

Impedance to EV Adaption in India

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This paper was written as a part of survey conducted in India towards the adaption of Electric Vehicle as a part of academic project in Institute of Product Leadership India.

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Abstract: While it is financially beneficial to switch to electric vehicle the adaption is not growing fast due to the infrastructure challenges and other challenges faced with battery charging and time. The cost & life of the battery is a major concern. DIY kits and converting existing vehicle also has many challenges that are discussed in this paper.

Keywords: Challenges in Two-Wheeler and Three-Wheeler Electric Vehicle Adaption in India.

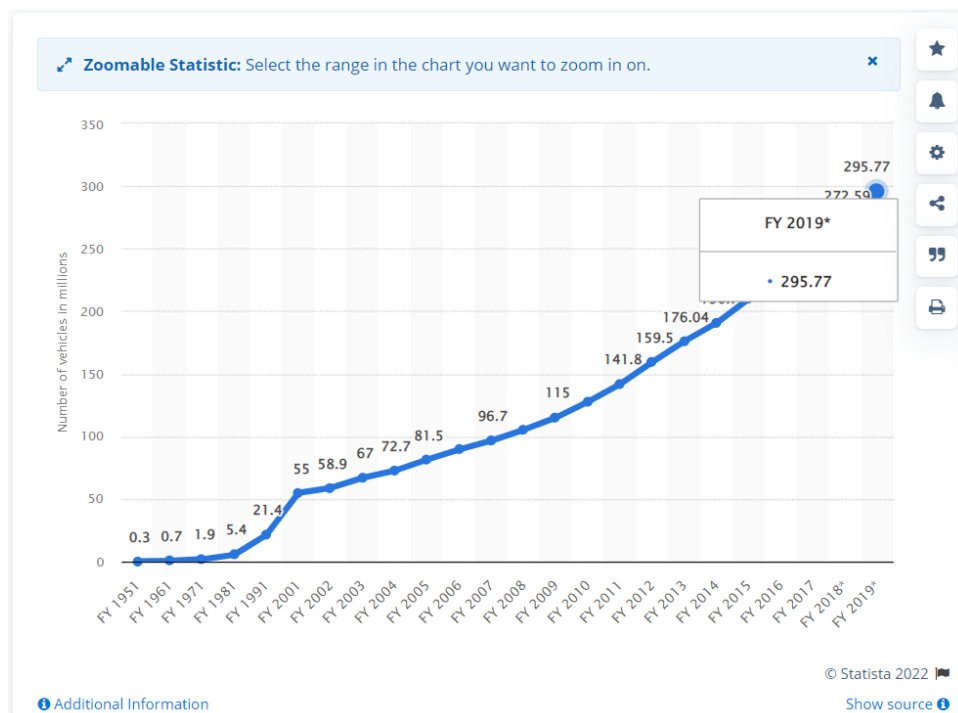
I. INTRODUCTION

The population of India was 1.41 billion as of January 2022. The most of its population is in the low- and mid-income range. They prefer the two-wheeler Bicycle or bikes for the daily commute. While there are other options, we will discuss in this paper how the electric vehicle adaption in two and three-wheeler auto-rickshaw are facing infrastructure challenges towards adaption.

II. IMPEDANCE TO EV ADAPTION

A. Total Vehicle Population in India

As per the Statista report there are more than 295.77 million vehicles operating in India in 2019. Reference: <https://www.statista.com/statistics/664729/total-number-of-vehicles-india/#:~:text=In%20a%20country%20with%20the,2019%20stood%20at%20295.8%20million.>



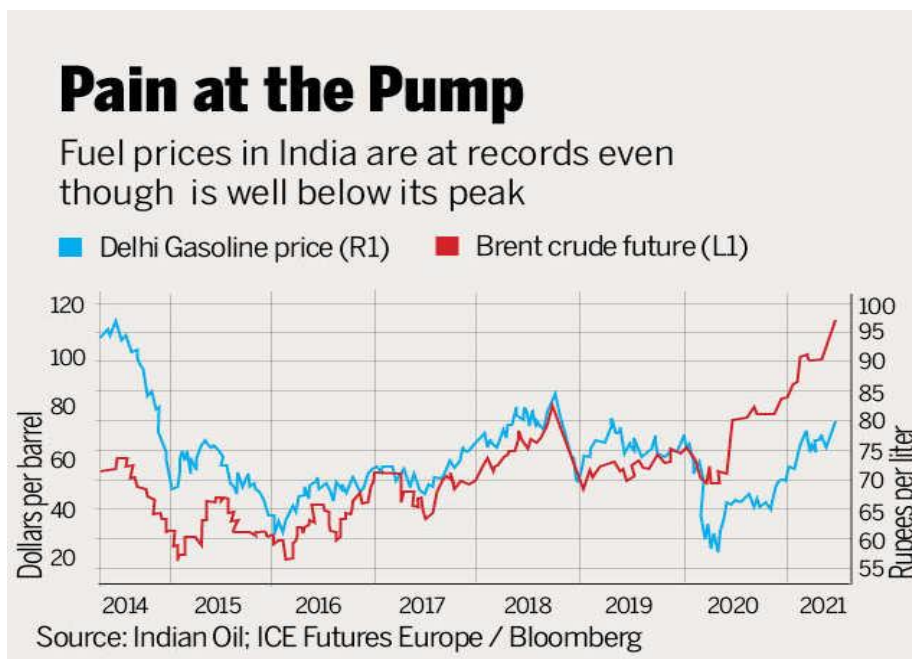
As per The International Organization of Motor Vehicle Manufacturers Two-Wheeler Sales is highest followed by Passenger and then the three wheelers for the year 2020-2021.

Domestic Motor Vehicle Sales (2020-21)

Vehicle Type	Sales (thousands)
Passenger	2 711
Commercial	569
Three wheelers	216
Two wheelers	15 119
Quadracycles	12

¹ Source: OICA ([The International Organization of Motor Vehicle Manufacturers](http://www.oica.org/))

The middle-class segment mainly relies on the Private Two-Wheeler or the three-wheeler auto rickshaw for daily commute. With the rising petrol prices the increasing cost of transportation is also impacting the family budgets.



B. The cost

The cost to cover 10Km distance on two-wheeler bicycle bike with 50KMPL average is 20 Rupees.

The cost to cover 10 KM distance on three-wheeler auto-rikshaw with 30 KMPL average is 50 to 60 Rupees.

C. The battery types and cycle life

Base on the type of the material used to make the battery the cost of the batteries varies and so the life span.

Chemistry	Shelf Life	Cycle Life
Alkaline	5-10 Years	None
Carbon Zinc	3-5 Years	None
Lithium Non-Rechargeable	10-12 Years	None
Nickel Cadmium	1.5-3 Years	1,000 +
Nickel Metal Hydride	3-5 Years	700-1,000
Lithium Rechargeable	2-4 Years	600-1,000
Lead Acid	6 Months	Varies, see above

Source: <https://www.batteryuniverse.com/blog/tags/lifespan/>

D. Impedance to Two-wheeler Electric Bicycle Adaption

Although the two-wheeler bicycle is still the most economical and preferred mode of transport for many low- and mid-income families.

Due to COVID-2019, people have become aware of the importance of fitness and now are taking proactive major to remain fit. With that now bicycling has become the new fitness exercise and now people are also exploring the option to commute to work places on bicycles, at least once or twice a week. Most of the people commute 10 – 30 KM daily on bicycle. If the bicycle is equipped with electric battery, it can cover longer distance with less fatigue.

The lack of charging infrastructure and high price of electric bicycles is impacting the adaption. The electric powered bicycle costs 25K to 130K INR.

Table: The price of electric Bicycles in India.

ELECTRIC CYCLE MODEL	CHARGING TIME	SCORE	PRICE
Hero Lector Renew 26T 7	3-4 Hours	9.7	Under 35,000
Swagtron EB-6 T Bandit	3-4 hours	9.6	Under 30,000
Hero Lector Clix 26T SS	3-4 Hours	9.5	Under 25,000
Swagtron Aluminum Foldable	4 Hours	9.1	Under 30,000
GoZero Mile	4-6 Hours	9.0	Under 30,000
LightSpeed Glyd (2019)	3 Hours	8.8	Under 30,000
Lector Kinza 27T	4 Hours	8.7	Under 35,000
Copernicus T3 E-Bike	5 Hours	8.5	Under 1,30,000
Elektron Cycles M5X Fat	5 Hours	8.4	Under 60,000
Egnite Alloy body Magnet	4 Hours	8.2	Under 55,000

Source: Amazon, <https://top10productsindia.in/best-electric-cycle-india/>

Due to the high price range, people prefer to convert their existing bicycle to electric one. There are many DIY electric conversion kits are available with varying feature and budgets.

Table: The price of electric conversion Kits.

Brand	Specification	Price (INR)
HALLOMOTOR	85% brushless gearless wheel hub, high efficiency. speeds of up to 55 km/h. 48V 1500W motor has an incredible 600rpm power and high-quality components that are relatively easy to install.	40,000
BAFANG	moderately loud motor. 48V 1000W brushless mid-drive motor provides 85% efficiency.	50,000
EBIKELING	Waterproof Electric Bike Conversion Kit. The powerful 1.45 kW brushless hub motor and controller are of high quality and can be used for climbing and downhill	49,000
BAFANG Mid Motor Ebike	Bafang BBSHD Mid BBS03B. Reliable 1000W brushless motor with a maximum power of 1500W.	80,000
Unbranded Kits	85% brushless gearless wheel hub, high efficiency. speeds of up to 25 km/h.	15,000

E. Challenges in using the electric conversion kits.

The motor weighs in between 4 – 6 KGs and Bicycle RIM is not strong enough to take up this extra weight along-with the weight of the rider. It also needs change of spokes. Once you put the battery on any wheel (front or rear), you also need to change the spokes as the motor diameter takes some space. The spokes need to be strong enough to hold the weight of the motor. After overcoming these challenges, you need charging infrastructure at the source or destinations. The charging time also matters. The converted bicycles do not look so neat and clean and the factory-made electric bicycles.

Depending on the capacity of the battery the charging time varies from 1 hr to 3 hr. It's very important to provide the charging infrastructure at offices, malls, theatres, shopping areas, parking places for two-wheeler, three-wheeler and four wheelers, and other public places.

To set up the charging infrastructure minimum 10 ft wide x 100 ft+(long) space is needed and it has to be weather proof to withstand rain, heat and cold. The cost land in the cities is high specially in the market areas and malls. Without government push and policy this will not be profitable. Such places need to provide the space for charging infrastructure free of cost.

The cost of electricity also needs to be at the discounted price or at the reasonable price so that it remains affordable to public. It can be charged at the commercial rate; it needs to be at special discounted rate. In doing so we can use the solar energy collected from nearby houses under the various government schemes.

The battery life has to be 4 to 5 years, the higher battery cost will erode the cost saving coming from usage of electricity.

Its ideal to have the battery swapping facility so that driver do not need to wait for hours to charge the battery.

Or the battery charging time has to be between 15 to 30 min.

F. Impedance to Three-wheeler Electric Auto-Rikshaw Adaption

When we talked to various auto drives, it gives us very meaningful insights. Generally, auto drivers work for 10 hours per day. The auto rickshaw covers 150 to 250 KM per day. For them the fueling time matters as they will be having passenger who may not want to wait, so re-fueling must finish in max 5 min.

The passengers sometime demand to go faster as they need to reach the destination on time and hence auto drivers need auto, they can run faster.

Generally, auto rickshaws carry 3 to 4 people so auto-rikshaw must have good power to pull the weights of the passengers.

With above requirements in mind, auto-rikshaw drivers needs a swappable charging point, where they can swap the low charge battery with fully charged battery. In this case, they do not need to wait to get the battery fully charges and they can continue their trip or the less idle time.

Again, this infrastructure has to be available at offices, malls, theatres, shopping areas, parking places for two-wheeler, three-wheeler and four wheelers, and other crowded public places or nearby.

The battery swapping infrastructure will also need some space and it has to be weather proof to withstand rain, heat and cold. The lands in the cities are costly specially in the market areas and malls. Without government push and policy this will not be profitable and feasible. Such places need to provide the space for battery swapping infrastructure free of cost.

The electricity also needs to be at the discounted price or at the reasonable price so that it remains affordable to auto-rikshaw drivers. It cannot be charged at the commercial rate; it needs to be at special discounted rate. In doing so we can use the solar energy collected from nearby houses under the various government schemes.

There has to be some way to convert the existing auto into the electric ones as these drivers cannot afford to buy a new auto. The affordable conversion kits will be really helpful. Or their autos should be exchanges with electric auto at the low exchange price.

The high fuel prices are also impacting the profit margins for auto-drivers as the customers are not willing to pay higher. Switching from petrol to electric option will improve the profit margin and reduce the maintenance cost for them.

The battery life has to be good as they can not afford to pay high cost for this battery that can only last for 3 years.

The programs like battery manufacturer own the battery and auto drivers may them some monthly fees will work better here and is more affordable.

G. Cost of Changing Electric Battery

The charging time of the battery can be calculated using the formula,

Charging Time of Battery = Battery Ah ÷ Charging Current

T = Ah ÷ A

Required charging current for battery = Battery Ah x 10%

A = Ah x 10%

Therefore,

Charging current for 120Ah Battery = 120 Ah x (10 ÷ 100) = 12 Amperes.

But due to some losses, we may take 12-14 Amperes for batteries charging purpose instead of 12 Amps.

Suppose we took 13 Amp for charging purpose,

then,

Charging time for 120Ah battery = 120 ÷ 13 = 9.23 Hrs.

Practically, it has been noted that 40% of losses occurs in case of battery charging.

Then 120 x (40 ÷ 100) = 48 (120Ah x 40% of losses)

Therefore, 120 + 48 = 168 Ah (120 Ah + Losses)

Now Charging Time of battery = Ah ÷ Charging Current

Putting the values;

168 ÷ 13 = 12.92 or 13 hrs. (in real case)

Therefore, a **120Ah battery** would take **13 Hours** to fully charge in case of the required **13A** charging current.

Presuming we have a 48 V battery, 120 AH battery, the charging voltage for most of the time is 13.8 V.

The charging (ah) efficiency of the battery is 0.85 & efficiency of the 12 V charger is 0.7.

Kilo Watt hours from the AC supply
 = 48 V x 120 AH/ 1000(0.85 x 0.7) =

9.6 approx.= 10 units.

The cost of each unit assuming for charging is 5 INR. It will cost us 50 INR.

H. Battery Capacity and range

<i>Battery Capacity</i>	<i>Range</i>	<i>Category</i>
3000 W	350 – 400 KM	Long Range Electric Bicycles
400 – 500 W	100 – 120 KM	Standard Bicycles
300 – 250 W	50 – 60 KM	City Bicycles

Therefore, electric bicycle with 120 Ah and 48 V will give us, 120 x 48 = 5760 W and will cover 400 KM range, that cost of drive will be per one Rupee (INR) 8 KM or 12.5 Paisa per KM or 0.125 Rupee per KM.

I. Conclusion Acknowledgement and Appendix

III. CONCLUSION

The battery powered electric vehicles are much affordable than petrol vehicles but it needs good charging infrastructure in place with capabilities like quick charging and battery swapping. The batter life has to increase and cost has to be reduced. The battery must get charges in less than 30 min or less.

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