

DESIGN AND FABRICATION OF FOLDABLE ELECTRIC THREE WHEELER

Submitted in partial fulfillment of the requirements

for the award of

Bachelor of Engineering degree in Automobile Engineering

By

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SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited with grade “A” by NAAC

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **THANGZAMUANA (Reg no : 38860017)** and **ERIC JOHN (Reg no : 38860004)** who carried out the project entitled "**DESIGN AND FABRICATION OF FOLDABLE ELECTRIC THREE WHEELER**" under my supervision from November 2021 to April 2022

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DECLARATION

We, **THANGZAMUANA** (Reg no: **38860017**) and **ERIC JOHN** (Reg no: **38860004**) hereby declare that the Project Report entitled “**DESIGN AND FABRICATION OF FOLDABLE ELECTRIC THREE WHEELER**” done by us under the guidance of **Mr. DILLIP KUMAR SAHOO, M.E., (Ph.D.)** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Automobile Engineering.



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ABSTRACT

Electric vehicles has become a recent trend in automotive sector as it is environmental friendly and emits zero emission, compared to the IC engines. The main goal of this project is to design and create a comfortable and cost-effective foldable electric three wheeler. A Lithium ion battery is used for better charging and light weight material is used for the body construction to make the vehicle light weight. The customized electric three wheeler is more suitable for different abled person. This vehicle can be folded at two junction one at front fork and another one at the central body portion which enabled a compact size and can be easily transported. The full charging time for the battery is upto 2hrs and can run upto 45km at a maximum speed of 35kmph. It is an unavoidable aspect of modern living that vehicular transportation is required in many areas. Unfortunately, there is a sizable population who has trouble getting into an automobile. This can be utilized by those who have disabilities and require the assistance of a caregiver. In such cases there is a need for a convenient means of transportation for the handicapped. In today's world there are some amount of population that are physically challenged that still dreams of either riding a bike or a car. It has been a challenge for decades to come up with suchan idea to provide the same to those people. There is a requirement of easy to operate and handle type of vehicle. . In this foldable electric three wheeler the vehicle is powered by a Brushless Direct Current (BLDC) hub motor. The power supply is done by a parallel connection of two Lithium-ion batteries of 36V each. The differently abled person can operate the vehicle by turning on a switch that supplies power to the DC motor located at the front wheel.

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CHAPTER 1

INTRODUCTION

Electric vehicles has become a major agenda for automotive manufacturers as they produce zero emissions and are more environmental friendly than IC engines. Particulate matter and toxins released into the atmosphere by gas-powered vehicles can aggravate asthma and irritate respiratory systems, whereas EVs do not. Also, in extremely densely populated areas where EVs are commonly used, traffic congestion means that flexibility is critical in terms of reducing trip times. They also do not require gasoline, and because they are a light vehicle with a low power demand, recharging them is within many people's budgets. Based on life cycle emission analysis, EV's emit significantly less pollution per km than cars.

Three wheeler being a compact and light weight vehicle, it is an adequate means of transportation in the modern world. Electric three wheelers can have two types of design: tadpole and delta type.

Tadpole design: Three wheeler having two wheels at the front and one at the rear.

Delta type: Three wheeler having two wheels at rear and one at front.

Both design types have their own share of advantage and disadvantages in regards to performance, rigidity, and safety parameters.

1.1 ELECTRIC VEHICLES:

Electric vehicles (EVs) offer an opportunity to replace fossil fuels in the transport sector. Electrification of the transport sector can also bring benefits in terms of increased energy efficiency and reduced pollution.

1.1.1 Environmental friendly:

The main advantage of electric vehicles is the contribution they can make to improving air quality in towns and cities. Pure electric vehicles emit no carbon dioxide emissions while driving because they do not have a tailpipe. This significantly reduces air pollution.

1.1.2 Reduce noise pollution:

Air pollution is not the only pollution that having electric vehicles (EVs) will change. Noise pollution will also be reduced and the roads around us will be much quieter. Switching from the engine roars of petrol and diesel vehicles to the simple quiet whirl of EVs making a huge difference.

1.1.3 Less fuel cost:

When compared to petrol and diesel, electricity is cheap in India. For example EV Tata Nexon consumes around 30 units of electricity for full charge. There are fluctuations in petrol and diesel prices but electricity prices are mostly constant

1.1.4 Less maintainance cost:

Electric vehicles don't need engine oil and servicing for every three months. They are a one-time investment for lifelong benefits.

1.2 BACKGROUND OF ELECTRIC VEHICLES:

Electric vehicles first appeared in the 19th century. Previously, they did not fare well in the market due to their high cost, slow speed, and short range. As a result, initially, global demand fell. However, they have been used for transportation and public transportation, particularly as rail vehicles. As environmental concerns grew in the twenty-first century, gas-powered vehicles emit a lot of smoke and are extremely harmful to the atmosphere.

As a result, interest in electric vehicles has grown. Electric cars were popular among those who drove them in cities, where their short range was not an issue. Another factor that contributed to its success was the fact that it did not require changing gears, making it a simple option. It didn't have any vibrations or sounds. It didn't need to be started manually, which was also a positive point.

Electric vehicle acceptance has been limited by a lack of power infrastructure. An exchangeable battery service was initially proposed in 1896 in order to address the limited operational range of electric cars and the absence of recharging infrastructure.

Hero Cycles introduced a series of bikes in 2007 in collaboration with ULTRA Motor of the United Kingdom. Other firms such as Electrotherm India, TVS Motor, Hero Electric, and others became known for their electric bikes. They also manufacture and market their own goods. In addition, in 2017, Etrio secured over \$3 million from HNIs and set out to convert existing gasoline-powered commercial vehicles into electric variations, setting a new standard for economical and environmentally friendly transportation.

CHAPTER 2

LITERATURE SURVEY

Numerous numbers of initiatives have been taken up by both the public and the government to uplift and motivate the differently abled person in terms of socializing and commuting. Some initiatives has been taken in order for the differently abled person to have access to public facilities and transport. The foldable electric three wheeler can act as a means of transportation and is suitable for the differently abled person to commute for daily use.

(1) US patent application number 841,754, Nobuyuki Kanno: A tricycle including a front frame with a front wheel mounted thereon, and a rear frame having two adjacent and parallel wheels linked to the front frame so that the front frame's center is offset to one side of the tricycle relative to the rear frame's center. Furthermore, if the tricycle is motorized, the motor is attached to the rear frame in such a way that the engine's center of gravity is shifted to the opposite side of the tricycle from the back frame's center.

(2) Japanese patent number 6,104,154, Tomitaro Harada, Ryoji Iwakiri, Ichiro Kagawa: A tricycle with an electric motor that has two rear wheels and that are powered by both an electric motor and manual pedals. The rotational force of the pedals is transmitted to the driving shaft via first bevel gears and then via second bevel gears from the drive shaft to a one-way clutch.

(3) US patent number 9,731,785, Yongbiao Liu: A tilt-able electric tricycle according to the present invention includes the following components: a frame, a front fork mounted to the frame, a front wheel with hub motor mounted to the front fork, a seat, a steering handle bar, a pair of laterally spaced rear wheels on a common axle, and a support base with two quick release clamps for securing the axle of the rear wheels, furthermore the bottom tube points to the ground contact point of the front wheel; furthermore the frame has a horizontal oriented metal plate at the rear end of the bottom tube positioned above the support base of the rear wheels.

(4) US patent number 10,875,596, Bravo Sports: A scooter with at least two front wheels, a rear wheel, a deck, a steering assembly consisting of a handlebar and a steering tube, an electric motor configured to supply power, and a transmission configured to transmit the electric motor's power. The transmission can be set up to send all of the power from the electric motor to the rear wheels. The scooter may have a battery, a power switch, and a controller that is connected to the power switch, the battery, and the electric motor in some versions. The controller ramps up the voltage given to the electric motor over a period of time in response to a signal from the power switch.

(5) US patent, publication number US 2020/0361560, Mathias Claes: An electric scooter that is foldable has been presented herein. The electric scooter comprises at least a first platform, a second platform, and a hollow member with a handlebar assembly. The first platform and the second platform are removable or fixedly attached or connected to each other by means of a folding mechanism. The folding mechanism comprises a plurality of components, a cylindrical nut, and one or more legs.

(6) Aditya Ganjapure et al. (2016): As road pollution rises in tandem with population expansion, the necessity for an alternative mode of transportation that allows for easy surfing in congested locations while producing zero pollution is becoming apparent. As a result, the design, fabrication methods, and characteristics of a compact three-wheeled foldable electric moped are discussed in depth in this study. It also goes through the main components of this electric moped and how it works in depth.

(7) Mrs. Swati Dhamale et al. (2018): A typical human being has a wealth of mobility resources at their disposal, but physically disabled people have fewer options because few automotive manufacturers focus on them. Hand-operated tricycles or modified scooters are used by the majority of physically challenged people. Mechanical tricycles necessitate more human work and are time consuming. Modified scooters, which are powered by an IC engine, are one of the better options, but they are expensive and require regular maintenance. In light of

the constraints of the previous solutions, this project tries to design an environmentally sustainable tricycle propelled by an electric motor. This tricycle is both practical and economical for a handicapped person, as money is a big concern for them.

(8) K. Ramash Kumar et al. (2019): This paper investigates the design and manufacture of an electric vehicle (EV) for physically challenged individuals. In the current situation, a physically challenged individual faces a transportation dilemma while travelling from one location to another without safety or convenience. They have a hard time reacting to the event in front of them. To address these issues, an Electric Vehicle (EV) was created that allows them to travel comfortably and safely. The battery, electronic commutator with control unit, BLDC motor, and mechanical frame are the main components of an electric vehicle. In comparison to existing vehicles, the created EV has the following advantages: no pollution, no fuel expense, less weight, redesigned mechanical structure, high pulling capacity, comfortable spacing for person travel, easy maintenance, and fewer components

(9) Jayaprabakar J et al. (2016): Moving into areas like bus stops, hospitals, universities, schools, railway stations, and airports is always a difficult task for patients, the disabled, and the elderly. In this study, a cheap electric bike was created and manufactured for the benefit of such persons. The four-wheeled electric bike designed here has three rear wheels and one front wheel. The vehicle also features one carrier basket and two pillions, which can accommodate two people and a driver. An electric motor is used in electric vehicles (EVs), which is powered by electricity stored in batteries. The electric car is designed to have a number of benefits, including little noise and zero emissions. Furthermore, electric vehicles are designed to use less energy than vehicles powered by internal combustion engines. In addition to the efficient propulsion technology, there are no energy losses due to transmission or idle. The goal of this research is to design and produce a highly compact vehicle that can enter buildings and structures such as industries, hospitals, and other indoor and outdoor locations. The recommended design was made and put to the test to see if it was compatible.

The vehicle was designed to be light in weight in order to extend its range and carry more weight. The car was designed to be as low-profile as possible, but ground clearance is also taken into account for its usability on Indian roads.

(10) Sharad Patel et al. (2016): In today's world, college and industry infrastructure is expanding, so if one needs to go or visit from one location to another, he must walk a considerable distance, which can be time consuming and inconvenient. When you wander around campus too much, your body can get strained and painful. So two-wheeled or three-wheeled electric scooters like the Segway PT was introduced to cover these distances. However, these scooters are quite expensive, starting at ₹50,000. Another issue with those vehicles is that they are tough to control the first time we drive them. As an alternative to this product, we devised a completely new design that is a dependable, environmentally friendly, and compact vehicle for campus use. College campuses, airports, industries, recreational parks, sanctuaries, museums, palaces, and villas are among its amenities. As a result, our study focuses on the design and development of three-wheel campus vehicles, as well as their multifaceted utility in society.

(11) Ranjan Kumar et al. (2018): The major goal of this review article is to present the concept of harnessing various forms of energy and putting them to use in today's world of human living. There are so many vehicles on the road nowadays that they burn more gasoline and endanger our environment. It is our job to cut down on gasoline consumption and the harmful emissions it produces. Taking this into account, it is our modest contribution to minimising the usage of more fuel-consuming cars and attracting people's attention to their alternatives, such as the electric bicycle. As a result, we want to build a battery-operated cycle that will run on an alternative source while also minimising human labour. In this study, we propose an alternative way of transportation for the benefit of the environment.

(12) Manisha Bhadade et al (2020): Our project's main goal was to create an environmentally friendly portable automobile that could be operated by both men and women and would emit zero emissions. We have employed a D.C motor as our primary power source, which produces no emissions and eliminates the problem of fuel usage. We also chose to build a triscooter that can be folded easily, so that after use, one may fold the triscooter and carry it with him/her. When the triscooter is "folded" into a compact size, our design allows customers to conveniently move it while taking up less space.

(13) Sachin Johny et al. (2020): Sustainable and flexible forms of transportation are becoming increasingly popular, owing to their economic and environmental advantages. It has shifted automakers' primary focus to electric automobiles. Cycling has been a popular means of short-distance travel in recent years, owing to its health benefits and versatility. They are, however, difficult to transport. As a result, adding a folding mechanism to the current design can help it be more portable. In addition, the addition of an electric motor improves the cycling experience in a harsh environment. The design, development, and construction of a foldable electric bicycle from a regular bicycle are described in this study. Folding and locking mechanisms are designed and manufactured during the design and construction process.

2.2 PROBLEM IDENTIFICATION :

Means of transportation for differently abled person has always been a challenge for the past few decades. Numerous initiatives has been taken up by both the government and the public and various organizations. Their objective regarding the transportation for a differently abled person goes alongside the slogan of greener energy(zero emission vehicle). Apart from the vehicle for differently abled person most vehicles available in the market has started using electricity as a means of its powerhouse. Decades of research has been taken up by various automotive manufacturers.

A small amount of population belonging to the differently abled group always had a dream of accessing all kinds of commodities available to an average person. Driving has always been a distant dream for a portion of this population. It has been a challenge for the past decade for manufacturers to come up with a solution to provide mobility to those. Different technologies such as motorized wheelchair has been produced for the past. Despite this we have failed to provide a better means of transport which can be used as daily commuting.

Three wheelers has become a recent trend, but there are few downsides in the present situation. Transportation cost has always been an issue, and there is a need for compact, subtle, and easy to operate design.

Therefore, the foldable electric three wheeler could rectify the downside being faced by the past invention. Its foldability will play major role in cutting down transportation cost making it compact. The concept of a simple mechanism has been adapted in this design in order to achieve ease of operation mainly for the differently abled person. With this design the above mentioned minority of population will be able to commute with comfort and that distant dream of theirs can be fulfilled

CHAPTER 3

AIM AND OBJECTIVE

3.1 AIM:

The major aim of this project is to develop and build a foldable electric three-wheeler that is both comfortable and cost-effective. Electric vehicles are thought to be 99 percent cleaner than gasoline-powered vehicles since they release no exhaust emissions that might pollute the air with particulates. Particulate particles and pollutants discharged into the atmosphere by gasoline-powered vehicles can aggravate asthma and irritate respiratory systems, whereas EVs do not. Electric vehicles, which are powered solely by electricity rather than internal combustion engines, are pushed by electric motors. Because it's a folding tricycle, it'll be simple to travel from one location to another.

3.2 OBJECTIVE:

The main objective of this project is to design and fabricate a foldable three wheeler that will be easy to use and affordable and cheap to operate. The foldable three wheeler is designed in such a way that it is suitable for a differently abled person to operate. The project concentrates on users who are differently abled in order to give them a convenient means of transport, this vehicle will allow them to move around freely with ease and help them move from one place to another. A Lithium ion battery is used for better charging and light weight material for the body construction to make the vehicle light weight. The fact that automotive mobility is essential in many regions is an inevitable part of modern life. Unfortunately, a significant portion of the population has difficulty getting into a car. Those with disabilities who require the assistance of a caregiver can make use of this. In such instances, handicapped people require a convenient mode of transportation. In today's environment, a sizable portion of the population is physically challenged yet nevertheless wishes to ride a bike or drive a car.

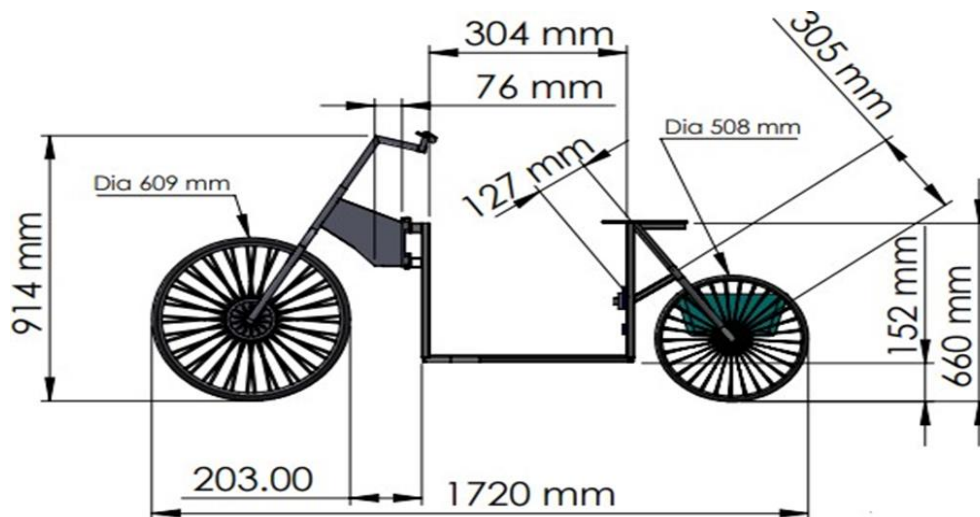
CHAPTER 4

MODELLING AND DESIGN

4.1 DESCRIPTION OF DESIGN

The design has been carried out using CAD software. CAD model of the three wheeler is made with SOLIDWORKS. 2D and 3D model can be made with SOLIDWORKS. Part design is the first phase in component design, followed by assembly. Surfaces, edges, and faces can be used to create 3D geometries in SOLIDWORKS component models. Beams, weld bead joints, surfaces, and edges are included in the tricycle model created with 3D geometrical tools.

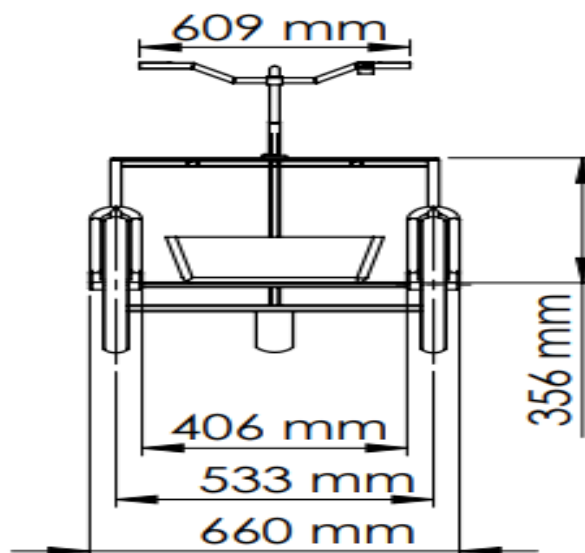
SOLIDWORKS was used to create a CAD model of a tricycle. Frame structure, steering, wheel hubs, braking space, wheels, tyres, motor space, and shock absorbers are all included in the model. The CAD model does not include the motor, batteries, motor controller, or any operational wire components. Motor, Batteries, Motor Controller, Wheels with brakes, steering geometry, and shock absorbers for all wheels are some of the parts that were simply copied from an older type of electric moped. The research methodology focuses on converting the frame of an outdated two-wheeler electric moped into a frame for a three-wheeled vehicle.



ALL DIMENSIONS ARE IN MM

Fig 4.1 Side view of the three wheeler in assembly state with dimensions.

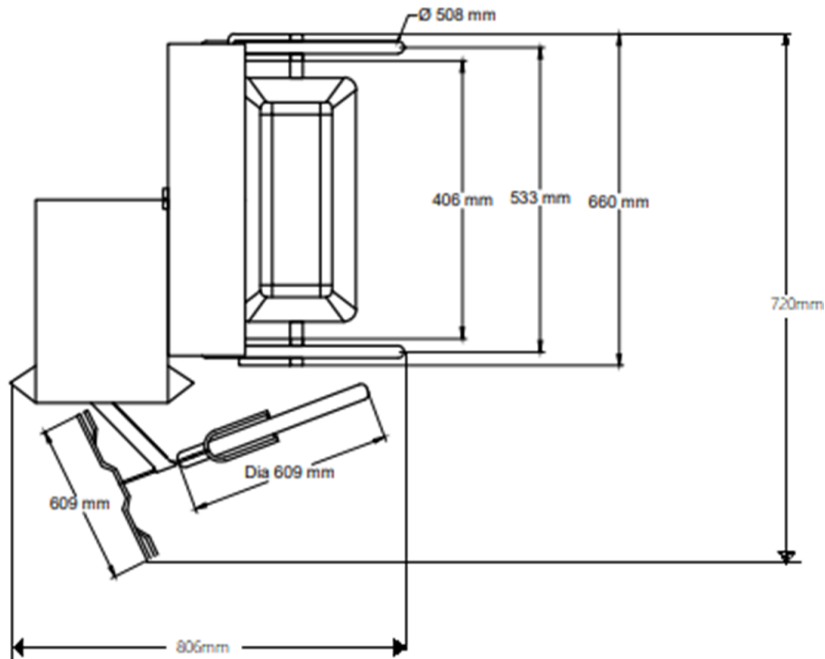
Fig 4.1 shows the schematic diagram of the foldable three wheeler which is made using CAD software called SOLIDWORKS. In this diagram detailed dimensions of the vehicle is shown. The figure shows the two dimensional side view of the foldable three wheeler at an assembly state in which different components of the three wheeler are in place.



ALL DIMENSIONS ARE IN MM

Fig 4.2 Rear view of three wheeler in assembly state with dimensions.

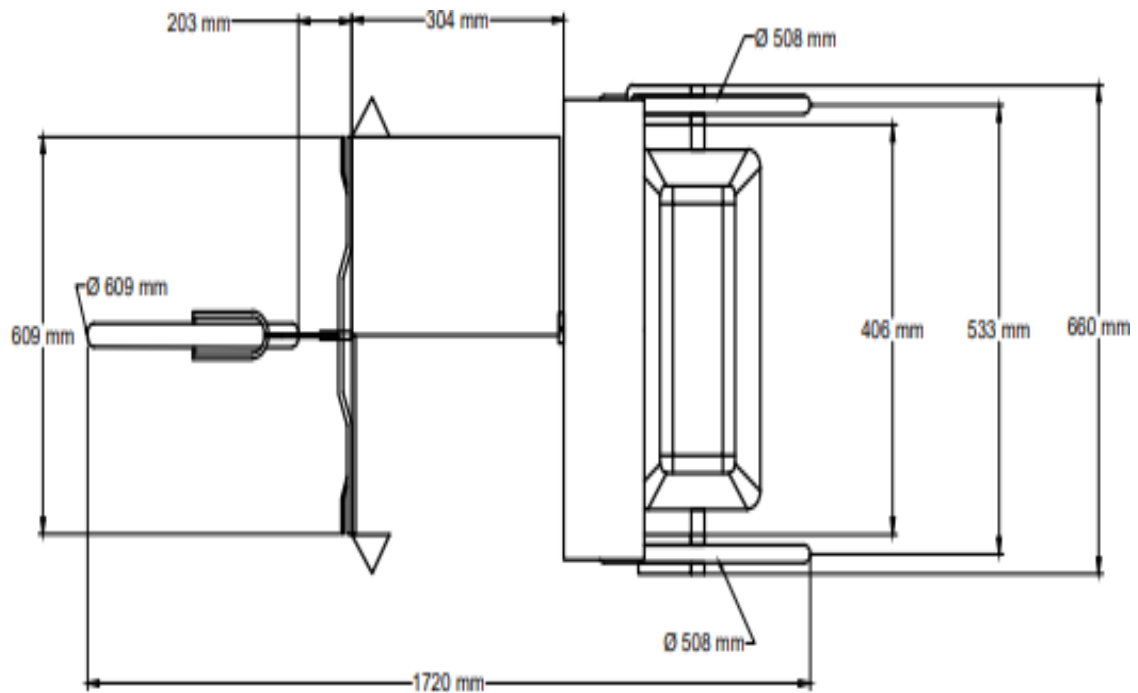
Fig 4.2 shows the two dimensional rear view of the foldable three wheeler in assembly state with detailed dimensions. The schematic diagram shown in figure is the schematic diagram made using CAD software called SOLIDWORKS.



ALL DIMENSIONS ARE IN MM

FIG 4.3 Top view of the three wheeler in folded state with dimensions.

Fig 4.3 shows the two dimensional schematic diagram of the top view of the foldable three wheeler in folded state with detailed dimensions. The schematic diagram was made using CAD software called SOLIDWORKS.



ALL DIMENSIONS ARE IN MM

Fig 4.4 Top view of the three wheeler with dimensions.

Fig 4.4 shows the two dimensional schematic diagram of the top view of the foldable three wheeler in assembly state with detailed dimensions. The schematic diagram was made using CAD software called SOLIDWORKS.

1. Rectangular basket
2. Rear wheel
3. Seat
4. Foot rest
5. Rear brake lever
6. Front brake lever
7. Rear wheel
8. Rear axle

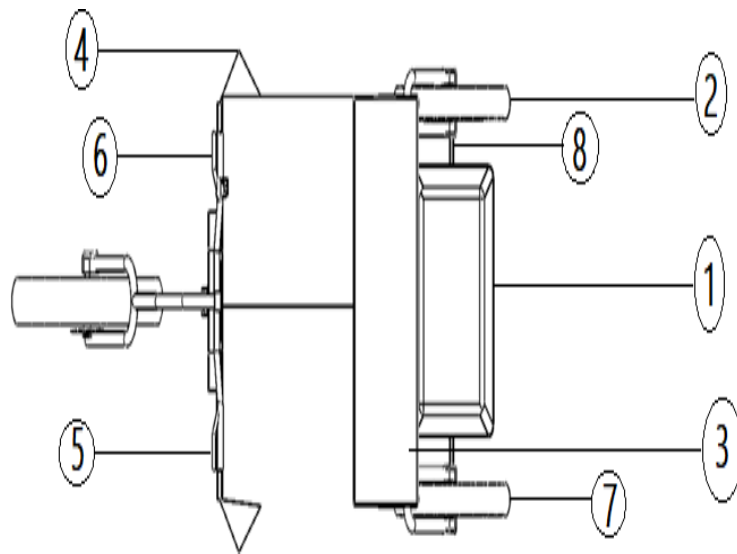


Fig 4.5 Top view of the three wheeler.

As shown in FIG 4.5 the top view of the three wheeler consist of a rectangular seat, a rectangular basket, rear wheels and, a rear axle, a foot rest, a front brake lever and a rear brake lever. The rectangular seat is attached on top of the main body structure, the rectangular basket is attached just below the rectangular seat, the rear wheels and are attached to a seat stay welded below the rectangular seat. A rear axle is located at the center of the wheel, a foot rest is welded on the lower part of the main body structure, a front brake lever and a rear brake lever are attached to the handle of the vehicle.

9. Heat tube.

10. Controller panel.

11. Controller.

12. Seat stay.

13. Main switch.

14. Hinge 1

15. Hinge 2

16. Hinge 3

17. Main body

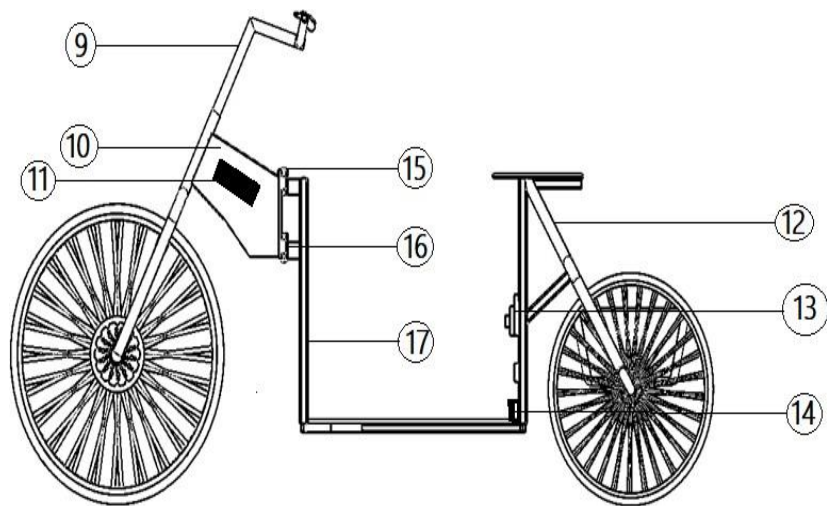


Fig 4.6 Side view of the three wheeler.

As shown in FIG 4.6 the side view of the three wheeler consists of a head tube which is connected to the handle and the front fork, that allows the vehicle to turn smoothly, a controller panel in which the controller is attached that controls the power delivery to the hub motor. A hinge 2 and a hinge 3 is fixed on the forward section of the main body that allows the vehicle to be foldable. The forward structure of the main body is welded on to the lower frame. A seat stay connecting the main frame and the seat stay giving a rigid structure, a main switch is mounted on the rear panel of the body for turning the vehicle on and off. A hinge 1 located below the seat at the mid section of the vehicle allowing the vehicle's second folding movement.

18. Handle.

19. Battery level indicator.

20. Throttle.

21. Hinge 3 mount.

22. Hinge 2 mount.

23. Rotary disc.

24. Poly carbonate panel.

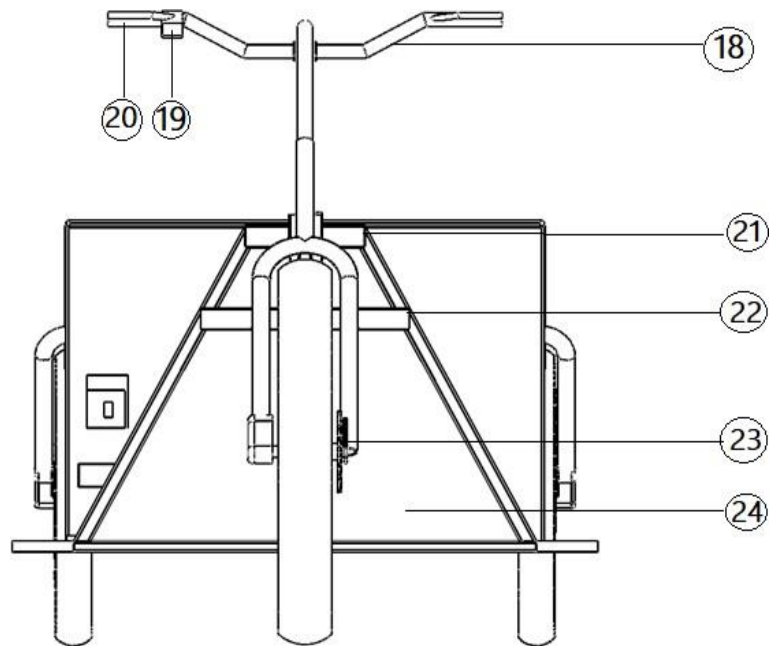


Fig 4.7 Front view of the three wheeler.

As shown in FIG 4.7 the front view of the three wheeler consists of a throttle and a battery level indicator attached to the handle allows the delivery of varying speed to the motor via the controller. Hinge 1 mount and a hinge 2 mount welded on the forward section of the body frame providing support to the hinge 1 and hinge 2. The rotary disc located at the center of the front wheel attached via an axle allows efficient braking to the vehicle operated by the front brake lever ,a poly carbonate panel provide a cover to the forward section of the main body of the vehicle.

25. Seat frame.

26. Seat stay.

27. Cross member.

28. Seat stay.

29. Mid frame.

30. Head tube.

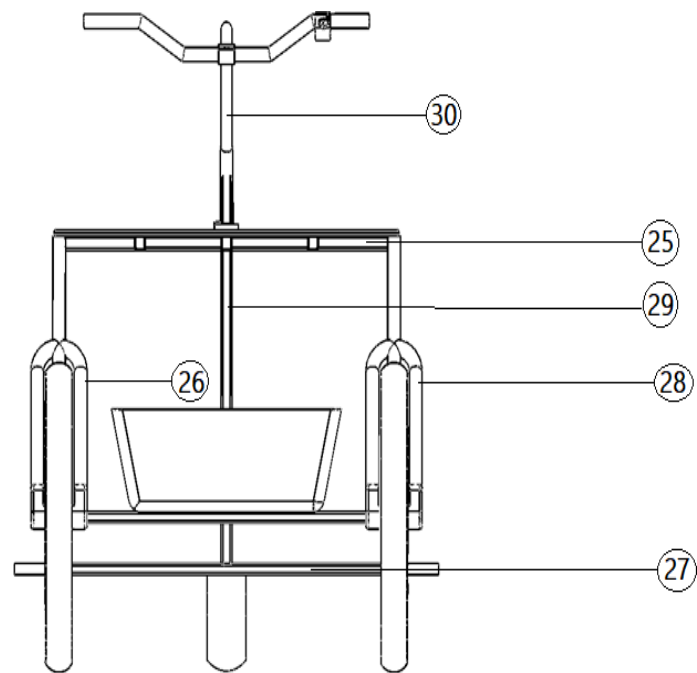


Fig 4.8 Rear view of the three wheeler

As shown in FIG 4.8 rear view of the three wheeler consists of head tube connected to the front fork providing support to the front end of the vehicle, a seat frame is welded on the back side of the vehicle's main frame providing support to the seat and the rider sitting on top. A mid frame welded vertically on to the rear end of the main structure below the seat providing a rigid structure. A seat stay and are welded to the main frame at the rear end via a circular tube to provide support at the rear end. A cross member connecting both sides of seat stay and providing a torsional support.

- 31. Seat frame
- 32. Brake lever
- 33. Inclined member.
- 34. Front fork.
- 35. Linear frame member.
- 36. Spoke.
- 37. Hub motor.

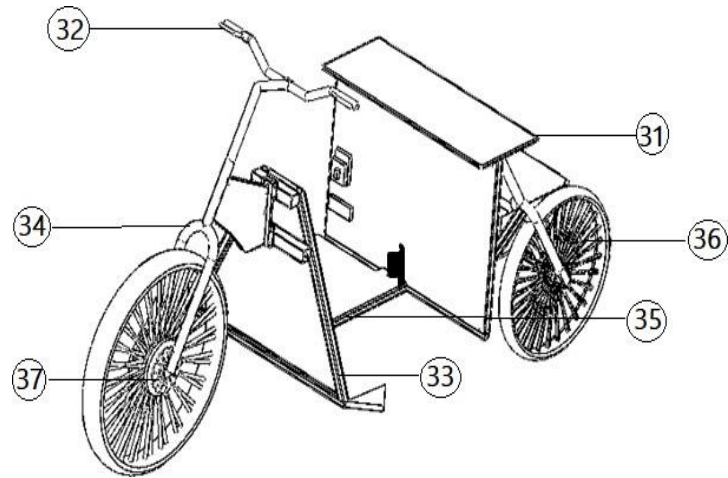


Fig 4.9 Isometric view of the three wheeler.

As shown in FIG 4.9 an isometric front view of the three wheeler consist of a brake lever wiring connection connected with the front brake that allows a power cut to the motor while applying brakes, a front fork that is connected with the head tube and holds the front wheel in place via an axle meanwhile providing support to the front end of the vehicle, a 36V hub motor that converts electrical energy to a rotating mechanical movement having rating of 350W acting as the main working component of the vehicle giving it a linear motion. A rectangular wooden seat frame is welded to the main frame. Spoke connecting the wheel hub and the wheel rim. An inclined member welded to the main frame giving an additional support to the vehicle, a linear frame member connecting the forward and rear section of the vehicle's main frame.

38. Hinge nut and bolt.

39. Li-ion battery.

40. Li-ion battery.

41. Rear frame.

42. Cross member.

43. Charging port.

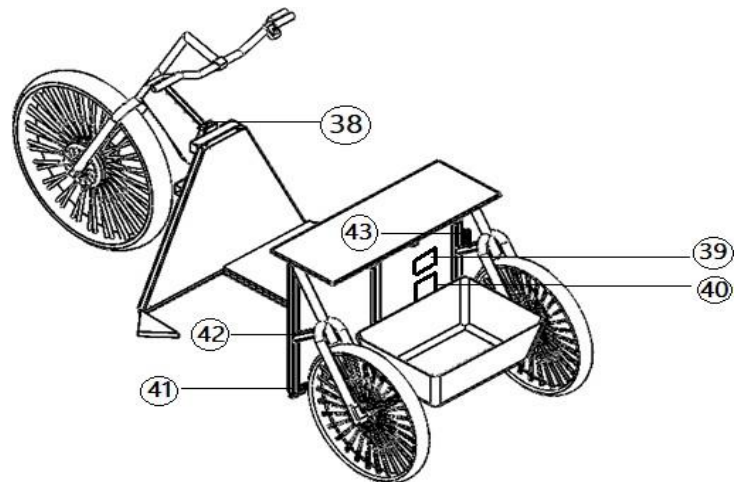


Fig 4.10 Isometric view of the three wheeler.

As shown in FIG 4.10 an isometric rear view of the three wheeler consists of a hinge nut and bolt that allows the hinge to fold after removal, a plug attached at the right side of the vehicle for charging the 36V lithium ion batteries and efficiently, the combination of two lithium ion batteries and provides advantage over a lead acid battery giving it a higher capacity and fast charging. A cross member acts as a linkage between rear frame and a seat stay providing a resistance toward pivoting movement. A charging port mounted at the right side of the vehicle.

CHAPTER 5

FABRICATION

This project involved the creation of detailed drawings, as well as the finalization of a cost-effective solution. This vehicle has one front wheel and two rear wheels, with a hub motor on the front wheel. The front wheel and the steering handle were linked. Disabled people can drive by twisting the throttle with their hands and applying brakes to the front and rear wheels with brake levers. The driver can sit in the spacious front seat, which also has a basket carrier. To achieve the proposed design, this type of vehicle's manufacturing includes material selection for the chassis, which was built by cutting mild steel and arc welding it together. Design techniques are also used to choose the rear axle, wheels, and bearings. Following the installation of the front fork, a polycarbonate sheet was used to cover the whole body of the vehicle as well as the seats. Finally, the wheels and hub motor were installed, and an electrical connection was established with the use of a battery.

5.1 FRAME

A vehicle frame, also known as its chassis, is the main supporting structure of a motor vehicle to which all other components are attached, comparable to the skeleton of an organism. Until the 1930s, virtually every car had a structural frame separate from its body. This construction design is known as body-on-frame. To support the vehicle's mechanical components and body. To deal with static and dynamic loads, without undue deflection or distortion. It's welded to the axles, and it holds the body and motor in which the frame should be stiff enough not to break under strain. A vehicle frame forms the basis of an automobile.

The tricycle's supporting member, the frame, is subjected to both static and dynamic loads. It can also withstand a variety of stresses, including vertical loads, cornering loads, side thrust, acceleration, and braking dip. The frame is covered in various accessories and components. A frame should be strong enough to withstand all of the mentioned loads. The frame's material must be inexpensive. We chose the frame based on the pipe sizes available, the maximum stresses

created in the key component, and the safety factor available. The following are the specs for a particular hollow pipe.

- Material: AISI 1018 (Mild/low carbon steel)
- Outer diameter: 25mm
- Thickness: 1.2mm
- Ultimate tensile strength: 440 N/mm²



Fig 5.1 Three Wheeler Frame

5.2 FOLDABLE JUNCTION :

A foldable electric three wheeler consist of two hinges located at the front and rear of the main body of the vehicle providing foldable operation that reduce the length upto 914mm as shown in the figure below. During the initial folding the front wheel with the handle and control pannel moves towards left approximately 90 degree which reduces the length upto 384mm. The final folding junction located below the seat i.e at center which rotates the main body direction towards the left which could be easy to fold and carry.



Fig 5.2 Initial Folding Of Three wheeler



Fig 5.3 Final Folding Of Three wheeler

Table 5.1 Dimensions of the three wheeler

Total Length Before Folding	1720 (mm)
Total Length After Folding	806 (mm)
Breadth Before Folding	660 (mm)
Breadth After Folding	720 (mm)
Height	914 (mm)

5.3 COMPONENTS OF THE THREE WHEELER

The electric three wheeler comprises of different components that are arranged and connected in order. Each components have different specification and have different function. All components needs to be connected in a proper manner in order to make the vehicle run in a good working condition.

The main components are:

- BLDC hub motor
- Li-ion battery
- Controller
- Charger

5.3.1 BLDC hub motor:

Permanent magnets move around a fixed armature in a brushless motor, eliminating the complications associated with supplying electricity to the moving armature. The brush/commutator assembly of a brushed DC motor is replaced by an electronic controller, which continuously shifts the phase to the windings to keep the motor spinning. Instead of employing a brush/commutator system, the controller uses a solid-state circuit to conduct equivalent timed power distribution. The axle is held solid in hub motors so that it cannot move and the entire motor begins to rotate.

Brushless motors provide various advantages over brushed DC motors, including higher torque per weight, higher torque per watt, better efficiency, increased reliability, decreased noise, and a longer lifetime. They are not subjected to centrifugal forces because there are no windings on the rotor, and because the windings are supported by the housing, they may be cooled by conduction, requiring no airflow inside the motor for cooling. As a result, the internals of the engine can be completely encased and protected from dirt and other foreign matter. The BLDC motor has an efficiency of 84 percent.



Fig 5.4 36v 350w BLDC hub motor

Table 5.2 Hub motor specifications

Properties	Values
Rated power	350 W
Voltage	36 V
Speed	600 RPM
Current	10 A
Torque	60 Nm

5.3.2 Li-ion battery

A lithium-ion battery, often known as a Li-ion battery, is a rechargeable battery made up of cells in which lithium ions travel from the negative electrode to the positive electrode through an electrolyte during discharge and then back again during charging. The positive electrode of a lithium-ion cell is made of an intercalated lithium compound, while the negative electrode is usually made of

graphite. Lithium-ion batteries have a high energy density, little memory effect (with the exception of LFP cells), and a low self-discharge rate. Cells can be made to optimize either energy or power density.

The electrodes of Li-ion batteries can be made of a variety of materials. The most popular combination is lithium cobalt oxide (cathode) and graphite (anode), which can be found in cellphones and computers. Lithium manganese oxide (used in hybrid and electric vehicles) and lithium iron phosphate are two other cathode materials. Ether (a class of organic chemicals) is commonly used as an electrolyte in Li-ion batteries.



Fig 5.5 36v Li-ion battery

5.3.3 Controller

The controller is the heart of an electric car, and it's the key to maintaining a high-performance vehicle with the right combination of top speed, acceleration, and range per charge. The controller is responsible for connecting the motor to the power source (battery). It maximises energy conversion by controlling speed and direction. The torque-to-speed ratio is usually controlled by the controller. The armature current is used to control torque, whereas the armature voltage is used to control speed. Chopping source current is used to control voltage; the voltage is

turned on and off, with the ratio of on-to-off setting the average voltage. The number of constant-width "on" pulses per unit time can be changed, as can the pulse width (duration). Diodes, thyristors, and silicon control rectifiers are used in power electronics circuitry to execute chopping (SCRs). The efficiency of a controller is usually 90%. The intended use of a motor controller is to manage the performance of an electrical motor.

The characteristics of a DC motor controller are determined by the type of motor (brushed, brushless, or stepper) and the functionality of the device that employs it. In comparison to an industrial DC motor controller for a brushed motor, an electric vehicle DC motor controller for a brushless DC (BLDC) motor has a distinct design and working principles.



Fig 5.6 Controller

5.3.4 Charger

After 45 kilometres of running, the battery will be drained and will need to be recharged. A charger is required for charging purposes. Batteries cannot be charged directly from an AC power supply. It requires the conversion of AC current to DC. Charger Converting AC to DC is a simple process. To provide constant voltage, it consists of a step down transformer, rectifier, and filtering circuit.

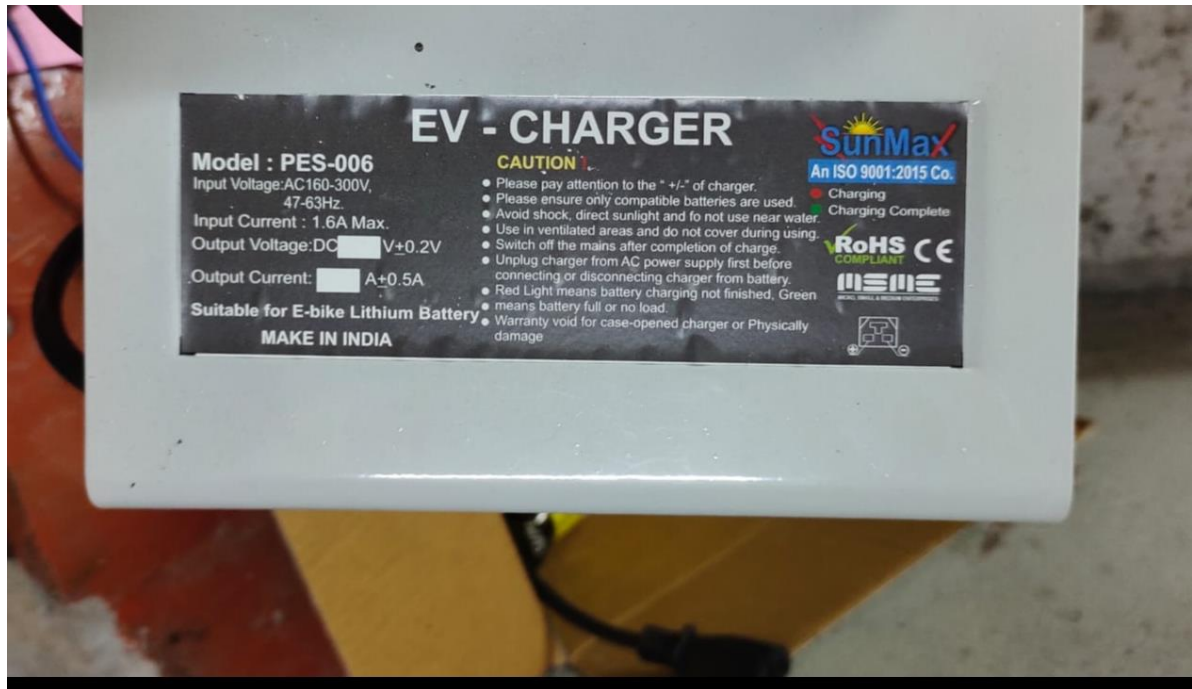


Fig 5.7 Charger

5.4 FABRICATION PROCESS:

The fabrication of the foldable electric three wheeler was carried out in different stages. The mild steel was selected as the material for the frame providing a rigid structure. The mild steel are being cut and welded in such a manner to form a rigid structure providing a frame for the foldable electric three wheeler. The foldable electric vehicle requires the assembly of different components in appropriate manner in order to successfully operate the three wheeler. The initial stage of the fabrication process is welding different section of mild steel to form the frame of the thre wheeler successfully.



Fig 5.8 Initial stage of fabrication.

Fig 5.8 shows the initial stage of the fabrication, the three wheeler frame has been welded together and a hinge is being welded connecting the main frame and the main body.



Fig 5.9 Hinge at the mid section of three wheeler

The hinge at the mid-section as shown above Fig 5.9 has been secured with the help of a nut and bolt system in order to avoid free swiveling movement.

Various component like the battery, controller, hub motor, wheels, charger has been assembled and fitted in the separate location according to application.



Fig 5.10 Initial assembly of components of three wheeler.



Fig 5.11 Wiring setup of the three wheeler

Our project, "Design and Fabrication of a Foldable Electric Three Vehicle," is a fantastic example of the theory and practice we've learned in engineering thus far. The goal of this project was to design and manufacture a light-weight vehicle that would take up less parking space and could be transported. This goal was met, and a foldable three wheeler with an electric motor was built and tested successfully.

A comprehensive literature review was carried out, which included technical material relevance to the project. The most efficient and reliable arrangement for fabricating the foldable vehicle was created using a defined design technique. To reduce mechanical, electrical, and rider compatibility issues, structural design was examined alongside component selection, aesthetics, and ergonomics. It can be used to reduce transportation issues for differently abled person. It is simple to use because it is powered by an electric motor. The vehicle is small, light, and simple in design, making it easy to transport. Manufacturing costs are moderate. As a result, our project "Design and fabrication of foldable electric three wheeler" is a successful effort to eliminate traffic congestion and parking issues.



Fig 5.12 Final image of Three wheeler

CHAPTER 6

CONCLUSION

A foldable electric three wheeler that can run upto 45km with a single charge was developed successfully. The three wheeler can be folded to reduce the length upto 914mm making it compact and easier to transport. Transportation cost are based on dimensions and weight, the vehicle has an advantage of reduced transportation cost due to the reduction in the dimensions after folding. The vehicle has a simple working mechanism making it suitable for differently abled person, as the vehicle is mainly operated using the throttle attached on the handle, it can be operated with the action of hands alone making it easy for the differently abled person. In comparison to existing EVs, the designed model has excellent pulling capacity, modified mechanical component, comfortable travel for differently abled person, simple maintenance, and a small number of components. The developed EV's performance is evaluated under a variety of operating conditions, including battery backup and time durations. The intended mode is set to go at a speed of 35 kilometres per hour.

- A foldable electric three wheeler comprising two wheels at the rear and one wheel at the front which is a driving wheel with the help of a brushless direct current hub motor of 36V and 350W.
- Two lithium ion batteries with voltage 36V are connected in parallel and placed below the seat attached to the rear panel to give a higher capacity, and act as a main power source for the 36V hub motor to provide a rotational motion which in turn provides a linear motion to the vehicle. The lithium ion batteries are connected to a main switch which plays a major role for connecting and disconnecting the power supply. The hinges located at the front and rear of the main body of the vehicle provides a foldable operation that reduced the length of the vehicle up to 914mm making it a compact body and gives advantage in transportation. Polycarbonate sheets with thickness of 6mm are added to cover the main body structures and the electrical components, providing a better attachment to the frame.
- The foldable electric three wheeler consist of a 36V 400W controller that

works as a switch mode power supply (SMPS) controlling the speed of the BLDC hub motor by controlling the power supply to the motor. When the BLDC hub motor receives power it tends to rotate the wheel at 350 rpm providing a linear motion to the vehicle. The power is received from the lithium ion batteries.

- A rectangular box placed below the seat provides a storage space for storing items making it more suitable for daily commuting and everyday use.
- A battery level indicator is attached to the handle of the vehicle is connected with the power supply via a controller that gives an indication of the battery level of the vehicle. The combination switch can be turned on and off using a key.
- Mild steel of 1.2mm thickness and 25mm square tube having good strength and toughness that can be welded using most welding process is used for all components of the vehicle frame giving a rigid structure to the vehicle.
- An auto power cut-off system can be achieved by an electric connection setup to the rear and front brake connected to the controller that cuts off power supply to the hub motor that allows the vehicle to stop.
- The foldable electric three wheeler is mainly designed for the differently abled person to operate and handle with ease.
- A 42V lithium ion charger with a capacity of 10Ah is used for charging a 36V lithium ion battery taking up to 2hours to fully charge the battery. The lithium ion battery makes the electric three wheeler lighter with a gvwt of 40kg compared to the ones using a typical lead acid batteries.
- A 36V with 350W hub motor and controller can give an ampere of 9.8A that allows the electric three wheeler to run at a speed of upto 30-35kmph
- Foldability of the electric three wheeler allows the vehicle to achieve a compact structure reducing the dimension of the vehicle that gives a huge advantage in transportation that makes it possible to cut down transportation cost.

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