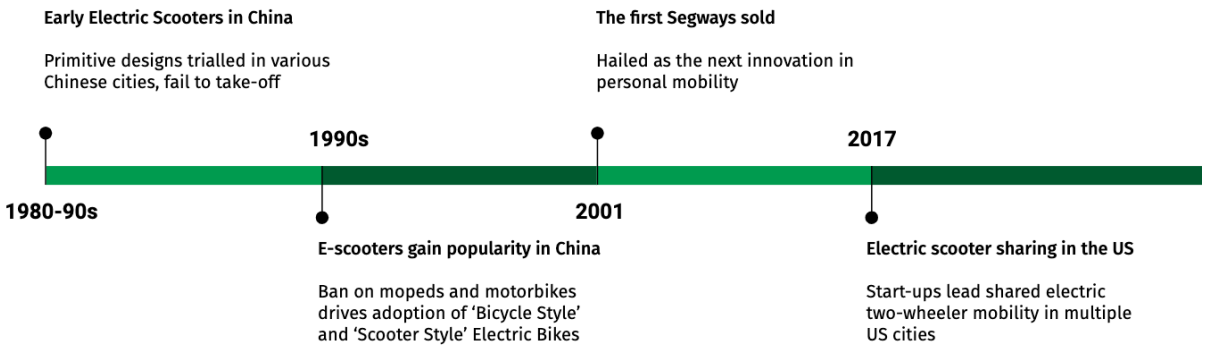

Figure 11: Four decades of micro-mobility

[26] *Jonathan Xavier Weinert, The rise of Electric Two-wheelers in China: China:Factors for their Success and Implications for the Future, 2007*

3.2. Worldwide scenario of e-bike[27]

In 2016, Asia Pacific accounted for the largest share of global e-bike sales, while the Chinese market was the largest. Germany, the Netherlands, France and Italy accounted for more than 68% of e-bike sales in 2016.

Table 1: Worldwide e-bike sales, 2016

Worldwide sales of e-bike	Sales in units
The Asia Pacific	32,800,000
Western Europe	1,600,000
North America	150,000
Latin America	90,000
The Middle East and Africa	70,000
Eastern Europe	40,000
Total	**34,750,000**

3.3. Region-wise growth analysis of e-bike

3.3.1. Europe:

Sales in Europe in 2017, 2018 and 2019 were 2.2 million, 2.78 million and 3.33 million respectively, with growth rates of 25.6%, 26%, and 19.8% respectively. According to Technavio's (a leading market research and advisory company with global coverage) forecast, the average annual growth rate of e-bike sales in the European market is 18% from 2017 to 2022 or 4.5 million e-bikes in European Market.

[27] *https://www.fwheel.cc/e-bike-market-research-report-from-dyu-fwheel/*

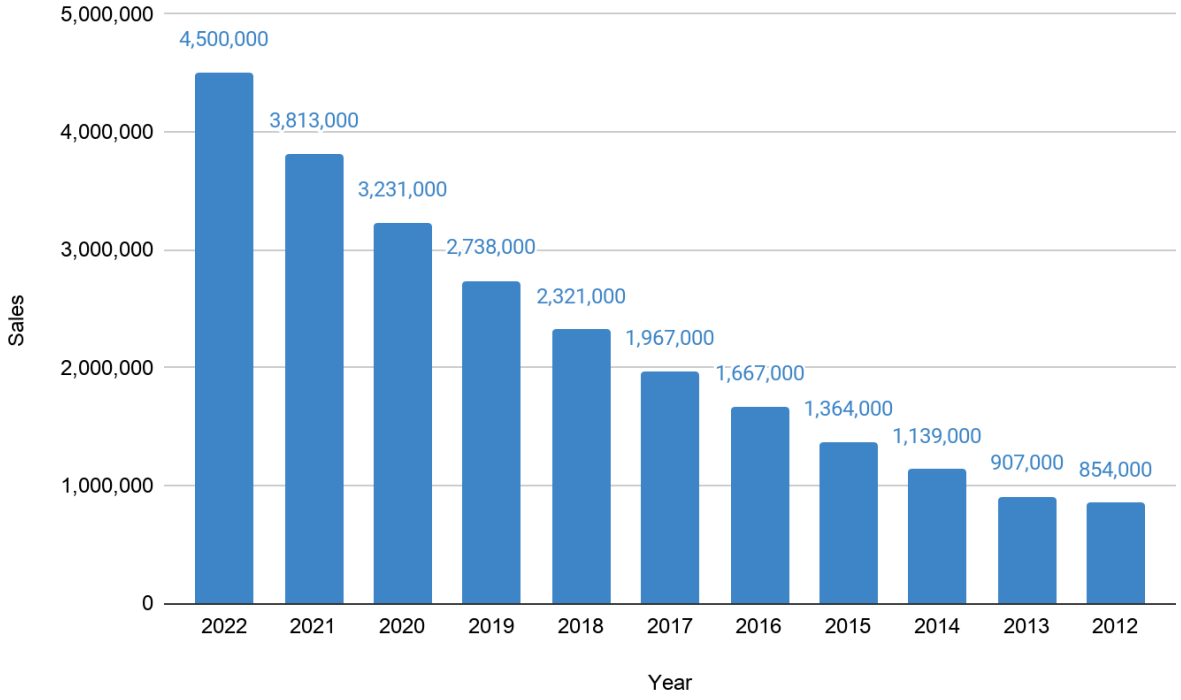

Figure 12: E-bike sales trend in Europe

According to the annual report of the CONEBI Association in 2016, the top three occupancies of e-bikes per 1,000 people were in the Netherlands, Belgium and Austria, while the top three total sales were in Germany, the Netherlands and Belgium.

Table 2: E-bike scenario in Europe (2016)

Country	E bike-sales	Population (thousand)	e-bike sales/1000 people	e-bike percentage of total bike sales
Germany	605,000	82,790	7.3	15%
Netherland	273,000	17,080	16.0	29%
Belgium	168,000	11,350	14.8	31%
France	134,000	67,120	2.0	4%
Italy	124,000	60,590	2.0	7%

Austria	87,000	8,773	9.9	22%
England	75,000	66,020	1.1	2%
Denmark	45,000	5,770	7.8	9%
Sweden	45,000	9,990	4.5	8%
Spain	40,000	466,570	0.9	4%
Finland	20,000	5,500	3.6	6%
Zec	15,000	10,580	1.4	3%
Poland	10,000	37,970	0.3	1%
Ireland	4,000	4,780	0.8	2%

The European Commission is committed to reducing carbon emissions in transportation by 60% by 2050. The EU members have reached a consensus that they are committed to energy conversion in the transport sector, namely “oil to electricity”, promoting clean energy and promoting the development of the lithium-ion travel industry.

Consumers have a high acceptance of lithium vehicles and a strong consumer capacity. The average price of an e-bike in Europe is 1,000 euros (~₹80,000). The European market has a strong bicycle travel base. Bicycle and e-bike sales have stabilized at more than 2 million vehicles in the past 10 years. On the supply side, bicycles and e-bike requirement in the European market is more than 12 million vehicles, of which at least 8 million are imported annually.

E-bike sales have increased rapidly over the past three years. The share of e-bikes is growing rapidly in Europe. Due to the consumption concept and product appearance and function, more demand is shifting from traditional bicycles to e-bikes.

I. **Germany:** The sales of electric bicycles in 2015, 2016, 2017 and 2018 were 530,000, 600,000, 720,000 and 850,000 respectively, with steady growth rates of 13%, 19% and 18% respectively. In 2021 the sales reached 1,200,000 with an increase of 9.1% from 2020. According to the Federal Bureau of Statistics, the share of imported electric bicycles was 32% in 2021.

Characteristics of E-cycle usage in Germany

- In 2001, the German Federal Government implemented the "National Cycling plan, 2020", the government financially supports and promotes bicycle travel with an annual budget of 3.2 million euros (~₹257 million).
- In May 2017, Germany introduced a new road traffic safety law StVZO, which revised the requirements of bicycles and electric bicycles. Bicycles and electric bicycles with speeds of no more than 25 km/h are grouped into one category, which adds more lighting functions to bicycles.
- According to Zweirad-Industrie-Verband (ZIV) data, more than 2.5 million electric bicycles are currently travelling on German roads. Consumers' willingness to buy e-bikes has been steadily increasing.

II. **Netherlands:** The Netherlands has a population of 17 million with more than 20 million bicycles, of which 2 million are electric bicycles. The sales of electric bicycles in the Netherlands in 2015, 2016 and 2017 are 275,000, 271,000 and 294,000 respectively, with steady growth. From 2008 to 2016, sales of Dutch traditional bicycles have been declining, while since 2012 sales of electric bicycles have been rising. In recent years, however, owing to the COVID pandemic e-bike sales have declined by 12.5% from 549,000 in 2020 to 479,960 in 2021 but with a higher market share of 52%[28].

Characteristics of E-cycle usage in the Netherlands

- Consumer population is younger but the trend from 2013 to 2016 is that cyclists are getting younger gradually, but still mainly 65+ of age.
- 66% of Dutch people commute between 15 km and 7.5 km, and most of them choose bicycle travel. Electric bicycles extend the distance of bicycle travel and will become a substitute for the demand for automobile travel within 15km in the future.
- The proportion of electric bicycles used for daily travel and work has increased significantly.

[28] *https://www.bike-eu.com/42402/dutch-e-bike-and-bicycle-market-shrinks-by-15-9-in-2021*

- The Fietsersbond Association (the first cycling association in Netherlands[29]) plans to propose to the government that fast bicycle lanes and bicycle lanes be used as electric bicycle driving roads.

III. **France:** France has a good bicycle infrastructure. In the past, the sales of e-bikes in France grew rapidly. The sales volume of e-bikes in 2015, 2016 and 2017 were 102,000, 134,000 and 200,000 respectively, with growth rates of 32%, 31% and 49%, respectively. The average selling price was 1,500 euros (₹121,000). In 2021, the sales of e-bikes have set a new record at 659,337 units sold, an increase of 28% from the previous year[30].

Characteristics of E-cycle usage in France

- On February 16, 2017, the French government granted a subsidy of 200 euros (₹16,000) under EPAC (Electric Pedal) policy.

3.3.2. *USA*:

The U.S. e-bike sales were 273,000 and 368,000 in 2020 and 2021 respectively. The number of trips recorded using shared micro-mobility services has also been on a rise in the USA, with 35 million rides in 2017, 84 million in 2018 and 136 million in 2019[31].

Characteristics of E-cycle usage in the USA

- The US Government imposed a 25% tariff on imports of electric bicycles and accessories from China, while the United States does not have a corresponding industrial base. Supply chains for motors, batteries and other accessories need to be imported from China.
- Differences in consumption concepts: For Europe, most regions believe that any type of bicycle is a means of transport, the corresponding cultural basis, and the rapid growth of the electric bicycle market. American consumers believe that bicycles are a tool for sports, fitness and entertainment, and the way of transportation is a car.

[29] *https://www.fietsersbond.nl/english-info/more-about-fietsersbond/*
[30] *https://www.bike-eu.com/42620/french-e-bike-market-share-hikes-to-25*
[31] *https://www.sciencedirect.com/science/article/pii/S1361920921004296?via%3Dihub*

- Shared electric scooters grew rapidly in 2018, with Lime and Bird valued at more than $1 billion (₹78 billion), while Uber, Lyft and major automobile manufacturers launched their own electric scooter services, which had a certain impact on short-distance travel demand.

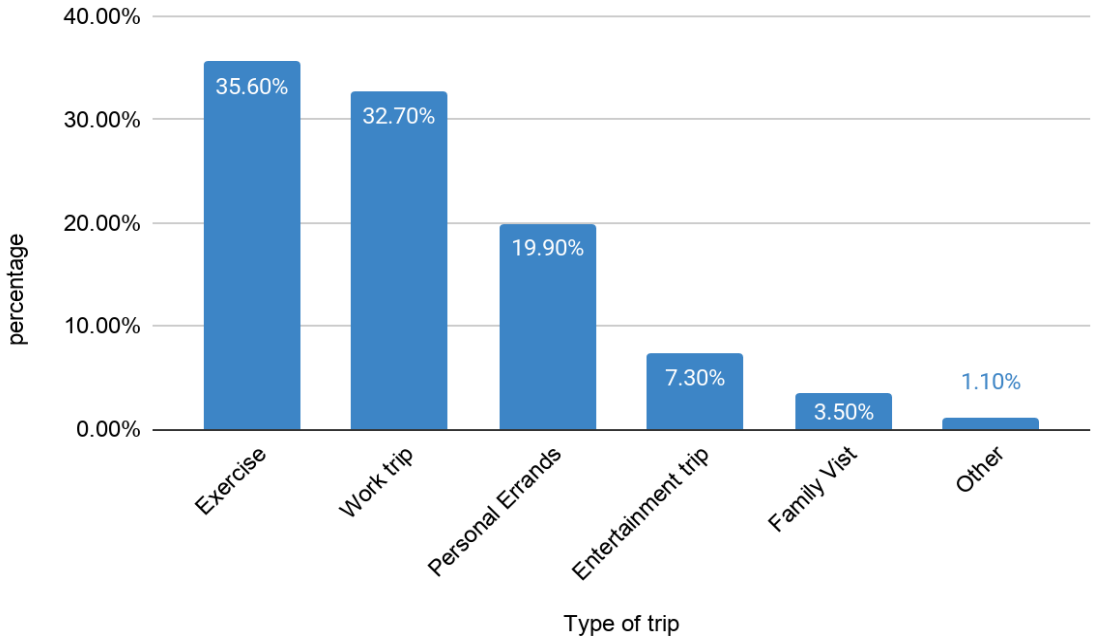

Figure 13: Percentages of trips made by E-cycle in America

3.3.3. Korea:

Korea's e-bike sales in 2015 and 2016 were 17,000 and 20,000 respectively. Nearly 78,000 electric bikes were sold in 2020[32]. Sales of electric bikes accounted for almost 20 percent of all bike sales in Korea.

Characteristics of E-cycle usage in Korea

- Previously, electric bicycles were equated with motorcycles as "motor vehicles", which required a driver's license and were restricted to driving in motor lanes.

[32]h*ttps://koreajoongangdaily.joins.com/2021/11/01/business/industry/electric-bicycle-electric-bike-samchuly/20211101164330744.html*

- In March 2017, the new Law on the Development of Electric Bicycles stipulated that electric bicycles with speeds less than 25 km/h and weighing less than 30kg belong to non-motorized vehicles and can be ridden on bicycle paths, and by anyone over the age of 13.

Figure 14: E-cycle in Korea, Image source - cyclingsouthkorea.com

3.4. E-Micro-Mobility Regulations around the Globe

Micro-mobility is an ambiguous term associated with a rapidly evolving range of light vehicles that are increasingly populating streets. The term micro-mobility was popularised by Horace Dediu, an American industry analyst and investor. According to Dediu, the term “micro” can refer to the vehicles used, which are typically less than 500 kg, but also to the short-distance trips that can be fun, cheap and convenient.

In most countries, the use of micro-mobility vehicles may not be legal under the ambit of existing laws governing urban transportation. Countries are, however, amending existing laws to allow the legal use of micro-mobility vehicles in their cities.

3.4.1. E-micro-mobility in Europe

European Union regulation established the L-category vehicles as a reference for member countries. L-category vehicles are powered by two, three and four-wheel vehicles. The category uses power, power source, speed, length, width and height as classification criteria. Some types of micro-vehicles that can be mapped to the L1e category called “light two-wheel powered vehicle” are:

- L1e-A powered cycle: Electric bicycle equipped with auxiliary propulsion with a maximum speed of 25 km/h and a net power between 250 watts and 1,000 watts. This category includes low-powered throttle-only electric bikes.
- L1e-B two-wheel moped: Any two-wheel vehicle with a design speed of more than 25 km/h and up to 45 km/h and a net power of up to 4,000 watts. It includes speed-pedelecs, though most speed-pedelecs have a power of 500-750 watts.

Other micro-vehicles are left outside the L1e category, most notably:

- Human-powered vehicles, such as bicycles, skates and kick scooters
- Pedelecs, defined as bicycles with pedal assistance up to 25 km/h and with an auxiliary electric motor having a maximum continuous rated power of up to 250 watts.
- Self-balancing vehicles and vehicles not equipped with a seat (ie. Standing scooters).

3.4.2. E-micro-mobility in the United States

In the United States, e-bikes and e-scooters are predominantly regulated at the state level. State-by-state legislation is being passed which distinguishes e-scooters and e-bikes from mopeds and other motor vehicles, thus enabling the use of bike lanes, and avoiding requirements for licensing and registration. For the use of e-scooters, some states impose a minimum age of 8, 12, 16 or 18 years, some only require the use of helmets, and others have set both minimum age and a helmet requirement. State-specific speed limits for e-scooters range from 20 km/h (12.5 mph) to 32 km/h (20 mph)

For the use of e-bikes, state regulations typically impose that an e-bike falls within one of the following three classes:

- Class 1 electric bicycles are equipped with a motor that provides assistance only when the rider is pedalling, and that ceases to provide assistance when the bicycle reaches the speed of 20 mph (32 km/h).
- Class 2 electric bicycles are equipped with a motor that may be used exclusively to propel the bicycle, and that is not capable of providing assistance when the bicycle reaches the speed of 20 mph (32 km/h).
- Class 3 electric bicycles are equipped with a motor that provides assistance only when the rider is pedalling, and that ceases to provide assistance when the bicycle reaches the speed of 28 mph (45 km/h) and is equipped with a speedometer.

3.4.3. E-micro-mobility in Latin America

Latin American countries classifies micro-vehicles according to the speed they can develop through assistance or propulsion engines. In Mexico City, the traffic regulations clearly define that any vehicle capable of autonomously developing a maximum of 30 km/h is a non-motorised vehicle. Any vehicle that exceeds 30 km/h is a motorised vehicle that needs a licence plate, and registration and must follow the common rules applicable to cars.

In Colombia, a vehicle type exists for pedal-assisted e-bikes with a motor power of up to 300 W, a weight of up to 35 kg and a maximum design speed not exceeding 25 km/h (MDT, 2017). Personal Mobility Devices (PMDs) were defined as a new vehicle category. They are defined as electrical motorised individual vehicles with one or more wheels, a minimum design speed of 6 km/h and a maximum design speed of 25 km/h (DGT, 2019). According to this definition, PMDs include e-scooters, e-bikes, e-skateboards, one-wheels and more micro-vehicle forms, insofar as they respect the limit applied to the design speed.

3.4.4. E-micro-mobility in Asia

In the People's Republic of China, electric bicycles are classified as bicycles. The latest regulation stipulates that electric bicycles must have working pedals, with a maximum design speed not exceeding 25 km/h, weight (including battery) up to 55 kg, motor power up to 400 W, and battery voltage up to 48 V.

In Korea, all power-driven vehicles are considered as motor vehicles. However, there is no specific classification to categorise the different vehicle types. Authorities are currently using the UNECE regulation and safety requirements as a reference (UNECE, 2019).

Singapore has also created certain rules for the Personal Mobility Devices (PMDs) and Power Assisted Bicycles (PABs) for the safety of the pedestrians as well as the micro-mobility users.

It allows only non-motorized vehicles on the footpath. It classifies e-bicycles and e-scooters as motorized vehicles, even if they are power-assisted and hence is not allowed on the footpaths. Wearing helmets and registering the vehicle with the authority is mandatory.

Figure 15: The new pedestrian code of conduct drawn up by the Land Transport Authority, Image Source - straitstimes.com

Figure 16 shows the regulations related to allowed road space and the usage of different motorised and non-motorised micro-mobility devices.

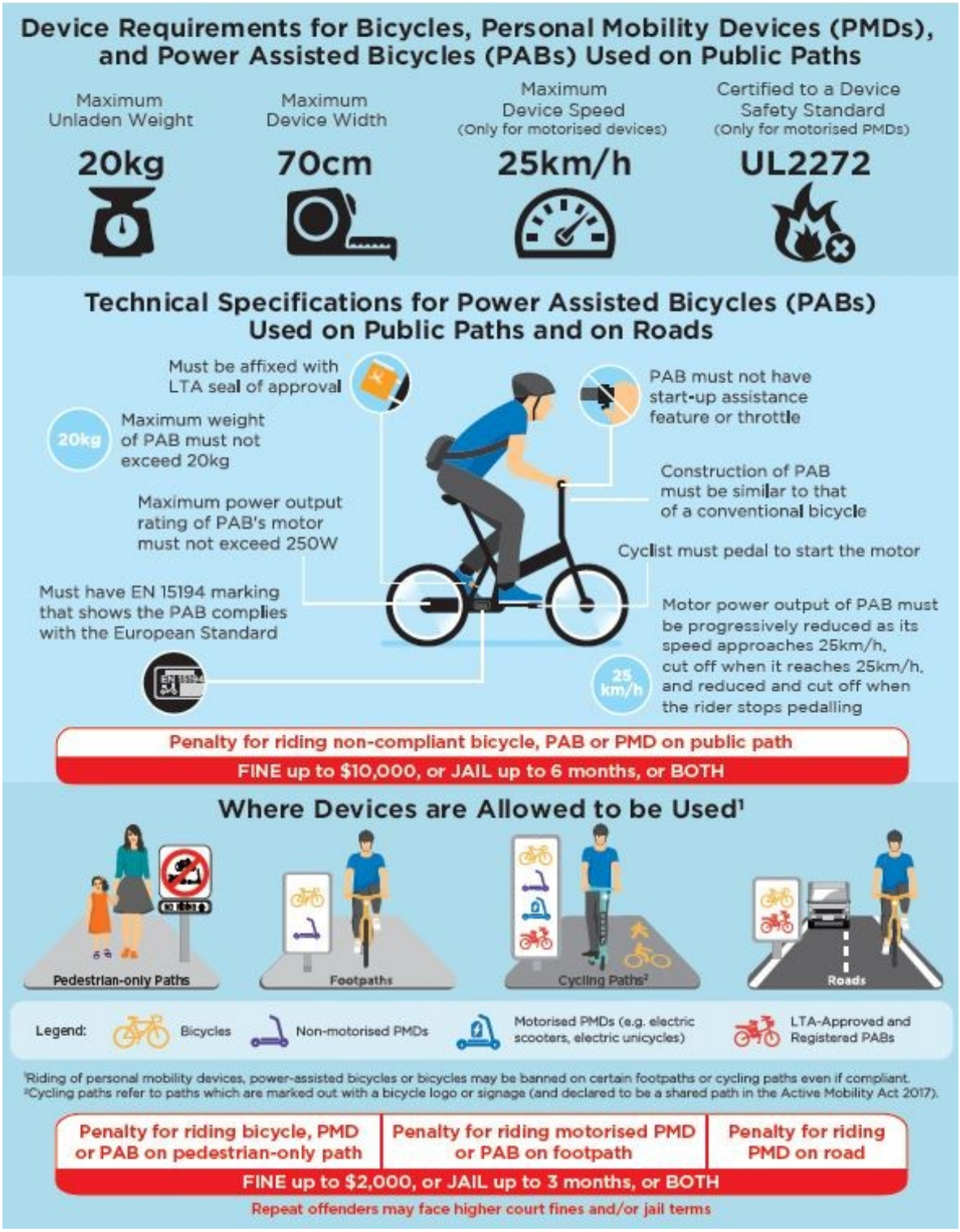

Figure 16: Regulations related to the use of micro-mobility modes in Singapore

3.4.5. Other efforts to classify micro-mobility

SAE International is a U.S.-based, globally active professional association and standards developing organization for engineering professionals in various industries. Their taxonomy can be used by authorities at the local and national levels to develop policy that is compatible with their policy objectives and with the infrastructure available. SAE International published the J3194™ Standard defining powered micro-mobility as a category of powered vehicles that can be classified according to four main criteria:

- Vehicle weight of up to 227 kg (500 lb)
- Vehicle width of up to 1.5 m (5 ft)
- Top speed of up to 48 km/h (30 mph)
- Power source by an electric motor or a combustion engine

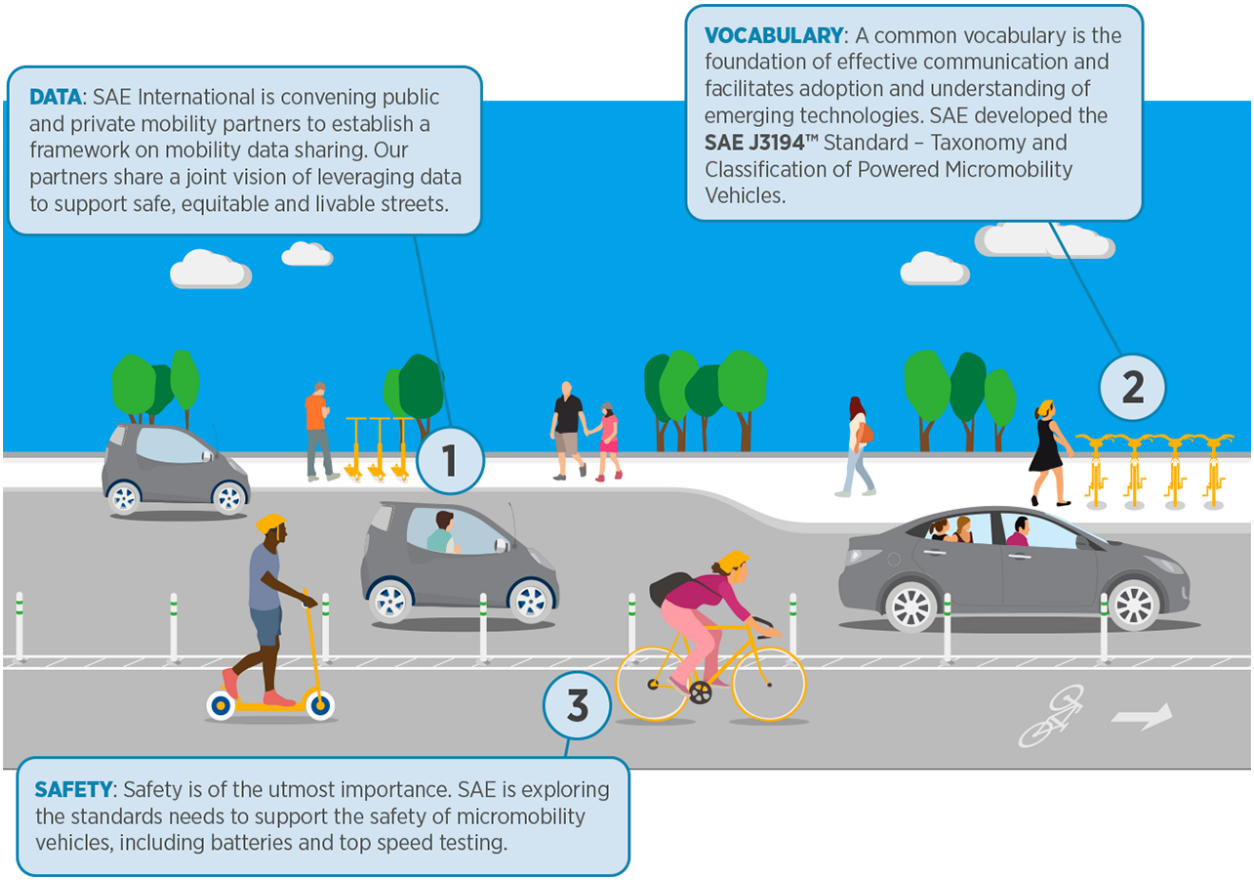

Figure 17: Standards in the World of New Mobility, Image Source - sae.org/micromobility

Source - Telegraph India

04

The Impact of COVID-19 on Micro-mobility

4.1. Micro-mobility segment hit by the pandemic

The COVID-19 pandemic witnessed a discernible shift in consumer behaviour. One of the most noticeable changes was people's transportation preferences. While lockdowns across the world shut down public transport, usage of shared scooters and bikes also dipped substantially as people were reluctant to step out.

In this period, Lime (an electric scooter and bike sharing app) laid off 13% of its workforce while its valuation saw a plunge of 79% - leading to its withdrawal from international markets. Its rival, Bird, also laid off 30% of its workforce and shut down operations in the middle east region in June 2020. However, as the world realigned itself to live with the pandemic, the micro-mobility segment saw a resurgence in demand and brought more riders into its fold.

4.2. Resurgence of micro-mobility services

The flexibility and relative simplicity of micro-mobility services helped this mode of transport bounce back more quickly than any other sub-sector. In the long run, we can expect further consolidation in this sub-sector as smaller players are pushed to the fringe and bigger companies gain more ground. For perspective, in January 2020, Bolt acquired assets from Gotcha, allowing it to move into 48 new markets in the US.

Amidst consecutive lockdowns, scooters and bikes gained precedence over cars and buses. In the US, Lyft's Citi Bike services and Lime offered healthcare workers free rides, emerging as essential infrastructure providers. Similarly, in India, micro-mobility start-ups like Bounce and Vogo were involved in providing essential deliverables during the pandemic.

4.3. Pandemic-induced realignments

The pandemic also saw many unprofitable businesses shutting shops or redesigning their business models and objectives. In May 2020, Uber invested in Lime leading to the merger of Uber's own micro-mobility startup Jump with Lime. Superpedestrian became a fully integrated micro-mobility company by acquiring Zagster, a bike-sharing platform in June 2020.

Micro-mobility providers are also solidifying key partnerships to stay afloat and increase reachability. Lime and Edenred Benefits have entered a partnership integrating transit benefits provided by Edenred with the sustainable commuting options from Lime. Over 10,000 of Edenred's clients – with over 10 million employees – can now offer their employees access to choose Lime's e-bikes and scooters with subsidized rates with the same card used for transit and parking.

4.4. Surge in D2C demand

E-bikes are witnessing fast uptake in Europe, with many customers preferring to own the e-bike and scooters rather than using shared mobility options. It is expected that e-bike sales will reach 17 million units sold annually by 2030 from 3.7 million in 2019. In the US, electric bike sales grew by 145% between 2019 and 2020. Several start-up companies are in a foray to capture market share. Netherland-based e-bike company, Vanmoof, raised $128 million (~₹10 trillion) in C-round funding, with each e-bike costing around $2,300 (₹180,000). Around 150,000 people are using Vanmoof bikes. New York-based Wing bikes, which offers cheaper e-bikes than Vanmoof, is also a strong contender. In August 2021, Bird launched an e-bike that costs about $2,300 (₹180,000). Veo, another e-scooter sharing company, sells e-scooters directly to customers as well. In August 2020, it launched personal use scooter – Astro Go in response to the depressed demand during the pandemic.

Figure 18: Bicyclists on the Rue de Rivoli as Parisians emerge from lockdown, Image source - The Verge

Source - WeareGurgaon.com

05

Micro-mobility Available in India

In India, motorized 2-wheelers dominate most of the market, whereas the proportion of electric motorcycles and cars is relatively small. In 2021, the total number of two-wheelers sold in India was more than 12.3 million. According to the Society of Manufacturers of Electric Vehicles, India has sold 767,000 electric vehicles since 2015[33]. In 2021-22, Hero Electric currently accounts for nearly 28% of India's electric vehicle market share[34]. The e-bike sales in India have increased from 73,500 in 2020 to 91,142 in 2021, seeing a rise of 24%[35], with many new players entering the market.

Mumbai-based bicycle maker, Ninety One Cycles, in December 2021, raised ₹2.3 billion ($29.6 million) in a Series A round, led by venture fund A91 Partners, along with existing investors Fireside Ventures, Avaana Capital and Titan Capital.

TVS Motor Company, the flagship firm of the ₹663 billion ($8.5 billion) TVS Group, acquired a 75% stake in Swiss e-Mobility Group (SEMG) for ₹7.8 billion ($100 million) in January 2022. This is the company's second acquisition in Switzerland in the e-mobility space during the current financial year, after buying 80% of EGO Movement for ₹1.4 billion ($17.9 million) in September 2021. The company is planning to launch SEMG brands — Cilo, Simpel, Allegro, and Zenith — in India by the end of 2022.

At present, India's power battery industry is small and dominated by lead-acid batteries. The lithium industry chain is getting established, and the lithium cores are totally dependent on imports, mostly from China, South Korea, Vietnam and other countries.

At present, India's Reliance Industries, Indian Oil, Exicom Industries and other manufacturing, energy and telecommunications industries have announced their lithium production plans. Suzuki and Toshiba have jointly invested in the construction of lithium-ion and pack plants in Gujarat state. Local production of the lithium-ion industry will further reduce the manufacturing cost of electric bicycles.

[33] *https://www.smev.in/fy-15-21*
[34] *https://www.smev.in/fy-20-22*
[35] *https://www.financialexpress.com/auto/electric-vehicles/electric-two-wheeler-sales-increase-by-132-top-10-ev-players-in-india/2399833/*

Table 3: Top electric Bikes in India[36]

Name	Range	Battery type	Battery capacity Options	Motor Type	Price
Hero Lectro eBikes	25 – 80 kms	Lithium-Ion battery	5.8 Ah	Rear Hub Motor, Mid Drive	₹28,999 – 54,999 ($385-705)
LightSpeed eBikes	35 – 100 kms	Lithium-Ion battery	7.8, 10.4, 13, 17.5 Ah	Rear Hub Motor	₹30,999 – 59,999 ($397-769)
eAddict eBikes	20-60+ kms	Lithium-Ion battery	5.2, 8.8 Ah	Front Hub Motor	₹39,999 – 59,999 ($513-769)
Toutche eBikes	75 kms	Lithium-Ion battery	11.6 Ah	Rear Hub Motor	₹48,900 to 55,900 ($627-718)
Elektron eBikes	80-100 kms	Lithium-Ion battery	11.6 Ah	Rear Hub Motor	₹35,999 – 65,999 ($462-846)
PURE EV eBikes	60 kms	Lithium-Ion battery	13 Ah	Rear Hub Motor	₹39,999 – 59,999 ($513-769)
COPPERNIC US e-bikes	100+ kms	Lithium-Ion battery	11.6 Ah	Rear Hub Motor	₹1,29,999 ($1670)
Being Human e-bikes	35-40 kms	Lithium-Ion battery	7.6 Ah	Rear Hub Motor	₹38,999 – 59,999 ($500-769)

[36] https://www.pluginindia.com/electriccyclesbrowse.html

5.1. Case study of YULU

Yulu is a Bengaluru-based, technology-driven bike-sharing platform that enables integrated urban mobility across public and private modes of transport. Yulu focuses on providing micro-mobility services for short-distance commutes below 5 km in the big city, aiming to reduce air pollution and quickly tackle traffic congestion. Using micro-mobility Vehicles (MMVs) through a user-friendly mobile app, Yulu enables first and last-mile connectivity that is seamless shared and sustainable[37]. For providing micro-mobility services, Yulu has launched YULU Miracle, a dockless and lithium battery-powered bike. The YULU Miracle can travel 70 km at 25 kph speed and weigh just 40 kg. Though the deposit and rental charges vary with the city, in the majority of cities, the bikes can be rented after paying a security deposit of ₹199 ($2.5) and it charges a base fare of ₹5 ($0.06) and ₹2 ($0.03)) per minute as a standard. There is no helmet or number plate requirement for these using YULU Miracle[38].

Currently, Yulu is operating in multiple cities like Bengaluru, Pune, New Delhi, Bhubaneshwar, Gurugram and Mumbai. Currently, there are about 7,500 vehicles operating in Bengaluru, 6,000 vehicles in Mumbai and 900 in Delhi. Most of the Yulu Zones have about 5-10 stands and some of them have up to 20 stands. The company has two products “Yulu Move” a bicycle and “Yulu Miracle” an electric bike. All these vehicles are IoT connected and can be tracked in real-time.

Figure 19: YULU Miracle, Image source-KrASIA

[37] *https://www.yulu.bike/products/move/*
[38] *https://stutalks.com/electric-bike-startups/*

In Bengaluru, Yulu operates under a permit model which includes identifying the location for the operations and the number of bikes that are planned to be deployed. In Mumbai, Yulu has entered into partnerships based on MOU with three different agencies which are – CIDCO in Khargar, NMMC in Navi Mumbai and MMRDA in BKC.

With NMMC it was an agreement for 5 years wherein there is a refundable security deposit amount for the stands (approximately ₹1,000 ($13) per stand, which translates into ₹10,000 ($130) for a stand with 10 vehicles) and a rental of ₹1,100 ($14) per bike per year. In Khargar, Yulu ran a non-commercial pilot for two years. At the end of the two years, a tender was floated. However, since there were no bidders the city has moved into an MoU format with multiple operators. With MMRDA, the model has been a non-commercial MoU for a period of 3 years with an extendable period of 2 years.

Post the EV policy in Delhi, Yulu has set up a satellite station in North Delhi. The city came up with a multi-operator permit wherein an operator can obtain a permit from the city at no cost, identify the locations in the city and deploy their vehicles.

Ahmedabad was added as a city with a very small fleet. The operations could not scale up because the cost of operation including the manpower cost was much higher than the earnings and eventually after operating for about 18 months the services were rolled back.

Business Model for Business-to-Consumer (B2C)

Yulu charges ₹100 ($1.3) or ₹199 ($2.6) depending on the type of vehicle, upon registration on its application which is refundable once a user decides to completely stop the services. The rate charged per ride is ₹5 ($0.06) for unlocking and ₹2 ($0.03) per minute. It is a time-based business model and not a distance-based model. In addition, saving packages have been introduced just like the top-up options for mobile recharging. For example, for a top-up of ₹300 ($3.9), one would get ₹400 ($5.1) as the total recharge amount. For ₹500 ($6.5) one would get worth ₹700 ($8.9), for a ₹1000 ($13) recharge the amount credited is ₹1500 ($19) and for a recharge amount of ₹2500 ($32) the credited amount is ₹5000 ($64). Though it is minute based package and the pricing would continue to be ₹2 ($0.03) per minute, the overall per minute rate comes down for instance if someone has recharged for ₹2500 ($32) the credited amount is ₹5000 ($64), which effectively comes down to ₹1 ($0.013) per minute from the regular ₹2 ($0.03) per minute.

Last Mile Connectivity

For the first time, a last-mile connectivity-based business model was introduced in Mumbai connecting to the suburban stations namely Kurla and Bandra stations. If any trip originates at Kurla or Bandra station to any destination in BKC, a flat ₹25 ($0.32) is charged for 30 minutes. For less than 30 mins, it is based on the actual minutes used or ₹25 ($0.32) whichever is less.

With Corporates and business tech parks, Yulu has created Yulu Zones based on specific MoUs with the companies. The partnerships have been non-commercial in nature and Yulu zones are created in the designated parking space for the employees of the partnering companies.

Long-term rental basis

Most of the bikes for the purposes of delivery are on a rental basis. The rental packages start with ₹199 ($2.6) per day for seven days and ₹185 ($2.4) per day for 15 days.

Battery Swapping

In the B2C model, Yulu takes care of battery swapping. In the B2B model, Yulu has set up multiple locations for battery swapping where the delivery executive can go and swap the battery. The battery swap stations are manned where a person from Yulu is assigned to the site for helping with the battery swapping. This is also to ensure there is no tampering with the batteries and they are well maintained. Eventually, automated battery swap stations will be introduced, where individuals can swap the battery on their own. A swapping station has about 9-12 batteries.

A station can charge 12 batteries in one go. Typically, at a charging station around 16 to 20 batteries are charged in a day. The battery sizes are 1 kWh and 48V batteries. There are 2-3 charging ports installed at every location. In Mumbai, Yulu has tied up with Adani Electricity (AEL), the largest electricity supplier in Mumbai and set up battery swapping stations to avail electricity at discounted prices wherever AEL supplies the electricity.

Yulu is now developing new vehicles for logistics delivery and has deployed a few vehicles in Bengaluru and these are equipped with a carrier. The business model of Yulu is pivoting towards B2B from B2C. The technology has also improved in the new vehicles. In the earlier version of the vehicles, with a low State of Charge (SoC) level of the battery, the speed would also come down. In the new bikes, even with a battery SoC of 20%, a speed of 25 kmph can be achieved. There are minor tweaks in the aesthetics as well.

5.2. Case Study of Zypp

Zypp Electric is making last-mile delivery more affordable and time-saving with zero emissions. It is a Business-to-Business (B2B) delivery and shared mobility platform and provides deliveries for e-commerce, grocery, medicine and food verticals to go electric with its e-scooter sharing app. A KPMG report revealed that there will be 6.1 million delivery executives in India by 2025 making last-mile deliveries. But as the majority of last-mile deliveries are completed using internal combustion engine vehicles, the opportunity presents a big issue, which Zypp Electric is trying to solve[39].

Zypp Electric started as a bicycle sharing company, Mobycy in 2015 and then slowly introduced electric vehicles in the B2C segment. With e-commerce deliveries picking up in India over the last few years the company switched to B2B logistics last mile delivery.

Zypp Electric serves businesses of all sizes, right from large e-commerce companies to e-grocery to convenience stores and restaurants. They handle their end-to-end last-mile deliveries from stores to customers' homes with various differentiated tech-enabled custom solutions, such as using e-vehicle, fixing the timings of services, IoT-enabled battery swapping infrastructure, ensuring good riders, and giving an exclusive experience to their end customers.

The startup has been delivering 200,000 shipments a month as of now, with an average month-on-month growth rate of 20% for the last six months. Currently, Zypp has over 300 clients, including Amazon, Rapido, Flipkart, Myntra, Big Basket, Grofers, Spencers, Modern Bazaar, Easyday etc.

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[39]https://thestartuplab.in/how-zypp-electric-is-making-last-mile-deliveries-efficient-eco-friendly-and-economical/

Business Model

Zypp Electric works on a B2B last-mile delivery model and offers businesses an electric fleet, provides them trained riders, customised pricing with technology, and API integration. The vehicles provided by Zypp are IoT-enabled for the real-time tracking of vehicles and delivery executives. Zypp also provides Zypp Hyperlocal service where businesses can list their stores on Zypp Merchant Panel and Zypp dedicated riders handle all their deliveries.

Zypp plays an additional role in providing vehicles, drivers and charging infrastructure to bike taxi companies thus accelerating the EV transition for bike taxi companies. Additionally, individuals can rent vehicles from Zypp platform and can become driver partners on Rapido's platform. Given the high cost of diesel and low maintenance cost of electric vehicles, this is very attractive for drivers as drivers might not be ready to buy electric vehicles due to technology hesitancy and financing challenges.

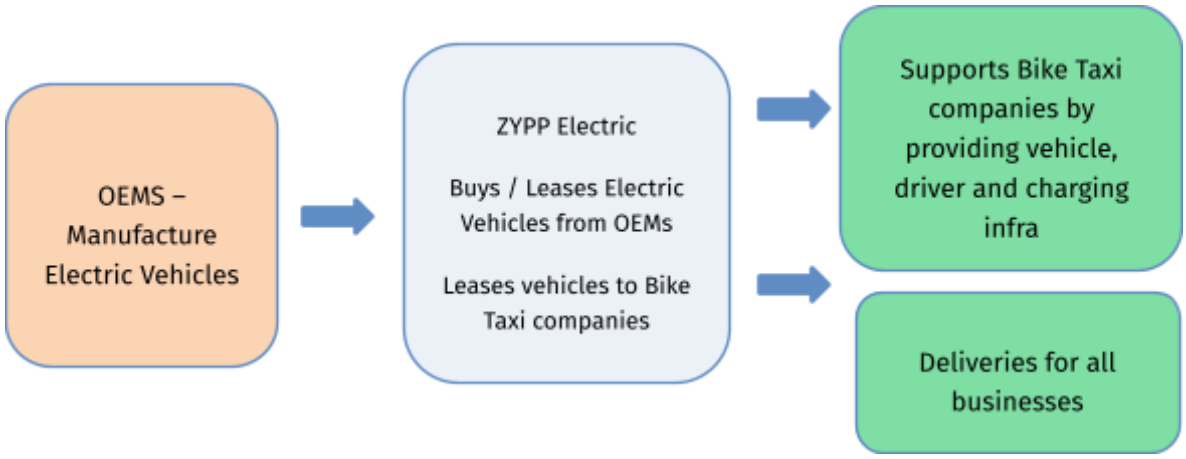

Figure 20: Zypp Business model

Zypp Electric has aggressive growth plans and has raised $ 1 million in debt funding to deploy 1.5 lakh electric vehicles across India[40]. The company aims at least 15% to be women-led and to cover ten major cities in India. The startup also aims to cross 1,000-plus partners by 2022. Zypp is also exploring a buy-and-lease model from individuals with assured returns. Individuals can buy electric vehicles and lease their vehicles to Zypp electric. Zypp electric will make a monthly EMI payment that includes the interest component spread over three years.

[40] *https://www.business-standard.com/article/companies/zypp-electric-raises-1-mn-from-northern-arc-to-expand-ev-fleet-service-122042500571_1.html*

Figure 21: Zypp Electric Vehicle, Image Source - WeareGurgaon.com

5.3. Case Study of Bounce Share

Bounce share which started as Metro Bikes tied up with Bengaluru Metro Rail Corporation Ltd. (BMRCL) in 2018 to launch its bike rental service across 36 metro stations in Bangalore with each metro station housing between 20-100 bikes including electric two-wheelers and bicycle. The riders were charged ₹5 ($0.06) per km and ₹0.5 ($0.006) per minute, including fuel charges. After the success in Bengaluru, the services expanded to 7 other cities in India.

Pre-COVID, Bounce was one of the largest ride-sharing companies in the world. They used to operate 25,000 scooters in two markets -20,000 in Bengaluru and 5,000 in Hyderabad. The company did close to about 120,000 rides a day. The ridership was almost 25% of Metro's ridership in Bengaluru pre-COVID. All this was done at an investment of approximately ₹1.56 billion($20 million).

However, Bounce's shared mobility business shrank by 83% due to the pandamic[41]. Currently, Bounce Share is operating 5,500 bikes in Bengaluru and 500 bikes in Vijayawada as micro-mobility services. Bounce continues to do mobility business where people can have access to affordable mobility So far bounce has done more than 10 lakh battery swaps across more than 200 battery swapping stations. It has done more than 5 Million EV rides and has clocked about 30 million kms.[42]

Figure 22: Bounce Electric Vehicle

Bounce Share plans to add at least 100,000 electric scooters over the next three years for mobility. Bounce share also deployed 200 electric scooters in Hassan, Karnataka on a pilot basis pre-COVID. The batteries and aluminium build with no plastic parts (keeping the total cost of ownership into consideration) are key features. Bounce has built a different scooter for their mobility services/bike taxis. The battery used is of 2.2 kWh capacity, 48V/60V and gives a range of 65 kms in the eco-mode and about 50 kms in the power mode with about 1,700 charge/discharge cycles. The battery swapping module has been developed in partnership with local vendors.

[41] *https://economictimes.indiatimes.com/tech/startups/bounces-shared-mobility-business-shrank-83-during-the-pandemic/articleshow/89827285.cms*

[42] *https://bounceinfinity.com/about.html*

Figure 23: Battery Swapping Machine by Bounce[43] [44]

Battery swapping will enable mass adoption due to:

- Reduced downtime because of increased efficiency
- Increased battery life through controlled charging.
- Reduced upfront costs for users (30-50%) by separating the battery for mass adoption
- Addresses range anxiety

In the battery-as-a-service model the customer will benefit because of the following reasons:

- 40% lesser upfront cost (2.2 KW powered scooter costs ₹45,000–₹65,000 ($580-$830) with Battery-as-a-Service option)
- Power cost could be lower than consumer's energy cost because of access to renewable energy, which has a lower cost per unit. Two units of power are required to charge a 2 kWh battery. Renewable power cost per unit is ₹3 ($0.04) to ₹5 ($0.06) compared to regular power cost of ₹7 ($0.09) to ₹10 ($0.13) per unit.
- Customers need not worry about power cuts and shortages, as they can find and swap charged batteries anytime.
- Required range is possible with battery swapping without additional costs, no need to increase the battery size to increase the range.

[43] https://www.bizzbuzz.news/technology/bounce-greaves-ev-battery-swapping-stations-soon-1119513
[44] https://www.firstpost.com/wp-content/uploads/2021/11/bounce-partners-with-park-plus-for-battery-swap-infra-infinity-electric-scooter-launch.jpg

- No infra-related challenges to charge – India is crunched on real estate and most vehicle owners do not have dedicated parking spaces where chargers can be installed.
- Replacement cost – Batteries in mobility use cases generally have around 1,000 charging cycles. The replacement cost of these batteries is ~50% of the cost of the vehicle itself.

In Battery-as-a-Service, customers need not incur these costs.

Business Model

Bounce Infinity has partnered with Bharat Petroleum Corporation Limited (BPCL) to set up Bounce Infinity's battery swapping stations in a phased manner, with an aim to set up 3000 swapping stations across 10 cities. Battery swap stations are automated stations for individuals to swap their vehicle batteries and in the beginning, a bounce team will be there to assist. The stations include mom-and-pop stores as well. Vijayawada was picked as a city to test the battery operating conditions in a high temperature and humid area and discover the business model in a Tier 2 city. There are three business models:

1. Pay as you Use – In this model, a user is charged based on the distance and time for travel from point A to B and varies based on the time of the day usage.
2. Daily and Monthly rentals- In this model, flat charges are applied for the stipulated time of usage (either daily rates or monthly rates are applicable)
3. Rent to Own Model – In this model, also known as rental-purchase or rent-to-buy, is a type of legally documented transaction under which is exchanged is leased in exchange for a monthly payment, with the option to purchase at some point during the agreement

Manufacturing

Bounce ventured into manufacturing of e-scooters given the challenges associated with electric scooters such as non-availability of battery swappable models, high cost and less lifetime (less than 10,000 km). Bounce acquired Force 22 Motors and started their own manufacturing of e-scooters for supplying to their consumer business and to their mobility business. The plant is located near Manesar, Haryana and has a capacity of 200,000 scooters a year.

In future, Bounce will be seen as a mobility company with a complete back-end integration and will generate revenue from energy as a service. Bounce will continue to manufacture electric scooters and offer Battery as a Service with inter-operability. Thus, Bounce emerges as a full-stack EV Company.

Figure 24: Bounce has 4000 keyless bikes in Bengaluru which are used for 2,50,000 rides a day. Source - Innovations of the world

Source - NikkeiAsia

06

Regulatory Challenges Related to E-micro-mobility

The role of governments in defining and enforcing requirements regarding various parameters, such as speed, vehicle registration, license, and personal protective equipment like helmets is of utter importance.

Personal protective equipment[45]

Many trips on shared micro-vehicles are spontaneous and unplanned, and users are less likely to carry a helmet. If the speed of e-bikes and other micro-vehicles is limited to 20 or 25 km/h, many countries choose not to require adults to wear a helmet, although they do encourage helmet use. This is the case in France, Germany, Denmark and Portugal and India.

A study by the City of Austin (2019)[46], Texas found that one-third of those injured while riding an e-scooter were first-time users of the vehicle. This may be due to the lack of experience in riding a vehicle with electric motors, which accelerate fast. However, cities in the United States evaluating their e-scooter pilots consider such vehicles to be safe to use. During its pilot between July and November 2018, Portland, Oregon found there were no e-scooter-related deaths, and that "most scooter injuries were not severe enough to warrant emergency transportation"[47]. Baltimore, where the pilot lasted from August 2018 and February 2019, found similar results. In over 700,000 e-scooter trips during the period, there were no deaths caused by e-scooters, and the injury rate requiring emergency treatment was low, at 0.087 visits per 1000. Further, the city estimated that driving resulted in 20 times more injuries annually than riding e-scooters[48].

Despite the injuries being non-fetal in nature, policymakers should mandate and enforce the use of helmets on micro-mobility vehicles travelling above a certain speed as it is a matter of safety for people.

Speed

An essential aspect of managing the safety of micro-mobility is setting and enforcing the speed limit applicable to electric micro-vehicles. France, Portugal, Queensland, Singapore, Spain and India have imposed a 25 km/h speed limit on e-bikes.

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[45] https://www.itf-oecd.org/sites/default/files/docs/safe-micromobility_1.pdf

[46] City of Austin (2019) Dockless Electric Scooter-related Injury Study

[47] PBOT (2018) 2018 E-scooter Findings Report

[48] Baltimore (2019) Dockless Vehicle Pilot Program Evaluation Report

The rationale for allowing speeds up to 25 km/h or beyond is to make micro-vehicles competitive with cars, addressing car dependence and the external costs on the environment and public health that come with it. On the other hand, if the speed of 25 km/h is allowed on footpaths and sidewalks, this may pose a threat to pedestrians to walk safely on the footpaths along with such high-speed moving vehicles. In the city of Singapore, e-bikes are completely banned from operating on sidewalks and footpaths, while India does not have any regulation related to this.

Pedestrian Protection

Injuries associated with riding an electric scooter were, however, not limited to riders alone, but included pedestrians as well. Pedestrian safety is negatively impacted when micro-vehicles are used and parked on sidewalks especially, wheelchair users and the blind are particularly affected. To prevent this conflict, a dedicated lane shall be provided for the use of e-micro-mobility vehicles in urban areas.

Rethinking cycling facilities

Wide bike lanes and tracks should no longer be seen as a luxury, but as a requirement, to accommodate a growing number of users in safe conditions. The presence of protected and wider bike lanes will encourage the use of e-micro-mobility vehicles. Speed humps, transverse rumble strips and cobblestone sections installed along the cycle network need to be carefully designed and safely passed by vehicles with small wheels and a short wheelbase. The most complex situation will be on residential roads, where micro-mobility shares the space with motor vehicles, and where speed humps are often deployed. This is an area where research is needed.

6.1. E- Micro-mobility regulations in India

There is no specific definition of micro-mobility in India, micro-mobility is often referred to as personal vehicles that can carry one or two passengers. Bicycles are probably the most common example along with electric bikes, and all sorts of scooters – generally small powered micro-mobility vehicles run on charged batteries.

According to the regulations of the Automotive Research Association of India (ARAI), e-bikes are defined as[49]:

[49] *https://sites.google.com/a/evhub.biz/ev/electric-vehicle-technology/arai-testing-and-regulations-for-electric-bikes-in-india*

- Vehicle with one or more electric motors with power of less than 250W
- Maximum speed of the vehicle with a single person load (75kg) should not be more than 25 kmph

Electric vehicles, which comply with the above requirements are not categorized as motor vehicles. Hence the transport rules (insurance, taxes, etc.) are not applicable for them and they become certified for exemption from license and registration.

As per the Central Motor Vehicle Act (CMVR), 1989[50] and the Motor Vehicle Act of 2019 (amended)[51] Electric cycles fall under the category of electric vehicles and no term such as electric micro-mobility is described.

According to Central Motor Vehicle Act (CMVR), 1989: "Battery Operated Vehicle" means a vehicle adapted for use upon roads and powered exclusively by an electric motor whose traction energy is supplied exclusively by a traction battery installed in the vehicle.

Provided that if the following conditions are verified and authorized by any testing agency, the battery-operated vehicle shall not be deemed to be a motor vehicle.

- The thirty minutes power of the motor is less than 0.25 kW
- The maximum speed of the vehicle is less than 25 km/h
- Bi-cycles with pedal assistance which are:
    - equipped with an auxiliary electric motor having a thirty-minute power of less than 0.25 kW, whose output is progressively reduced and finally cut off as the vehicle reaches a speed of 25 km/h, or sooner, if the cyclist stops pedaling; and
    - fitted with suitable brakes and retro-reflective devices, i.e., one white reflector in the front and one red reflector at the rear.

Along with the Central Motor vehicle Act, the State Motor Vehicle act of Tamil Nadu and Maharashtra also does not specify any definition, rules and regulations related to electric micro-mobility.

[50] *Central Motor Vehicle Act, 1989: https://morth.nic.in/central-motor-vehicles-rules-1989-1*
[51] *THE MOTOR VEHICLES (AMENDMENT) ACT, 2019: http://egazette.nic.in/WriteReadData/2019/210413.pdf*

Source - Futuretransport-news.com

07

Policies & Initiatives to Promote E-micro-mobility in India

7.1. FAME Scheme[52]

Faster Adoption and Manufacturing of (Hybrid & Electric Vehicles) Scheme (FAME) was formulated in India as part of the National Electric Mobility Mission Plan (NEMMP) 2020, launched by the Department of Heavy Industry. Phase-I of the scheme was launched in 2015 to promote the manufacturing of electric and hybrid vehicle technology and to ensure sustainable growth of the same. The phase-I of this scheme was initially launched for a period of 2 years, commencing from 1st April 2015, which was subsequently extended from time to time and the last extension was allowed up to 31st March 2019, while the Phase-II of the scheme started from April 1st, 2019 with a validity of 3 years and was recently extended till 31st March 2024.

The main thrust of FAME is to encourage electric vehicles by providing subsidies. Under the NEMMP scheme, the government aimed to invest ₹14,000 crores ($1.79 billion) in creating infrastructure and promoting the use of electric vehicles.

Under Phase-I of the scheme, the incentive for lithium-ion battery-based two-wheelers was provided at ₹17,000 ($220) or ₹22,000 ($280), based on the fuel savings potential and irrespective of the size of the battery. But, under FAME-II, the incentives are provided based on the size of the battery, with the government providing ₹10,000 ($130) per kWh of battery used for a two-wheeler[53]. However, it is noted that the e-bicycles do not attract the subsidy under FAME-II. Only the state of Delhi is providing a demand subsidy on the purchase of the e-bicycles currently.

7.2. Karnataka's e-bike taxi policy

Bengaluru, the capital city of Karnataka is served by multiple mobility modes. The Bangalore Metropolitan City had more than 8 million vehicles in 2019, with the number of vehicles growing at the compounded annual growth rate of 10.32% between the years 2008 and 2019[54], with two-wheelers constituting the highest percentage of the vehicular composition. During the same period, the population of Bengaluru has increased from 7.66 million to 11.9 million at a compounded annual growth rate of about 4%[55]. This means the vehicle population is increasing at a much higher rate compared to the rate of growth in population.

[52] https://pib.gov.in/PressReleasePage.aspx?PRID=1577880
[53] https://www.thehindubusinessline.com/economy/fame-ii-to-impact-electric-2-wheeler-segment-most-crisil/article26762483.ece
[54] https://www.statista.com/statistics/665764/total-number-of-vehicles-in-bengaluru-india/
[55] https://www.macrotrends.net/cities/21176/bangalore/population

Vehicle ownership has increased from 284 vehicles per thousand persons in 2001 to 419 vehicles per thousand persons in 2011 and further to an estimated 640 in 2018[56]. Two-wheelers dominate the vehicular composition with a share of 69% of the total registered vehicles, followed by cars and jeeps at 19%[57].

In the past, ride-hailing companies such as Ola, Uber, Rapido, and others tried to introduce bike taxi services in Bengaluru by attaching personal bikes to riders (white-board vehicles). But the transport department took strong objection and impounded hundreds of vehicles, making owners pay a heavy penalty for using private vehicles for commercial purposes. However, bike-sharing companies were allowed to operate. As of November 2018, records show that 28 bike rental companies had received licenses from the transport department in Bengaluru. Companies in Bengaluru included Drivezy, ONN Bikes, Bounce (previously Metro Bikes), Vogo, Fae Bikes, Ontrack, Royal Brothers, Self Ride, Wheelstreet, Bykemania, RentOnGo, Roadpanda, Rentomojo and Rentrip, with the biggest two or three operators maintaining fleet sizes of 3000-5000 bikes each.

In a bid to generate employment, bring down pollution and reduce dependence on private vehicles Karnataka became the first state to formulate an electric bike taxi scheme in July 2021. This scheme will give opportunities for individuals, partnership firms and companies to participate. The vehicles registered under this scheme will be in the transport category for which the government has given several exemptions like permits, tax and in addition financial benefits for the electric vehicle manufacturers.

Salient features of the policy:

- Individuals can register their e-bike as a taxi
- Individuals are also allowed to attach their vehicle with a ride-hailing company or operate independently
- Customers can book e-bike taxis to travel a maximum distance of only 10 kms
- The main aim for e-bike taxis has been envisioned to serve as feeder services for Metro and buses in the city
- Fare structure will be likely in two stages- 5 kms and 10 kms
- It is also mandated for e-bike taxis to have GPS, clearly identifiable as a bike taxi (written on the vehicle) and to have a valid insurance policy

[56] *https://timesofindia.indiatimes.com/city/bengaluru/how-many-vehicles-ply-on-city-roads-transport-dept-clueless/articleshow/77533015.cms*
[57] *https://transport.karnataka.gov.in/storage/pdf-files/May%20Blr%202020.pdf*

7.3. Inclusion of E-bicycles in Delhi EV Policy[58]

The primary objective of the Delhi EV Policy 2018 is to bring about an improvement in Delhi's air quality by bringing down emissions from the transport sector. Delhi is also one of the leading states to provide subsidies for electric cycles. The electric vehicle models eligible under EV subsidy include the electric bicycles, under which e-cycles are eligible for a purchase incentive of 25% of the MRP up to Rs 5,500 ($70).

Moreover, the first 1,000 owners of e-bikes are eligible for an additional Rs 2,000 ($25) subsidy. E-cargo cycles are eligible for a purchase incentive of 33% of the e-cycle price up to Rs. 15,000 per vehicle. Figure 25 provides the details of the maximum retail price and the subsidies provided by the Delhi government on different Hero e-bikes models.

HERO LECTRO E-CYLCES						
EV model	Range	Max Purchase Price (excluding incentives)	Applicable purchase incentive	Top up incentive (For Ist 1000 consumers)	Net on-road price (with purchase incentive and tax exemption)	Maximum scrapping incentive (on matching basis)
Hero Lectro C6	33.72km	₹34,999	₹ 5,500	₹2000	₹27,499	
Hero Lectro C8i	29.95km	₹ 39,999	₹ 5,500	₹2000	₹32,499	
Hero Lector F6i	45km	₹ 54,999	₹ 5,500	₹2000	₹47,499	
Hero Lectro C5	28.54km	₹ 30,999	₹ 5,500	₹2000	₹23,499	
Hero lector Winn (Cargo)	52.72 km	₹49,999	₹ 15,000	-	₹34,999	₹3000

Figure 25: Maximum Selling Price and Subsidy provided on Hero e-bicycles in Delhi

[58] *https://transport.delhi.gov.in/sites/default/files/All-PDF/Electric%20Policy%202018.pdf*

Source - Free Press Journal

08

Conclusion

The e-micro-mobility modes present an amazing opportunity to serve the first-mile and last-mile trips. The easy access to these modes has a great potential to offer a high-quality seamless journey to a commuter, leading to an improved user experience of public transport as well as making public transport more attractive. Additionally, there is potential for the short trips to shift entirely to the e-micro-mobility modes. With zero tailpipe emission and lesser overall emissions, e-micro-mobility can also help to reduce the air pollution level in a city.

Aided by various government initiatives, the e-micro-mobility market in India is expected to continue expanding, offering people various types of e-vehicles to choose from. However, at the same time, it is equally important to keep the users as well as the pedestrians safe, which necessitates the formation and adaption of a policy covering various aspects like speed, use of personal protective equipment and segregation from mixed traffic and pedestrians.


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