

Electric Three-Wheeler: A Next-Gen Transport System for Developing Countries.

Bhushan Magar, Anshul Gangele, Gokul Mahajan

Abstract: *Electric three-wheelers are now a day's becoming an emerging trend in the ecumenical market. Sundry manufacturers are coming into the market with different variants of electric three-wheelers. This paper aims to study these electrically powered three-wheelers comparing with conventional three-wheelers. As three-wheelers are the major source of road convey in developing countries and withal the more frugal one it is very consequential to study those. The conventional petrol engines, three-wheelers are engendering a plethora of pollution due to which electric three-wheelers are becoming a major source of magnetization in cities. Electric three-wheelers are comparatively very eco-cordial as they do not utilize any kind of fossil fuels. This paper aims to find a better alternative for sundry types of conventional three-wheeler running on the road. The exiting conveyances are to be superseded by the conveyance which can be operated utilizing a renewable source of energy, to minimize the unpropitious effects of conventional ones such as air pollution, low efficiency, high running cost, etc.*

Keywords: *Auto-rickshaw, Electric vehicle, Electric three-wheeler, Effects of EV's, Public transport.*

I. INTRODUCTION

India today is dwelling with a lot of traffic quandaries & pollution and which is incrementing day by day. The automobile industry is dealing with tremendous pressure of developing a better technology to make eco-amicable conveyances. Indian regime is withal endeavoring to increment the number of environment cordial as well as efficient public conveyance. In many of the metro cities like Mumbai, there is a facility of public convey like local trains, metro (mass transit system) which can truncate traffic as well as emission quandary as they run on renewable energy sources. But the only quandary with such convey system is it connects only major components of a city, it does not provide end to culminate connectivity. So to provide congruous connectivity Rickshaw, Taxi, Bus, etc. are utilized in the cities. Currently, India is mostly dependent on non-renewable energy resources for energy requisite[1].

Here come the Electric conveyances in the picture, which runs on renewable source of energy and it is withal cost-efficient. Dependency on the non-renewable source of energy like crude oil is not only affecting our health but additionally causing an immensely colossal encumbrance on our economy. Indian regime has set a target of developing 6 to

7 million Electric conveyances in India by 2020 out of which there will be 4 lack Passenger conveyances which will evade a lot of oil requisite and withal minimize inimical gasses emission. The regime is withal providing special subsidies and tax redemptions on Electric conveyances to increment the sale of Electric conveyances. So considering the above facts the paper reviews the system of electric three-wheeler which is being currently utilized in India[1].

The Electric conveyance (EV) is homogeneous to conventional conveyances it involves electric propulsion. The direct current source is utilized to power the electric conveyance, which is stored in the battery. The electric motor is utilized in the conveyance for converting electrical energy into mechanical energy. This energy is then used to rotate the wheels of the conveyance. The only distinction between electric conveyance and conventional conveyance is its power train[2].

Description of Electric three-wheeler:

The electric three-wheeler is commonly utilized for the public as well as goods convey conveyance in urban and semi-urban areas for short distance traveling of 5 to 10 km. These are expeditious and frugal mode of conveying in cities. These are the better alternative for petrol/LPG three-wheelers as they are economic and environment-cordial. These three-wheelers are powered by 700-1400 watt motors for propulsion utilizing which they can run with a celerity of 25-30 km/h. Power required to the motor is stored in a battery of congruous designations[3], [4].

II. WORKING PRINCIPLE OF ELECTRIC THREE-WHEELER

The power train of electric three-wheeler mainly consists of an electric motor, electronic motor controller, and battery[5]. The battery supplies direct current as a potency supply to run the motor, controller and all the other auxiliary units of the conveyance. Motor engenders mechanical energy (rotary kineticism of shaft), which is utilized for propulsion of the conveyance, but it is compulsory to control speed and torque of motor in case of electric conveyances as it requires to commence, stop, or slow-down the conveyance when-ever required, and additionally while starting speed of the conveyance should be gradually increased. Where the controller plays a major role in varying the haste of motor. The controller takes command from the driver and accordingly adjusts the haste of the conveyance. Expeditor is the connecting link between driver and controller which is utilized to increment or decrease the celerity of the conveyance[6]. Fundamental block diagram of the electric conveyance is shown in the Fig.1

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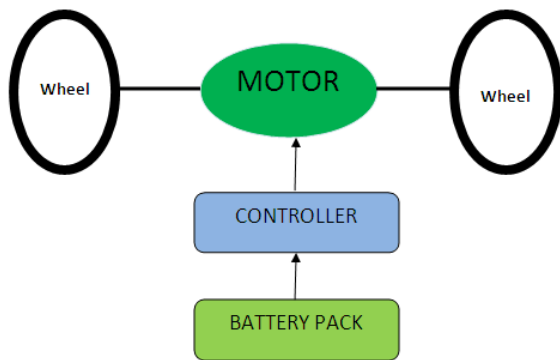


Fig.1 Block diagram of EV

A. Key parts and Components

- a. Electric Motor:
Brush less DC (BLDC) motor of 48V having a potency rating of 700 to 1400 watt is utilized in electric three-wheelers. Its celerity is controlled utilizing an electronic motor controller.
- b. Electronic Motor Controller:
Controller is a devise which turns on/off the motor according to users need. It can run motor in forward as well as in inversion direction utilizing single switch, it can regulate celerity, regulate or limit torque, and withal forfend against overloads. Controller victual input to the motor and other auxiliary units of the conveyance.
- c. Battery:
48V power supply is provided by set of four 12V batteries connected in series. Considering power rating of motor batteries are culled.
- d. Shock Absorbers and Suspensions:
Front wheel of an electric three-wheeler is equipped with Helical spring and damper with hydraulic telescopic shock absorber. Whereas rear wheel is suspended utilizing leaf spring suspensions along with shockers.
- e. Differential:
Differential comes directly connected with electric motor which is connected to rear wheels to minimize the turning radius of the conveyance[7].
- f. Steering:
Electric three-wheeler is equipped with handle bar type steering system.
- g. Brakes:
Internally expanding shoe type drum brake is utilized in electric three-wheeler.
- h. Auxiliary units:
Some of the other parts such as wheels, front lamp, tail lamp, indicators, speedometer, switches, etc. are withal utilized in an electric three-wheeler.

III. EFFICIENCY & POWER RATING OF ELECTRIC THREE-WHEELER

A. Power rating

Power rating of the vehicle is calculated by considering following three resisting forces,

- Rolling resistance
- Gradient resistance
- Aerodynamic drag

a. Rolling resistance:

Rolling resistance is the force resisting the motion when a body rolls on a surface[1], [5].

Rolling resistance is given by the equation :

$$F(\text{rolling}) = C_{rr} * M * g$$

here, C_{rr} represents the coefficient of rolling resistance, M represents the mass of the vehicle including passenger,

g represents gravitational acceleration.

b. Gradient resistance:

Gradient resistance is the highest grade or inclination a conveyance can ascend with a constant haste. In power rating calculation gradient resistance is the most paramount parameter as it requires more power as compared to rolling resistance. But it is only considered in the case of Sports Utility Conveyance or heftily ponderous-obligation conveyance and as electric three-wheeler is consummately different from these conveyances as it is a lightweight conveyance there is no desideratum to consider gradient resistance in electric three-wheelers[8].

Gradient resistance is given by the equation :

$$F(\text{gradient resistance}) = M * g * \sin \alpha$$

here, M , represents the mass of the vehicle including passenger,

g , represents gravitational acceleration,

α , represents angle of inclination of a road with the horizontal.

c. Aerodynamic drag:

Drag (sometimes called air resistance or fluid friction) is a force acting opposite to the relative motion of any object moving concerning a surrounding fluid.

Drag depends on the properties of the fluid and the size, shape, and speed of the object[5]. One way to express this is by using the drag equation:

$$F_D = \frac{1}{2} \rho v^2 C_D A$$

here, F_D , represents the drag force,

ρ , represents the fluid density,

v , represents the velocity of the object relative to the fluid,

C_D , represents a drag coefficient – a dimensionless number,

A represents the cross section area,

Therefore, Power required to move the vehicle is then calculated by using following formula:

$$P(\text{total}) = P(\text{rolling}) + P(\text{gradient}) + P(\text{aerodynamic drag})$$

Lakshya Motor, E-Gati has a power rating of 900 W.[9]

B. Energy requirement and efficiency

Energy or we can verbalize battery capacity is consummately dependent on power rating, maximum speed and range of the conveyance. It is considered accordingly.

Lakshya Motors, E-Gati is equipped with four 80 Ah, 12 V batteries connected in series. For a consummate charge of these batteries, 7 units of electricity are required, and in one charge it covers a distance of 100 km.[9] Ergo, it requires only 0.5 to 1 rupees per kilometer of drive which is very much efficient as compared to conventional three-wheeler. So utilizing electric three-wheeler provides more savings to drivers and additionally it is very good for our environment. On comparing with conventional three-wheelers, Electric three-wheelers are much propitious to users as well as environment.

A incipient technique of Battery swapping has been withal introduces in market to minimize the charging time of the conveyance. In this technique a discharged battery is superseded with a charged batteries so there is no desideratum to keep the conveyance idle while charging the battery. For implementing this technique in the electric conveyance design of the conveyance needs to be scarcely transmuted. The location of the battery must be provided such that we can supersede the battery whenever required without perturbing the passenger. The location of the entire battery is in the rear or front of a conveyance making it compatible in design with passenger automobile’s current layout and can be utilized for floor plans withal[10].

C. Technical Specifications of Electric Three-wheeler

Table 1. Technical Specifications

Sr. No.	Parameters	Specifications
1	Drive Train	Electric
2	Speed	25 km/h
3	Motor Type	BLDC
4	Power Rating	900 watt
5	Tyre Size	90/90 - 12
6	Tyre Capacity	300 kg
7	Transmission Type	Differential
8	Roof	Water proof double coated fiber
9	Brakes	Drum brakes
10	Charger	Automatic 220 V 50 Hz I/P
11	Battery	80 Ah (Lead acid)
12	Mileage	85-100 km/charge
13	Kerb Weight	310 kg
14	Length	2700 mm
15	Width	995 mm
16	Height	1450 mm
17	Turning Radius	3000 mm
18	Front Suspension	Hydraulic shockers telescopic
19	Rear Suspension	Leaf spring
20	Reverse gear facility	Provided

As the manufacturing of an electric three-wheeler is not well standardized its designations withal change company to company.

Here above-mentioned designations are of Lakshya Motors, E-Gati (passenger three-wheeler). Lakshya Motors is an ISO 9001:2015 certified company, located in Nashik, Maharashtra.

Electric passenger and loader three-wheeler is shown in following figure 2 and figure 3.



Fig. 2. Electric Passenger three-wheeler



Fig. 3. Electric Loader three-wheeler

D. Benefits of Electric Three-wheeler

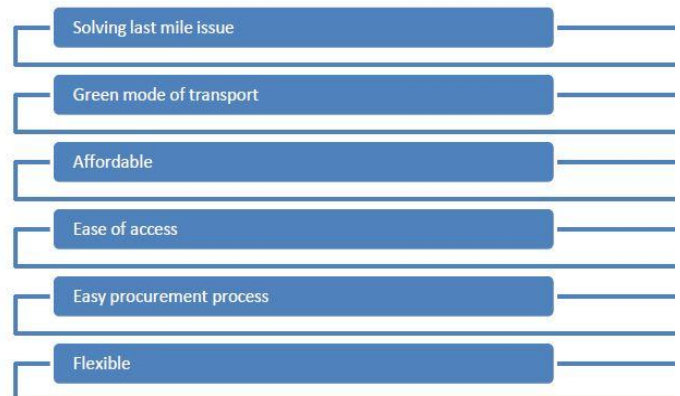


Fig. 4. Benefits of Electric Three-wheeler[11].

IV. PRESENT USES OF ELECTRIC THREE-WHEELER

Currently, Electric three-wheeler is utilized in semi-urban and urban cities like Delhi, Kolkata, Nagpur, etc in India. Electric three-wheeler plays a major role as an end to culminate accommodation in these cities.

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They provide connectivity from railway stations, bus ceases, and additionally from airports to major components of cities. Millions of peoples are now a day's utilizing electric three-wheeler for traveling in major cities. Electric three-wheelers are additionally designed to carry good, and additionally, they can be redesigned to be utilized for other purposes[4].

V. FUTURE SCOPE

- Energy storage is the major part of an electric three-wheeler, which is currently very extravagant and less efficient. In future energy storage systems can be upgraded so that the overall weight of the conveyance decreases and efficiency increases. Conveyances range can supplementally be incremented by ameliorating energy storage systems.
- Current Electric three-wheelers are running on BLDC motors which are quite efficient as compared to Induction motors. So in the future, we can visually perceive the Induction motors in Electric three-wheelers which will make the conveyance more efficient and puissant[2].
- Electric three-wheelers are not yet equipped with the transmission system, In future, it may get equipped with the transmission system thereby incrementing the performance of the conveyance [7].
- Regenerative braking can adscitiously be implemented in Electric three-wheelers as it can result in a lot of energy preserving of the conveyance [12].
- Future electric three-wheelers will be more efficient and potent as compared to the current one.

VI. RESULTS & DISCUSSION

Electric three-wheelers run on electricity so it does not engender any kind of pollution. Even electricity is economical as compared to fossil fuels which amend the efficiency of the conveyance. From below comparison, we can optically canvass that Electric three-wheeler is economical as compared to conventional three-wheeler as its running cost is less[13].

Table 2. Comparison of Three-wheelers

Sr.No.	Fuel type	Mileage	Cost of fuel
1	Petrol	20 km/l	Rs. 81/lit.
2	CNG	21 km/kg	Rs. 44.22/kg
3	Electric	15 km/kwh	Rs. 7-14/kwh

Electric three-wheelers are the best kind of public conveys in developing countries. It solves the last mile issue of such countries. It is very affordable for people as the cost of traveling is very less. Electric three-wheelers are additionally utilized for goods convey in cities.

There is some amendment required in the performance of electric three-wheelers as there celerity and load carrying capacity is very low as compared to conventional three-wheelers. That can be amended by some vicissitudes in the design of the conveyances.

Electric three-wheelers do not have many more regulations and can be manufactured facilely, many minute scale industries can get into this business. Thereby incrementing the GDP of the country.

Overall electric three-wheelers can be termed as a very good conveyance for prevalent people in day to day life.

VII. CONCLUSION

In this paper, we have comparatively studied electric three-wheelers with a conventional one. From this, we can conclude that Electric three-wheelers are better as compared to conventional three-wheelers bases on pollution control, efficiency, and cost. Being environment-cordial and economical electric three-wheelers are the best which one can utilize in daily life for peregrinating. Electric conveyances can be termed as the only solution for conventional conveyances in developing countries.

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