Performance Analysis of 48V/100Ah Lithium-Ion Battery in 1000 Watt Electric Buggy Against Load and Mileage

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Abstract. Buggy development is increasingly rapid with its application to tourism facilities such as hotels or golf courses. The development of electric vehicles is certainly inseparable from the energy source or energy storage component, better known as the battery. The battery component is an important part of an electric vehicle because it affects the carrying capacity and distance traveled. This development aims to increase battery storage capacity in line with power requirements and distance traveled. This research tries to test the use of a 48 volt 100 Ah 1000 Watt battery as energy storage for a 1000 Watt BLDC motor. Tests were carried out using asphalt highways. The length of the road used is 1128 meters. Characteristics of a road with a slope of 5^0 with a length of 40 meters. The number of bends is 10. Testing is assumed to be without obstruction from other vehicles. Battery power consumption is influenced by vehicle distance, in this case with a track length of 1128 m, an average of 66.8 watts. Battery power consumption is influenced by the load given to the electric car, the smallest power consumption is 78.03 watts at 50 kg, the largest power consumption at a load of 300 kg is an average of 162.5 watts.

Keywords: Battery, Distance, Lithium, Load

1 Introduction

Buggy development is increasingly rapid with its application to tourism facilities such as hotels or golf courses. The buggy for this facility uses an electric motor drive. Battery electric vehicles have advantages compared to Internal Combustion Engine (ICE) based vehicles in reducing air pollution and GHG emissions. Electric vehicles produce much less air pollution and can be said to be close to zero when compared to Internal Combustion Engine (ICE) based vehicles (Parinduri et al., 2018). The application of electric motors to buggies in hotel facilities is needed because it has the advantage of not causing air and noise pollution (Harisdani & Simalango, 2023). Noise pollution is of course an important concern for hotels and facilities with hospitality services so that it does not disturb customer comfort. Hotel or golf buggies are specifically used to transport passengers and goods with a relatively large carrying capacity (±1000kg) (Yüzbaşıoğlu et al., 2014). This carrying capacity is for carrying 4

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passengers. This type of buggy has been widely circulated and is used by companies that sell hospitality services. Electric vehicles are still considered to have shortcomings, namely that they do not have optimal charging places because they are equipped with batteries to store power. Current electric vehicles are still limited by distance and speed so they are still not suitable for long-distance travel (Kumara, 2018). The disadvantage of this type of vehicle is that the selling price is still very high (± Rp. 120,000,000) for a vehicle with a carrying capacity of 4 people. This is of course very expensive for people who also wish to use this type of vehicle as another means of transportation.

KBL (electric motorized vehicle) technology is a “disruptive technology” whose presence has been awaited to help reduce the use of diesel fuel and the effects of GHG (greenhouse gases), especially in the transportation sector. The seriousness of KBL was continued with the issuance of Presidential Decree Number 55 of 2019 concerning the Acceleration of the Battery-Based Electric Motor Vehicle Program for road transportation (Nur & Kurniawan, 2021). The government has issued some incentives to encourage the use of KBLBB. Providing incentives includes zero percent PPnBM, maximum local tax of 10%, minimum down payment of zero percent, and low interest rates. The manufacturing industry is given tax holidays, tax allowances and super tax deductions for research and development. The government sets a special tariff of zero percent import duty for motorized vehicles imported in incomplete and incomplete condition (Incompletely Knocked Down/IKD) through Minister of Finance Regulation Number PMK-13/MK.010/2022 concerning the Fourth Amendment to Regulation of the Minister of Finance Number 6 /PMK.010/2017 concerning Determination of the Goods Classification System and the Imposition of Import Duty Tariffs on Imported Goods which was determined on February 22 2022. The presence of KBL in Indonesia will not only help the environment by reducing air pollution but will directly affect the economic sector and energy (Sindhu, 2019).

The development of a buggy for service in the hotel area is still not optimal, just based on the form without ever touching on the technology. Previous research has conducted trials using conventional engines using CVT as a power transmitter (Darmawa et al., 2023). This research found that CVTs are still effectively used to continue engine power. This research also still uses conventional engines. The development of electric vehicles is certainly inseparable from the energy source or energy storage component, better known as the battery. The battery component is an important part of an electric vehicle because it affects the carrying capacity and distance traveled (Pasra et al., 2022). The development of batteries, especially for electric vehicles, is very rapid, from using ordinary cells (copper) to now what is better known as lithium. This development aims to increase battery storage capacity in line with power requirements and distance traveled. The dimensions and size of the battery are also very important considering that it reduces space on the vehicle and can affect the weight of the vehicle which is related to the power of the BLDC motor to move the vehicle (Setyaning et al., 2022).

This research tries to test the use of a 48 volt 100 Ah 1000 Watt battery as energy storage for a 1000 Watt BLDC motor. Lithium battery material with dimensions 236×66×60 mm and weight 457 grams. These dimensions were chosen so that they can be compatible in placement so they do not require a large space. The battery is placed under the buggy driver's seat because the back will be maximized as a place for goods. The battery is fully charged in each test to obtain the ability to carry the load and the distance that can be traveled. Testing will be carried out by varying the load given to the buggy. The expected final result is that the buggy can carry loads optimally and travel distances according to needs.

2 Methodology

This research tries to test the use of a 48 volt 100 Ah 1000 Watt battery as energy storage for a 1000 Watt BLDC motor. Lithium battery material with dimensions 236×66×60 mm and weight 457 grams. These dimensions were chosen so that they can be compatible in placement so they do not require a large space. The battery is placed under the buggy driver's seat because the back will be maximized as a place for goods. The battery is fully charged in each test to obtain the ability to carry the load and the distance that can be traveled (Jatmiko et al., 2018). Testing will be carried out by varying the load given to the buggy. The expected final result is that the buggy can carry loads optimally and travel distances according to needs.

2.1 Design

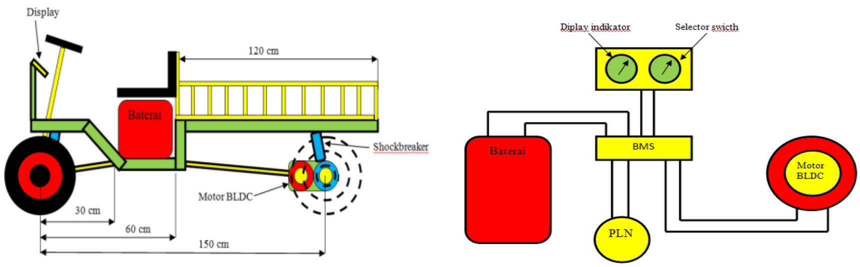

Figure 1. Design of BLDC motor battery implementation

This research flow is divided into several stages, the stages are as follows:

1. Battery
   The battery used is a 48 volt 100 Ah lithium ion type. This battery is in pack form which is sold in stores to make maintenance and replacement easier because spare parts are available.
2. Display indicators
   Diplay uses existing screens sold. On this screen there is a battery volt and amphere indicator, an indicator of the charging process. The speed indicator will be added separately because the system used is different which is measured by wheel rotation.
3. Selector switches
   This selector switch is used to regulate the rotation of the BLDC motor so that it can rotate back and forth. This back and forth rotation is needed so that the vehicle can move back and forth.

4. Battery managing system
   A battery managing system (BMS) is needed for the battery charging process as well as the process of using the energy stored in the battery. BMS regulates the battery charging system so that overcharging does not occur. The BMS will automatically disconnect the charging system when the battery is full.
5. BLDC motors
   The BLDC motor used is a 1000 watt type which can be found in many shops.
6. PLN source
   This PLN source is needed during the battery charging process.

2.2 Data anlysis

This research is divided into several stages, the stages are as follows:

1. Analysis of transportation equipment needs
   Nowadays, transportation means are very necessary to meet human needs. Various kinds of human activities or activities today cannot be separated from vehicles. The only vehicles that have been developed are limited to engines with internal combustion chambers or engines using fossil fuels. Vehicles are needed to meet the needs of moving people and goods. The transport equipment or vehicle required is able to carry relatively heavy loads (± 300kg) and can move quickly and flexibly. Flexible movement means being able to move forward and backward.
2. Carrying capacity
   Carrying capacity is an important part of a conveyance or vehicle. The vehicle's ability to move goods or people is a determining factor in determining the type of vehicle needed. Electric vehicles certainly have limitations in carrying loads. The load is given according to the power of the driving motor. The load is given in a varied manner to obtain the ability of the electric motor to move the vehicle.
3. Mileage
   Electric vehicles have drawbacks in terms of required power storage. Electric vehicles require batteries to store energy. Charging this battery certainly takes a relatively long time, unlike filling fossil fuels in conventional vehicles. Battery power will be used as an energy source for the electric motor. The load given to the vehicle will linearly affect the electric power of the motor. The load is given in various ways to provide data on how far the distance can be achieved if the battery is fully charged.
4. Accredited journal
   The final target of this research is to obtain the carrying capacity and distance that can be traveled by electric vehicles driven by BLDC motors. Vehicle speed is also recorded to obtain data on the ability of electric vehicles to move goods or people. The entire results of this research will be presented in a written work published in an accredited national journal.

Tests in the research entitled Analysis of 48v/100Ah Battery Performance in 1000 Watt Electric Buggy on Load and Mileage were carried out by direct observation where this BLDC motor driven electric vehicle will be tested with direct loading on the road. The assumption is that the road surface and terrain are flat. This research uses descriptive analysis. Descriptive analysis is a depiction or description of a graph that describes the phenomena that occur in a trial. The fixed variable in this research is the load given, namely 50kg, 100kg, 150kg, 200kg and 300kg. The independent variables are the distance voltage and power of the electric vehicle.

3 Result and Discussion

Tests were carried out using asphalt highways. The length of the road used is 1128 meters. Characteristics of a road with a slope of 5^0 with a length of 40 meters. The number of bends is 10. Testing is assumed to be without obstruction from other vehicles. Power testing for distance traveled is carried out using the vehicle directly on the road. Power is recorded before and after the vehicle has traveled a specified distance. Load testing is carried out by adding a load to the rear side of the vehicle according to the variables. The vehicle is driven according to the specified distance. Battery power is recorded before and after reaching the specified distance.

3.1 Result

Power Testing Against Mileage. Power testing for distance traveled was carried out 20 times. Each test records the voltage from battery use. Test results data can be seen in Figure 2 and Figure 3.

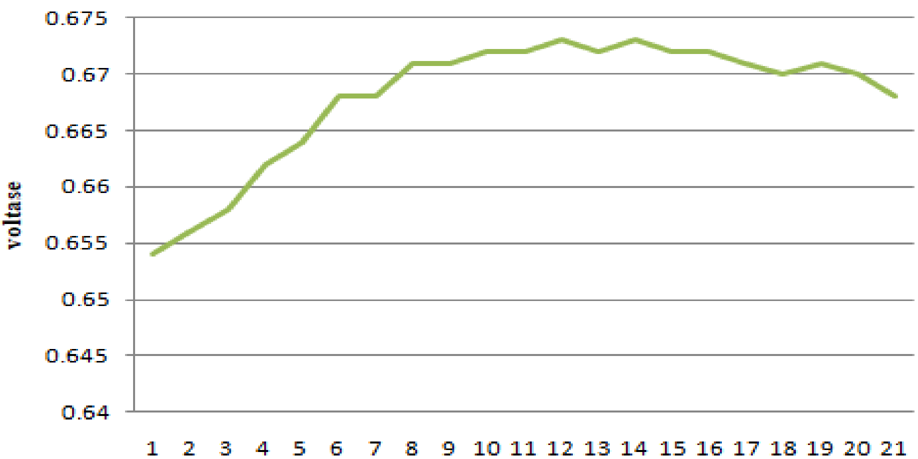

Figure 2. Voltage versus distance traveled

Figure 2 shows the voltage characteristics of the vehicle's distance traveled. Test 1st shows that the voltage used is still low until test 6th. The voltage ranges from 0.064 – 0.066 volts. The low voltage used is influenced by the average speed of the vehicle, namely 22 km/hour. This low speed affects the voltage consumption of the battery. The tension began to increase and become stable from the 7th to 20th trial. The speed in the 7th to 20th trial was an average of 24 km/hour. Voltage consumption testing on vehicle mileage is an average of 1.39% of the battery.

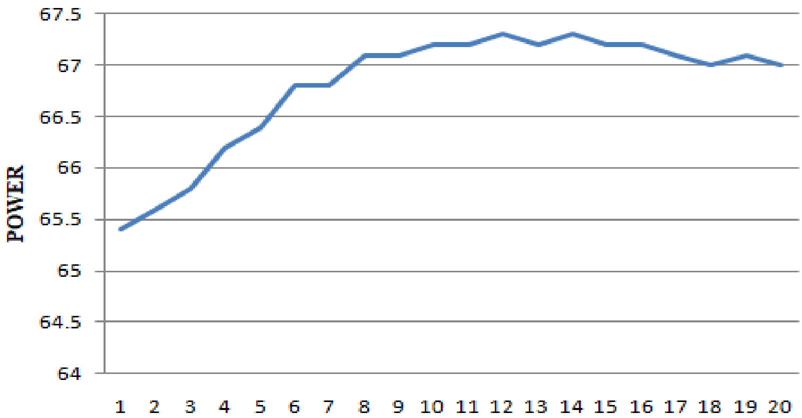

Figure 3. Power versus distance traveled

Figure 3 shows the characteristics of battery power relative to the distance traveled by the vehicle. Test 1st shows that the power used is still low until test 6th. The power ranges from 64 - 66 watts. The power begins to increase and reaches stability from the 7th to the 20th experiment. Power consumption is influenced by the average speed of the vehicle. The speed in tests 7th to 20th averaged 24 km/hour. This low speed affects the power consumption of the battery. Power consumption testing for vehicle mileage averages 1.39% of the battery.

Power Testing of the Load. Power testing of the load was carried out 10 times for each load variable, with the assumption that the driver load was ignored. Each test records the voltage from battery use. Test result data can be seen in Figure 4 and Figure 5.

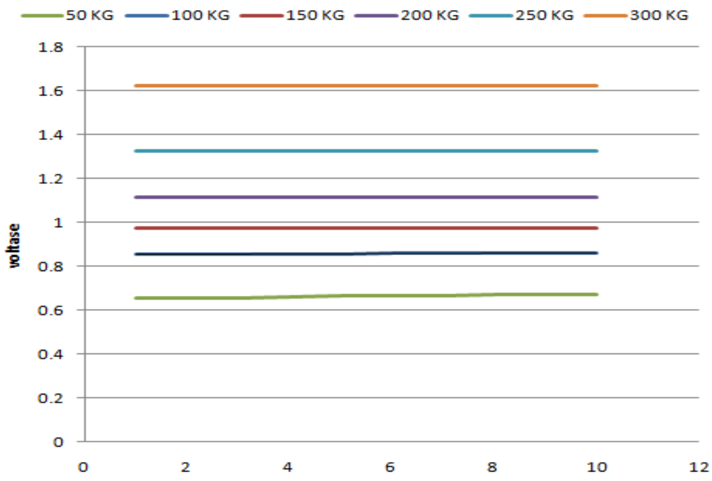

Figure 4. Load versus voltage

Figure 4 shows the load characteristics of the vehicle's battery voltage. Voltage consumption at a load of 50 kg tends to be low. The battery voltage drops on average by 0.78 volts. The voltage used is still relatively low because the load is still small. A decrease in battery voltage begins to appear as the load increases. The increase in voltage usage when the load is added to 100k is 9.17%. Voltage usage tends to increase on average by 2.23%. The greatest increase in power use was when the load was added from 250 kg to 300 kg, amounting to 18.46%. This is because the use of the gas pedal for acceleration becomes heavier. The gas pedal is used to control the distribution of voltage from the battery to the electric motor. The average vehicle speed is 22.8 km/hour. The highest speed when the load is 50 kg is 23.6 km/hour. The lowest speed was obtained when the load weighed 300 kg, namely 21.6 km/hour.

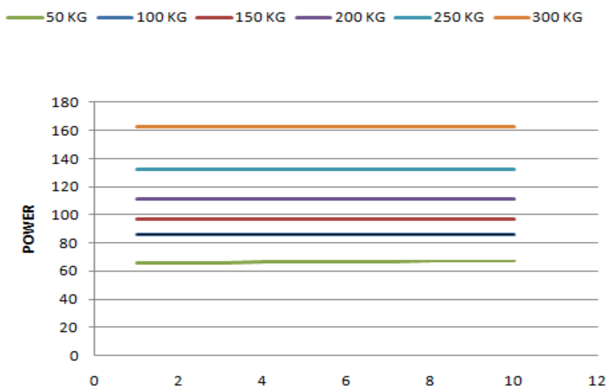

Figure 5. Load versus power

Figure 5 shows the load characteristics of vehicle battery power consumption. Power consumption for a load of 50 kg tends to be low, namely 78.03 watt. Battery power consumption increases by 9.17% when the load is increased to 100 kg. The power used is still relatively low because the load is still small. The increase in battery power consumption begins to be seen as the load increases. Increased power usage when load is added. Voltage usage tends to increase on average by 2.23%. The largest increase in power consumption when the load is added from 200 kg to 350 kg is 3.02% from power consumption of 111.5 watt to 132.5 watt. The gas pedal controls the distribution of voltage to the electric motor and influences the acceleration or speed of the electric car. The average vehicle speed is 22.8 km/hour. The highest speed when the load is 50 kg is 23.6 km/hour. The lowest speed was obtained when the load weighed 300 kg, namely 21.6 km/hour. Low acceleration due to heavy load so requires more battery power.

3.2 Discussion

The data obtained is displayed in graphical form. The graph is analyzed to obtain the characteristics of the influence of the variables used. Descriptive analysis is used to explain the characteristics of variables. Descriptive analysis is a description or depiction of phenomena that occur from a graph or table (Nasution, 2017). The distance traveled by an electric vehicle affects the battery voltage (Alfian & Nurhadi, 2022). The test results showed that the distance traveled by the vehicle affected the voltage drop and power consumption of the battery. The average decrease in battery voltage is 0.668 volts. Battery power consumption for a distance of 1128 m is 66.8 watts. The load given to an electric vehicle affects the voltage drop from the battery (Alfian & Nurhadi, 2022). The test results showed that the increasing load applied would affect the voltage drop and battery power consumption. The voltage drop is greatest when the load is increased to 250 kg with a constant distance traveled. The average voltage drop is 1.33 volts and the average power consumption is 132.5 watts. The greatest power consumption when the load is 300 kg is an average of 162.5 watts with an average decrease in battery voltage of 1.63 volts. Using the gas pedal to accelerate can also affect battery power consumption. The intensity with which the gas pedal is pressed more often will affect acceleration and the distribution of voltage to the electric motor (Dawami et al., 2020). More voltage channeled to the electric motor will reduce battery voltage and power consumption will increase.

4 Conclusion

Based on the results of this research, it can be concluded that battery power consumption is influenced by both vehicle distance and load. For a track length of 1128 meters, the average power consumption was 66.8 watts. Additionally, the load applied to the electric car significantly affects power consumption, with the lowest consumption recorded at 78.03 watts for a 50 kg load and the highest consumption averaging 162.5 watts for a 300 kg load.

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