

DESIGN AND FABRICATION OF CHASSIS AND BODY OF BATTERY ASSISTED HUMAN POWERED VEHICLE

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Abstract :-Now a day's transportation is a mandatory element in the life of mankind. In order to transport from one place to other several vehicles are used which emits harmful gases into the atmosphere. With the usage of the conventional fossil fuels in vehicles posing a threat for existence of life on the Earth, so it's the time for the usage of eco friendly vehicles for transportation. So the tadpole design of Battery assisted human powered vehicle will be a solution for this problem. Our vehicle is the cleanest possible mode of transportation for environment. If this vehicle is used regularly, it can prevent as much as 6 tons of CO₂ from entering into the atmosphere each year. The focus has been laid on the simplicity of design, high performance, easy maintenance and safety at a very reasonable price.

1. INTRODUCTION

About 80 lakhs rickshaws ply all over India in both rural and urban areas. Therefore, rickshaws provide livelihood of eight millions very poor rickshaw pullers families in India [1]. It has been observed that most of these rickshaws are of age-old design, and consequently design and manufacturing are not in an organized sector. Therefore, the present study is concerned with design and development of a hybrid human, mechanical, and electric powered tricycle for short city trips as an alternative mode of transport. Conventional human powered tricycles are amply available in different cities in India. However, they are not ergonomically designed with respect to rickshaw puller and passengers comfort and maneuverability. There are different literatures available both nationally and international level on improved tricycle design development in manual, mechanically assisted and electric hybrid mode. However, for improved design in electric hybrid mode, the success story is very limited mostly because of high cost involved to economically very poor rickshaw pullers, unwillingness of illiterate rickshaw puller to adopt new technology, non-availability of easy after sell services and most importantly inadequate quality assurances from inventors as well as manufacturers. However, researchers are putting effort to address the inherent inefficient mechanical design of conventional rickshaw. The few national research and development works are cited below.

CSIR Central Mechanical Engineering Research Institute, Kolkata had carried out research and development works on prototype development of an improved solar powered hybrid rickshaw. Solar panel charging system was based on some recognized charging station. The design had shock absorbers for a comfortable ride, headlamp for night riding. Moreover, it had (240 -350) W, 36 VDC motor independently housed with front wheel hub of the SOLECKSHAW with a regenerative capability. The rear wheels are manually powered by the rickshaw puller. The electric mode riding lessen the effort required to drive the rickshaw. Brakes were provided to all three wheels, maximum payload 200 kg and speed 15 km/h [2]. However, in spite of all advantages, cost, and non-availability of solar charging system easily may be a prohibiting factor for poor and illiterate rickshaw pullers for popularization this model. Hickmen studied on India tricycle rickshaws for design improvement. He observes that rickshaws are not designed for driver comfort and safety. Traditional rickshaws have single speed ratio that causes driver to put high effort for starting or hill climbing or in bad road condition. Moreover, Indian rickshaw pullers are poor and under-nourished. These studies discussed different techniques like addition of an electric drive, multiple gear ratio chain and sprocket, regenerative capability, use of a flywheel or spring for energy conservation and delivery as per load, etc., had been discussed [3]. The present price of a conventional rickshaw is nearly Rs.150000.00 whereas an electric assisted one will still cost Rs.350000.00 to Rs.400000.00. Therefore, reduction of cost of utmost important before any new design of rickshaw is available to the poor rickshaw pullers in India.

1.1 International:

Alam et al., studied significance of aerodynamic design and comfortable riding of human powered tricycle. Wind tunnel testing was performed to find out the key characteristics of this human powered vehicle. The magnitude of aerodynamic drag significantly varied with the test vehicles' physical profiles. They observed that the human powered vehicle manufacturers did not necessarily took into account the importance of aerodynamics in conventional tricycle design. This study showed a significant reduction in aerodynamic drag compared in an appropriately designed vehicle (aerodynamically) compared to a conventional vehicle. The seating position in such vehicle plays an important role. The reclining position further backward allowed an

additional reduction of frontal area thus it lowered net drag force. Additionally, the reclining position further backward may provide better physical advantages for endurance as indicated by observations at a race event. As expected, component add-ons and their positions generally increased drag more at low speeds than at high speeds. Wheels covers reduced total drag on the vehicle than uncovered wheel one [4]. Yang et al., studied an energy management system with an electronic gearshift and regenerative braking for a directly driven electric scooter. This was presented to improve the gross efficiency and driving range of an electric scooter. It was driven directly by a four-phase axial-flux DC brushless in wheel hub motor. The integration of stator windings, batteries, ultra- capacitors, and a digital controller constituted an energy management system, which featured smooth electronic gear shifting and regenerative braking. The gross efficiency of the experimental scooter was improved in the drivable range by 20% with respect to that without regenerative braking. The battery-to- wheel efficiency was also above 70% for both low- and high-speed gears [5]. Asaei and Habibdoost studied design, simulation, and conversion of a normal motorcycle into a Hybrid Electric Motorcycle (HEM). At first, a simple model was designed and simulated with ADVISOR2002. Then, the controller schematic and its optimized control strategy were described. A 125 cc ICE motorcycle was selected and converted into a HEM. A brushless DC (BLDC) motor assembled in the front wheel and a normal internal combustion engine in the rear wheel propelled the motorcycle. The nominal powers were 6.6 kW and 500 W for the ICE and BLDC respectively. The original motorcycle had a Continuous Variable Transmission (CVT). This was the best choice for a HEM power transmission because it could operate in the automatic handling mode and has high efficiency. Moreover, by using the CVT, the ICE could be started while motorcycle was running. Finally, three operating modes of HEM, two-implemented energy control strategies, and HEM engine control system by servomotors, and LCD display were explained [6].

There is a steady increase in the emission of greenhouse gases in the earth's atmosphere that is creating changes in the global climate. A third of GHG emissions in the world originate from the combustion of fossil fuels in IC engines that is reflected in recent studies [7]. Therefore, the European commission in Europe has set a target of reducing CO₂ emissions from new vehicles to an average of 125 g/km by 2015 with a longer aim of 100 g/km by 2020 [8]. The primary concept behind a hybrid vehicle is to use stored or secondary energy source in the vehicle to supplement the primary energy converter for improved overall energy efficiency. The primary energy converter operates at a constant power output that is much more efficient than the dynamic operation needed to match vehicle needs gains in fuel efficiency are the driver for this technology. The secondary energy source supplements the primary energy converter or stores the excess energy. Additional benefits of the hybrid design include: (1) A smaller primary energy converter that costs less, (2) Reduced emissions resulting from substantially eliminating dynamic modes of internal combustion engine (ICE) operation, and (3) An electric power train that allows for other advantages such as fewer moving parts and regenerative braking. It is generally recognized that the hybrid with its electric power train is compatible with the use of fuel cells for the primary energy converter [9].

The ability of the hybrid technology to reduce the size of the fuel cell stack as a primary energy converter will be crucial to reduce the costs of fuel cell vehicles during initial stages of commercialization. The plug-in hybrid is a modified version of a hybrid vehicle with a secondary power source larger than in a standard hybrid that can be recharged using grid electricity. By replacing vehicular fuel consumption with grid power, advantages of zero point-source emissions and displacement of petroleum fuel consumption can be realized. In this configuration, the hybrid vehicle functions more like an electric car with ICE (or fuel cell) backup to provide increased range upon demand [10]. The fuel cell hybrid provides an additional degree of freedom on this plug-in option; namely, the grid power could be used to recharge batteries (the secondary power source) or to hydrolyze water to hydrogen for use with the fuel cell (primary energy converter). As the costs of fuel cells decrease, the likelihood of transforming large sectors of the petroleum-based transportation infrastructure to a hydrogen-based infrastructure increases. These trends are motivated by the potential of fuel cells to reduce vehicle-operating cost. Table 1 summarizes typical vehicle operating costs, and as illustrated by these itemized costs, fuel costs are minor in comparison to those costs related to the vehicle, its maintenance, and the insurance costs to repair damaged vehicles.

Table 1: Typical operating costs for vehicle

Parameters	Vehicle operating Average cost (\$/mile)	Average cost (%)
Depreciation	22.5–31.8	49.2
Insurance	6.9–10.5	14.3
Financing	4.8–8.3	12.3
Fuel	4.5–6.9	10.9
Maintenance, oil, tires	4.7–5.3	9.1
License and registration	1.4 –3.2	4.2

Ranges include low-end cost of mid-sized car and upper-end costs for luxury car and SUV [11]. In many Asian and

South American cities, petrol powered scooters are popular means of transport due to limited space requirement caused by large population density in cities. In these areas of the world, scooters are a more affordable option than automobiles [12, 13]. However, the infrastructure in urban cities does not support an extensive transport network as well as parking spaces. Scooters are therefore more popular as they can be maneuvered around traffic more easily than larger vehicles, especially in congested roads and take less parking space. Scooters are different from cars as they are not normally equipped with advanced engine management and catalytic converter systems to reduce harmful emissions. It was shown by Sripakagorn and Limwuthigrajirat [14] that conventional petrol motorcycles emit 95% more pollutants than larger sport utility vehicles due to the lack of installed emission control technologies. Recently, Zero Emission Vehicles (ZEVs) have received a lot of attention worldwide. For example, battery electric vehicles (BEVs) and hydrogen fuel cell vehicles (HFCVs) are seen a possible solution to tackling GHG emission. Major global automotive manufacturers such as Honda (FCX Clarity), Nissan (FCV X-trail) and Daimler-Chrysler have invested significant amounts on R and D for fuel cell vehicles.

Norcliffe [15] studied that working tricycles in China's cities serve as the platform for millions of micro-enterprises. A study was undertaken by Kendallaet al., on the hydrogen fuel cell hybrid vehicles which were introduced in Birmingham Campus [16].

Based on above literatures the principal objectives of present studies are: (1) Development of an ergonomic and improved mechanical design tricycle, particularly for rickshaw puller and passenger in general. (2) Development of electric powered tricycle with 400 W, 24 VDC motor to supplement motive power for riding in hybrid mode. Both the rickshaw puller and passenger seat height from the ground will be lowered to most comfort ride. Therefore, the efficient and eco-friendly tricycle is propelled without using a fossil fuel. To build a tricycle that is aerodynamic, highly engineered for operational aspects, safe and ergonomically designed to utilize lesser effort and of course must have higher top speed than the counterpart already in place. Moreover, the innovation is proposed to use a fraction rider and rickshaw weight to assist partially pulling effort of rickshaw puller during operation. The new idea if practical implemented might substantially reduce drudgery and hardship of poor rickshaw pullers.

2. MATERIALS AND METHODS

The present design of an improved electric tricycle is an attempt to explore the inherent shortcomings of conventional tricycle (rickshaw). This is a developmental design of existing rickshaw available in road. Some standard parts of a commercially available rickshaw and bicycle are selected as standard components requirement. They include chain and sprocket, freewheel, wheel and axle, etc. Standard motorcycle and scooter ball bearings were selected instead of conventional rickshaw bearing to get less frictional resistance in shafts. The frame of the rickshaw is consisted of 25 mm diameter mild steel pipes and 25 mm mild steel angles. The frame is provided with two independent suspensions adopted from motorcycle. This suspension is supposed to provide comfortable ride to the passengers and riders.

The front wheel suspension is a fork type one. The front and rear subassemblies of the designed tricycle is pivoted at the center with two swing arms. These swings arms are provided to effectively absorb road vibration through shock absorbers. The conventional handle steering of rickshaw is replaced with a PVC based steering wheel for better control and drivability. Steering effort is transferred to the front wheel through a low cost light weight belt drive. The adjustable driver seats with arm and head rest have been provided both for agronomy and comfort. Unlike conventional rickshaw, an innovative differential is provided that totally eliminated pulling towards one side. The 3D CAD of the hybrid tricycle is shown in Fig.1 and its drive train is presented in Fig.2. Table: 1 shows different operations for analysis of the tricycle.

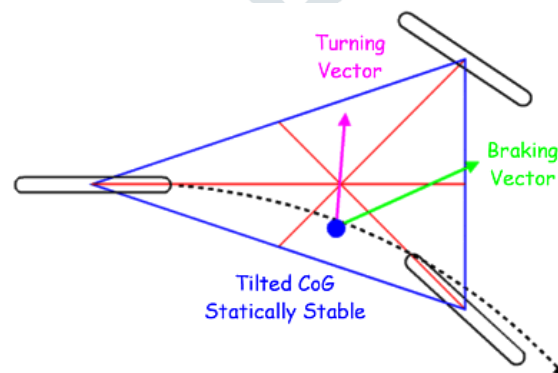


Fig-1. 3D CAD model of the hybrid tricycle



Fig-2. Physical model of the cycle

3. RESULTS AND DISCUSSIONS

The layout of the hybrid electrical tricycle is given in Fig.3. It is clear that different combinations of free wheels are used for fabrication of the transmission.

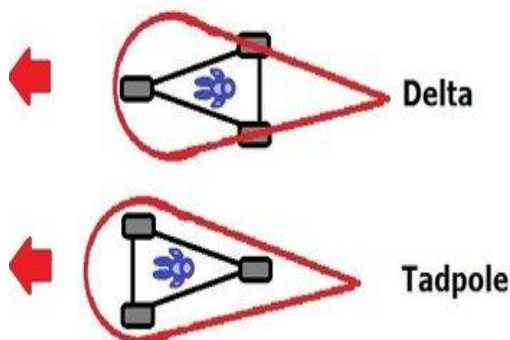
Sufficient safety features will be provided to the riders. They include independent seat belts for each rider, integrated structure and Roll Cage to protect riders in case of accident, mudguards on all three wheels and chain tubes for the part near riders' legs.

The design of tricycle is fully incorporated with ergonomics for comfort of rider and energy optimization. They are summarized as follows:

- Biomechanically optimized sitting position and knee angle (80-89 °).
- Crank adjuster to suit both tall and short person.
- Ease of entry and exit due less width.



Fig-3. Final Stage of Physical Prototype



- Seat frame design to provide easy and comfortable ride to both members.
- Pedaling, braking and steering system designed to provide accessible and easy control of the vehicle.
- Unobstructed vision to increase better maneuverability.
- Low maintenance and production requirement due to use of common but sturdy rickshaw components.

4. CONCLUSIONS

Therefore, the ecosystem and environment is protected from ever increasing pollution. Moreover, this design uses of battery vehicle that is economic and pollution less transport.. So the vehicle can be used by weight and special persons (handicapped) as they tried in normal cycles, but here we are using a motor & alternator which charge the battery regularly. So it is eco friendly and easy to use.

As there is synchronization between the electric motor and Internal combustion engines propulsions, less petrol consumption can be seen with less charging cycle of batteries (long life per charge).If one vehicle can save about an average of 30% of petrol fuel, then an average of about 40%-60% of national fuel can be conserved by using this type of vehicle. Also electric bill can also be saved, as the batteries last long per charge.

An idea of charging the batteries through Internal combustion engine can also be implemented here. The durability and convenience to consumer can be improved by using this type of vehicle. Charging of Lithium-Ion batteries can be done through idling or running internal combustion engine during the vehicle propulsion scheme discussed can also be used.

5. REFERENCE:

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