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Performance study of two wheeler vehicle to four wheeler vehicle

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Abstract - This project presents a performance comparison between two-wheeler and four-wheeler vehicles using parameters such as fuel efficiency, acceleration, braking, stability, emissions, and operating cost. The study analyzes vehicle performance under typical urban driving conditions. Results show that two-wheelers provide better fuel economy and lower emissions due to their lighter weight, whereas four-wheelers offer improved stability, safety, load capacity, and passenger comfort. The comparison highlights the trade-offs between efficiency and safety, helping in better vehicle selection and transportation planning.

INTRODUCTION - Two-wheeler vehicles like motorbikes and scooters are generally adopted as a cost-effective form of transportation in the urban and rural setup all over the world. Their small size, ease of operation in congested roads, lower purchase price, and fuel efficiency make them a soughtafter option for a large number of people. However, the stability factor, load-carrying capacity, and level of safety offered by two-wheeler vehicles are relatively lower compared to four

wheeler vehicles. Moreover, the level of safety offered by two-wheeler vehicles compared to four-wheeler vehicles is relatively less when analyzed.

In recent years, there has been an increased focus and interest in unlocking the possibility of modifying and upgrading two-wheelers into four-wheelers to overcome these constraints. It has becomeincreasingly popular to try and modify two-wheelers into four-wheelers for rural mobility solutions, low-costtransport solutions, senior citizens and disabled mobility solutions, and engineering applications. The basic reason for modifying two-wheelers to four-wheelers and catering to these purposes would be an economic and viable solution for better mobility and stability solutions of the vehicle. Modifying two-wheelers into four-wheelers would provide an economic solution for these purposes rather than purchasing a new four-wheeler.

Nevertheless, the conversion process of a two-wheeler into a four-wheeler has a complex set of operations. These operations include the alteration of the chassis design of the two-wheeler to sustain four wheels, modification of the suspension mechanism for maintaining the balanceof the four-wheeler, implementation of braking systems, alteration of the steering geometry, and enhancement of weight distribution on the four-wheeler. Each of the aforementioned operations has a vast impact on significant characteristics like dynamics, center of gravity, handling, braking performance, traction, and fuel efficiency of the four-wheeler.

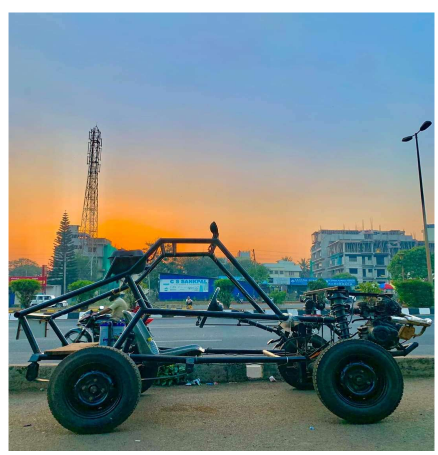

Fig. Buggy

LITERATURE SURVEY

There have been many research activities in the areas of vehicle dynamics, modification of structures, alternative mobility solutions, and performance analysis of modified vehicles. Modifying a two-wheeler vehicle to four-wheeler has been analyzed by taking various other aspects of engineering, such as improvement of stability, modification of chassis, optimization of suspension systems, braking, and fuel efficiency. The following are the key findings brought forward from the present literature survey and past research works performed on the subject

- **Vehicle Stability**

There has been extensive research involved in vehicle stability which proves that both the wheelbase and track width are important factors which determine lateral and longitudinal stability. If the track width of a vehicle, which is smallin two-wheelers, is shorter, it easily turns over in sudden changes of direction. It has been proven in research that an increase in track width through the addition of booster wheels has been very effective in decreasing the overturning moment. With longitudinal stability and wheelbase, longer wheelbases enhance this aspect by ensuringmore equal weight distribution is accomplished between the rear and front axles of a car. According to research, when a car stands wider from its stance, there is less inclination to skid or topple over because its weight rests on a wider area of contact. This is enough reason for the designers to widen the track width during the transformation of two-wheeler to four-wheeler

• **Chassis Modification**

Several researchers have emphasized that simply adding wheels is insufficient unless the

chassis structure is reinforced. Two-wheeler frames are originally designed to support only

two contact points and limited lateral loads. Conversion into a four-wheeler introduces new

stress paths, increased load-bearing requirements, and higher torsional forces.

Studies focusing on frame dynamics recommend the use of:

• Cross members

• Reinforcement plates

• Steel tubing subframes

• Additional weld joints

These structural enhancements distribute load evenly and prevent frame deformation or failure. Literature also suggests performing finite element analysis (FEA) to assess stress concentrations and ensure that the modified frame can withstand static and dynamic forces encountered during real-world operation.

- **Suspension and Steering**

The conversion process significantly affects the suspension and steering characteristics. Research indicates that **suspension tuning** becomes essential because the added weight, modified wheel alignment, and altered center of gravity create different vibration patterns and load transfer behaviors. Conventional two-wheeler suspension systems may not handle the increased weight and may lead to discomfort or instability if not adjusted. Studies recommend the use of:

• Stiffer springs or dual suspension systems

• Additional dampers

• Modified swing-arm geometry

• Realigned fork angles

Steering geometry also requires recalibration. Literature explains that parameters such as **caster angle, trail, toe-in, camber, and steering ratio** must be adjusted to maintain predictable handling. Improper steering setup can result in understeering, excessive tire wear, or reduced maneuverability. Research indicates that **suspension tuning** becomes essential because the added weight, modified wheel alignment, and altered center of gravity create different vibration patterns and load transfer behaviors. Conventional two-wheeler suspension systems may not handle the increased weight and may lead to discomfort or instability if not adjusted.

OBJECTIVES

The main objectives of this study are:

• **To compare performance characteristics before and after conversion**, including handling behavior, braking efficiency, fuel efficiency, and ride comfort

• **To analyze changes in stability**, especially lateral and longitudinal stability, and observe how the repositioned or additional wheels influence the center of gravity and load distribution.

• **To evaluate braking performance**, including braking distance, brake force distribution, and wheel locking tendencies after conversion.

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- **To identify variations in fuel consumption** resulting from increased vehicle mass, additional rolling resistance, and structural changes.

- **To design a structurally sound and cost-effective conversion model**, incorporating appropriate chassis reinforcements, suspension modifications, and wheel configurations.

- **To recommend improvements** based on observed test results, ensuring that the converted four-wheeler performs safely and efficiently in practical use. These objectives collectively ensure a comprehensive evaluation of all critical aspects that influence the converted vehicle's performance.

METHODOLOGY

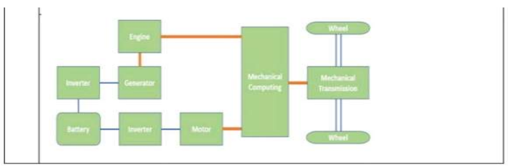

Fig: Block diagram of Buggy

To achieve the project objectives, the following methodology is adopted:

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1. Baseline Data Collection

The initial step involves gathering complete technical data of the original two-wheeler. This includes:

- Overall vehicle weight and distribution
- Braking distance under standard conditions
- Center of gravity location and stability characteristics
- Steering response and handling behavior
- Mileage and fuel consumption pattern
- Load-carrying capacity and frame strength

This baseline data serves as the reference for comparing post-conversion performance.

2. Design of Conversion

This stage focuses on conceptualizing and engineering the conversion process. Tasks include:

- **Adding auxiliary wheels** or designing a custom rear-axle assembly to achieve a fourwheel configuration.
- **Modifying or strengthening the chassis**, including addition of support frames, brackets, or subframes to handle increased loads.
- **Upgrading the suspension system**, such as modifying spring stiffness, adding dampers, or adjusting fork geometry
- **Reconfiguring steering components**, ensuring proper alignment, reduced vibrations, and improved handling.

The design ensures the modified vehicle remains structurally stable and functionally practical.

RESULT

- **Company Cost Estimation For Pulsur 220 Engine :**

Engine type: Single cylinder, 4 stroke, DTS-i (Digital Twin Spark Ignition)

Displacement: 220 cc (Oil

Maksimal: 20.4 PS (≈20.1 bhp)

Max. torque: 18.55 Nm @ 7,

Cooling system: Oil Cooling

Fuel system: Carburett

Transmission: 5-speed manual

Transmission/clutch: Wet multi

Speed: up to 130-134 km/h

- **After making bugyy By Using Pulsur 220 Engine :**

Pulsar 220 cc, 20.4 PS, 18.55 Nm

Total weight of buggies: ~200–250 kg

Top speed: ~60–80 km/h torque-oriented gearing

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Fuel efficiency: ~20–25 km/l (≈10–15% reduction compared to two-wheeler)

Carrying ability: ~200–300+kg

Braking distance: ~15–20% reduced due to four-wheel contact

Stability: increasing track width → approximately 50–60% risk reduction in tipping

Application: Low speed rural transport, utility, and mobil

- **Uses of Buggy Made with Pulsar 220 Engine :**

1.Rural transport and transport

2.Small load and agricultural products transport

3.Mobility services for senior and physically challenged groups

4.Off-road & recreational

5.Application for Educational and Engineering Projects

6.Reasonably priced substitute for traditional

Fig. 3D View of Buggy

CONCLUSION

The above study establishes that the modification of a two-wheeler to a four-wheeler entails major changes in terms of mechanics, structure, and performance. A close analysis of the stability, road handling, braking, structural integrity, and fuel consumption of four-wheeler two-wheelers makes one realize that this process has both advantages and disadvantages.

One of the most eminent improvements noticed in the new design is the improved stability owing to its broad track width and four-point contact with the earth. This will further reduce the possibilities of accidents like skidding, tipping, or losing balance, making it safe for elderly people, differently abled, and use in the transport of goods in rural areas. This will further provide a means of a cheaper substitute for transporting small goods in the converted vehicle.

Nevertheless, there are some constraints that are also created through this conversion. This includes wheels, supports, and lengthy members, which add mass to the vehicle. This results in a slight reduction in fuel economy. Moreover, modifications in geometry, along with a change in the composition of the chassis, also influence vehicle dynamics. This needs to be properly analyzed to ensure that steering, brakes, and vibrations are in their designated places. As per the study, if these factors are neglected, then some problems may crop up.

Nonetheless, despite all these difficulties, the results depict that through proper engineering interventions in terms of improving the chassis, suspension, steering, and braking systems of the car, the converted car is able to run safely and efficiently. In this context, car conversions have tremendous potential for serving as low-cost solutions for mobility, particularly in countries where low-cost and feasible solutions are of prime importance.

In conclusion, it can be said that if done correctly, it is possible to convert a traditional two-wheeler into a four-wheeler and derive economic and social advantages.

FUTURE SCOPE

The concept of two-wheelers turning into four-wheelers is still a developing idea and holds a range of possibilities for more research and development. Below mentioned are some points which highlight the future scope of the study:

- **Development of Lightweight Materials**

Using advanced materials such as aluminum alloys, fiber-reinforced plastics, or composite frames can significantly reduce the added weight of the conversion. This would help improve fuel efficiency, reduce structural stress, and enhance overall performance.

- **Designing Modular Conversion Kits**

There is strong potential for designing standardized, easy-to-install conversion kits that can be commercially distributed.

- Pre-fabricated axles
- Bolt-on auxiliary wheel assemblies
- Reinforcement modules

- Adjustable suspension components

This would encourage widespread adoption, especially in rural and small-scale industries.

Implementation of Electric Powertrains

Future models can incorporate **electric motors, hub motors, or hybrid drive systems** to improve efficiency and reduce environmental impact. Electric powertrains also offer smoother torque delivery and lower running costs, aligning with global trends in sustainable mobility.

- **Improved Steering Geometry**

Research can focus on developing more refined steering systems with:

- Optimized caster and camber angles
- Better steering ratios
- Reduced turning radius
- Enhanced response at low and medium speeds

This would make the converted vehicle easier and safer to maneuver.

- **Integration of Advanced Safety Features**

Modern technologies such as:

- Anti-lock Braking System (ABS)
- Anti-roll bars
- Electronic brake-force distribution

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