DESIGN AND MANUFACTURING AN ELECTRIC BIKE AS ENERGY-SAVING TRANSPORTATION

FINAL PROJECT

submitted in partial fulfillment of the requirements for the degree of
Bachelor of Mechanical Engineering Vocational Education

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SUPERVISOR APPROVAL PAGE

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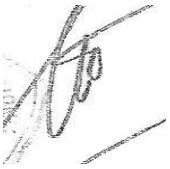

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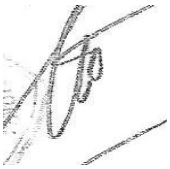

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DECLARATION

I hereby confirm that:

1. My final project, title “Design and Manufacturing an Electric Bike as Energy-Saving Transportation” is my own;

2. This final project is my original work from aspects of idea, formulation, and research without other guidance, except from supervisor;

3. In this final project, no others works’ except for quotations and summaries which have been duly acknowledge;

4. I made this statement in truth and if there is a deviation in this statement, I am willing to accept academic punishment in the form of revocation of the academic title that have been obtained, as well as other punishment in accordance with the norms and legal provisions in force.

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ABSTRACT

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The issue of global warming is rising. The damage caused by global warming has significant impact on the survival of living things. Considering the important of electric bike as one of solution in reducing gas emission (air pollution), thus, it is necessary to conduct a study on the design and manufacture electric bike as energy-saving transportation. Thus, this study conducted to design and manufacture proper electric bike as energy-saving transportation.

This study is an experimental. It uses a 24 Volt 250 Watt DC electric motor and 3000 rpm. The power system used is a 24 Volt 12 Ampere battery.

From the test results and data analysis show that average speed obtained by an electric bike with a load of 78 is 4.94 m/s, a load of 83 is 4.59 m/s, and a load of 88 is 4.25 m/s. Power output to drive electric bike with load of 78 is 266,679 Watt, load of 83 is 263,810 Watt, and load of 88 is 258,984 Watt.

FOREWORD

Alhamdulillaahirabbbil'alamin. Thanks to Allah SWT for all the gifts that are always poured out to the author so that the author can complete the thesis with the title "Design And Assembling An Electric Bike As Energy-Saving Transportation". Salawat and greetings are always bestowed on the Prophet Muhammad SAW by saying Allahhumaa Sholli'Ala Sayyidina Muhammad, who has brought mankind to the present era with sophisticated and modern science.

During the writing of this thesis the author received a lot of guidance, advice, motivation and assistance from various parties, either directly or indirectly. For that, with all humility the writer would like to thank:

1. Allah SWT for the extraordinary blessings that have been given to me, so that I can complete this thesis proposal in a healthy state and without any shortcomings.
2. Drs. Purwantono, M.Pd. as the Supervisor who provided guidance and assistance in writing thesis.
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6. All of lecturers and administrative staff Department of Mechanical Engineering, Faculty of Engineering, Universitas Negeri Padang.

7. Fellow in Department of Mechanical Engineering, Faculty of Engineering, Padang State University.
8. All parties who have helped in writing this thesis that the author cannot mention one by one.
9. Especially my parents and my beloved family who have given great support and prayers in completing this thesis.

Hopefully the favour that has been given get a reward from Allah SWT, aminnn yaa robbal alaminn.

This thesis is unperfect, all constructive criticism and suggestions for the improvement of this study is welcoming. Finally, this thesis can be useful for readers and related parties in education for the advancement of science.

Padang, February 2020

Shundy Pareza

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CHAPTER 1

INTRODUCTION

A. Background

The issue of global warming is rising. The damage caused by global warming is very influential on the survival of living things on earth. Global warming occures in all around the world (East, West, North and South). Global warming is caused by the increasing number of fossil-based vehicles, thus increase the emmision on atmosphere. According to the Central Statistics Agency (2017), the number of vehicles in Indonesia is 138,556,669 vehicles. It has increased by 12.4% in a period of 2 years and will increase along with population growth in Indonesia.

The main problem with the large number of vehicles in Indonesia is air pollution. Each vehicle produces residual fuel combustion or exhaust gas emissions and charcoal hydrant compounds (9HC). Exhaust gas emissions contain moisture content (H_2O), carbon dioxide (CO_2), nitrogen oxides (NOx), sulfur oxide (SOx) and toxic carbon monoxide (CO) due to incomplete combustion. Exhaust gas emissions from vehicles are the largest source of air pollution in Indonesia which is harmful to the environment. Thus, electric-powered vehicle is one of solutions to reduce exhaust gas emission.

The development of environmentally friendly transportation is currently very intensively carried out by automotive companies around the world which is

an issue of global warming to reduce pollution and keep the earth safe to live in. Many electric vehicles being developed today, the most popular and attracting the attention of the public are electric bike. Electric bike are used like bikes in general, what distinguishes between electric bike and ordinary bike is that an electric bike is added with a propulsion device such as a dynamo, whereas an ordinary bike is not.

Electric bikes are quite widely available in the Indonesian automotive market. Some of the products available in market manufactured by China such as the Yahonta and Tiger electric bikes. However, there are also domestic products such as Xelimo and Berix. The design of an electric bike must obtain several criterias; (1) Function (function/usage), electric bike must be in accordance with daily needs, (2) Safety in terms of security, bike must have good security and comfortable to use either within a short distance or long distance. In addition, security that is designed is not only for riders but must also consider the passengers or other people. (3) Reliability, the design must be able to withstand loads or be able to be restrained in daily activities. 4) Cost, the design must have proper cost. In terms of manufacturability, the design must be capable of mass production or according to market needs.

One of the advantages of electric bike is that they do not cause pollution so that can reduce global warming caused by exhaust gas emission from fossil fuel vehicles. Elctric bikes are also quiet and very light, so easy to be stored and saving space.

In designing an electric bike, what needs to be done is to choose a

motorbike to be used. In order to get maximum bike performance, the selected motorbike must be in accordance with the needs. The wrong choice of a motorbike can cause manufactured electric bike have low performance such as slow speeds, and the inability of an electric bike to carry loads. Considering the important of electric bike as one of solution in reducing gas emission (air pollution), thus, it is necessary to conduct a study on the design and manufacture electric bike as energy-saving transportation.

B. Identification of problems

Based on the above background, identification of problems as follows:

1. Uncertain increased global warming day by day.
2. The increasing use of fossil-based vehicles is a trigger for air pollution
3. Air pollution can cause various diseases for environment.
4. The wrong choice of an electric motorbike impact to the sub-optimal bike performance.

C. Scope of problem

Scope of problems in this study are limited to performance and speed of an electric bike. This study discusses the effect of a 24V 250W MY1016Z DC electric motor on the performance and speed of an electric bike.

D. Research Question

Based on the prior background, the research questions are:

1. How to design and manufacture an eco-energy electric bike?

2. How is the performance and impact of the 24V 250W MY1016Z electric motor on the performance and speed of an electric bike?

E. Research objective

The objectives of this study are:

1. Design and manufacture eco-energy electric bikes.
2. To determine the performance and impact of the 24V 250W MY1016Z electric motor on the performance and speed of an electric bike.

F. Benefits of Research

1. For Researchers
   - Apply skill in design and manufacture
   - Contribute to related research and as one of references in design and manufacture of an electric bike.
2. For the Government
   - Can help the government in overcoming global warming that caused by exhaust gas emission from fossil fueled motorbike.
3. For the Community
   - People can save expenses by using electric bike. People who used to spend money on the purchase of fossil fuels for driving vehicles can now substitute it with electricity at home.

CHAPTER II

LITERATURE REVIEW

A. Theoritical review

1. Understanding Electric Bikes

A bike with an electric motor driver is a vehicle without fuel and driven by a dynamo and an accumulator (Januar Ishak Wijaya, 2015 : 30). Along with the increasing problem of pollution and scarcity of fuel oil, manufacturers of motorized vehicles make hybrid vehicles include electric bike.

Electric vehicles are one of the efforts to protect the earth from global warming caused by exhaust gas emission from fossil fueled vehicles. Due to electric vehicles are driven by electric motors, thus they do not emit exhaust fumes that pollute the air. An electric motor is an electromagnetic device that converts electrical energy into mechanical energy. This mechanical energy makes movement of electric vehicles. An electric motor requires a direct voltage supply to the field coil to be converted into mechanical energy.

The coil in a DC motor is called the stator (non-rotating part) and the yellow anchor is called the rotor (rotating part). The performance of electric vehicles is also influenced by the wiring that will be made, such as good placement and arrangement will make good performance. Meanwhile, according to Thedy Yogasara and Febri Silviani (2004), the basic principle of most manufacturing process design procedures is to reduce the number of components in an assembly and to make other components easy to handle and assemble.

Meanwhile, according to the Indonesian Dictionary (KBBI), the definition of design is the process, the method, the deed of designing. Designing is arranging everything before acting, working, or planning.

From the above understanding, it can be concluded that designing is a first step in manufacturing. After designing, further manufacturing conducts easily and can be used properly. Electric bikes are energy-efficient, cost-efficient, and environmental friendly vehicles since they do not require fossil fuel and do not require large maintenance costs. In general, electric bike are driven by dynamos and accumulators. The accumulator stores electrical energy and convert electrical energy into mechanical energy (motion). The motion energy is produced by the rotation of the motor on the electric bike.

The concept of an electric bike is actually very simple and less surgical with an ordinary bike. Electric bike can be moved by the gas pedal without any human power. The battery is a supply the electric current dynamo on an electric bike. The amount of current and the amount of voltage required by the motor or dynamo is regulated by the controller. The main components of electric bike are motor, battery, and controller.

Bikes are a human-powered transportation that very popular in Indonesia. However, recently, electric bike (a combination of human power and electric motor power) is impressive. There is also a hybrid-fuel electric motorbike is being developed.

In general, the components of an electric bike are not much different from an ordinary bike, but have several additional components as follows:

a. A switch functions to transfer the electric current from the battery to the motor or dynamo.

b. An electric motor or dynamo functions to convert electric power into a torque.

c. The battery to produce of electrical energy.

In addition to being environmental friendly and energy efficient, electric bikes also have other advantages. Electric bikes are classified as vehicles with speeds below 35 km/h and rider does not need license to ride it, especially recently there are also 3-wheeled electric bikes that are used for special transportation for people withphysical limitations.

a. Electric Bike Mechanism

The working mechanism of an electric bike is very simple. The mechanism is not much different from an ordinary bike. Is equipped by battery as power supply

to move the motorbike. In its working mechanism, an electric bike is also equipped with other components including a controller as a speed regulator.

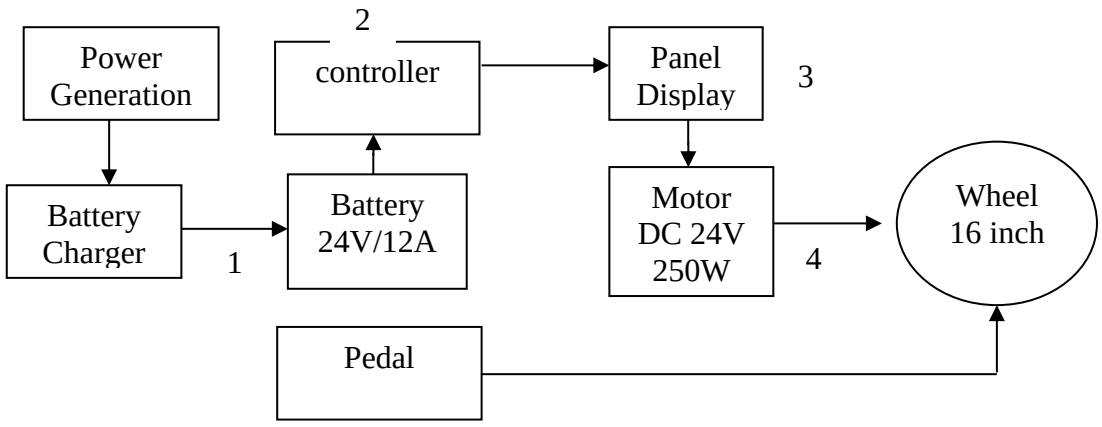

Figure 1. Electric Bike Components

1) 24V 12A battery

24V 12A battery is used as a source of electrical energy.

2) Controller

The controller is a control device and displays the status of all the features available on an electric bike.

3) Display Panel

The Display Panel is an electric component that displays features or status of current state of bike.

4) 24V 250W DC motor

The DC motor is the main propulsion system on an electric bike.

2. Electric motor

An electric motor is a tool for converting electrical energy into mechanical energy (Electric Motors, https://id.m.wikipedia.org, accessed on 14 September 2019). This mechanical energy can run household appliances such as fans, washing machines, water pumps and vacuum cleaners. In the modern industrial, the electric motor plays an important role. For example, electricity consumption for electric motor is around 65-70% of the total cost of electricity. Thus, it consumes less electricity. Electric motor will reduce production of overhead costs. The use of electric motor will more efficient since electricity rates increase every year.

a. Working Principle of Electric Motor

In electric motors, electric power is converted into mechanical power. This

conversion is produced by electric power into a magnet which is known as an electro magnet. Unlike poles of different magnets attract each other; like poles repel each other. This movement will rotate the shaft of the electric motor. The working principle of an electric motor can be described as follows:

1) An electric current in a magnet will exert a force
2) If the current-carrying rod is bent into a loop, the two sides of the loop, at right angles to the magnetic field, will get a force in the opposite direction.
3) The force-pair produces torque to rotate the coil.
4) The motors have several loops in the dynamo to provide a more uniform torque and the magnetic field is generated by an electromagnetic arrangement called the field coil.

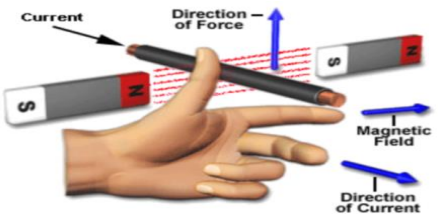

Figure 2. The Working Principle of An Electric Motor

Source:(google.com)

In understanding a motor, it is important to understand motor load. Load refers to the output of rotational power/torque according to the required speed. Loads can generally be categorized into three groups, including the following (http://www.energyefficiencyasia.org):

1) Constant torque load is a load where the demand for energy output varies with the speed of operation but the torque does not vary. Examples of constant torque loads are conveyors and constant displacement pumps.

2) A load with variable torque is a load with a torque that varies with the operating speed. Examples of variable torque loads are centrifugal pumps and fans (torque varies as the square of speed).
3) A load with constant energy is a load whose torque demand changes and is inversely proportional to the speed. An example of a constant power load is machine tools.

b. Types of Electric Motors

Electric motors are divided into two types, namely Alternating Current (AC) electric motors and Direct Current (DC) electric motors. AC electric motors utilize alternating electric currents to carry out their work. Synchronous mooring, single-phase induction motors and two-phase induction motors are included in the types of ball-back current (AC) electric motors. Meanwhile DC motors utilizes direct electric current to run their work. DC electric motors have two field amplifiers, namely a self-amplifier and an external amplifier. DC motors with self amplifiers take advantage of a series of field coils which are divided into series, shunt and mixture.

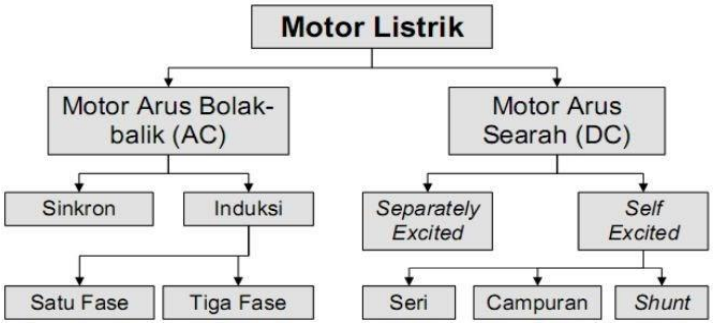

Figure 3. Types of Electric Motors

c. DC Electric Motor

DC motor is a component that can convert electrical energy (originating from the DC axis) into mechanical energy based on the principle of an electromagnetic field. DC motors have three main components, namely, the armature (stator) dynamo (rotor) and the commutator:

1) The field pole (stator) is simply illustrated that the interaction of two magnetic poles will cause rotation of the DC motor. The DC motor has a stationary field pole and a dynamo that moves the bearing in the space between the field poles. Simple DC motors have two field poles, a north pole and a south pole. The magnetic energy lines expand across the openings between the poles from north to south. For motors that are larger or more complex, there are one or more electromagnets. The electromagnet receives electricity from a power source that is outside providing the field structure.

2) Dinamo (rotor) when the current enters the dynamo, this current will become an electromagnet. The dynamo is cylindrical, connected to the driving axle to move the load. In the case of a small DC motor, the dynamo rotates in a magnetic field formed by the poles, until the north and south magnetic poles change locations. When this happens, the currents reverse to change the north and south poles of the dynamo.

3) This component commutator is mainly found in DC motors. The purpose of the commutator is to reverse the direction of the electric current in the dynamo. The commutator also assists in the transmission of currents between the dynamo and the resource.

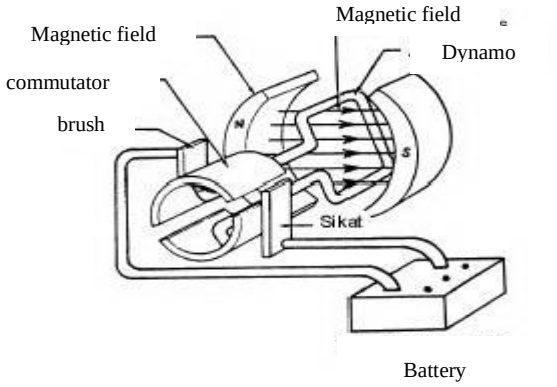

Figure 4. DC electric motor

The main advantage of a DC motor is a speed controller does not affect the quality of the power supply. This motor can be controlled by adjusting:

1) Dynamo power: increasing the armature voltage will increase the speed.
2) Field current: decreasing the field current will increase the speed.

d. Types of DC Motors

Based on the source of the magnetic amplifier current, DC motors can be divided into several parts including:

1) DC motor with separate amplifier (separately excited), the magnetic amplifier current is obtained from a outside DC source.
2) DC motor with its own amplifier (self excited), the magnetic amplifier current is obtained from the DC motor itself. Many DC motors use an electromagnet instead of a permanent magnet to provide static current. The coil that is used as a field generator is called a field coil. The current for the coils can be established by placing the coils in parallel or in series. The characteristics of a DC motor with a field coil are as follows.

a) Series field, this motor has a large initial torque but it is difficult to contorl the speed. This motor is suitable for light starting applications that speed control is not important, for example for quick-opening valves.

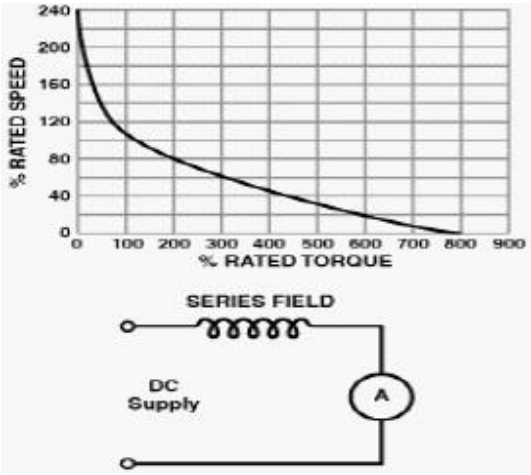

Figure 5. Series DC Motor

Source: (zonaelektro.net)

b) Shunt Motor, this motor has a lower starting torque, but has excellent speed control characteristics with a wide range of armature excitation currents. Motor is suitable for applications that speed is to be controlled, for example in conveyor systems.

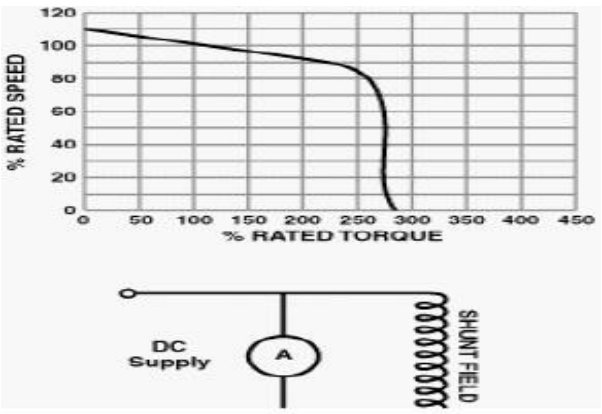

Figure 6. DC Shunt Motor
Source: (zonaelektro.net)

c) Mixed Field/Compound, this motor is a combination of the two motors above, this motor improves the weaknesses of the previous motorbikes. Initial power and speed control on the motor is between the two cases above.

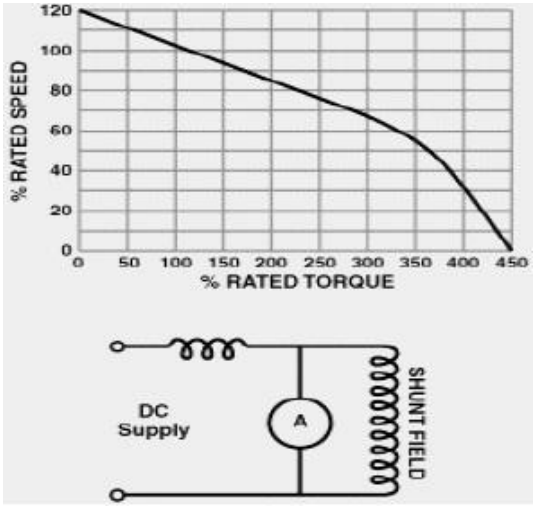

Figure 7. Mixed/Compound DC Motor

Source: (zonaelektro.net)

According to Nainggolan Benhur et al. (2016), the DC motor is ideal for applications that requires high reliability, high efficiency, and high power-to-volume ratio. Thus, the DC motor was chosen.

3. Transportation

According to Abbas Salim (1993), transportation is the activity of moving goods and passengers from one point to another. In sports transportation, there is an important element, namely the transfer/movement of goods (commodities) and passengers to other places. Thus, transportation is the movement of goods or people from one place to another by means of transportation either from land, sea or air.

a. Types of Transportation

1) Land transportation is all forms of transportation that use roads to move goods or people from one place to another. Land transportation consists of bike, motorbikes, cars, and trains.
2) Water transportation is all forms of transportation that use water to move both people and goods from one place to another.
3) Air transportation is any activity carried out by using an airplane to transport passengers, cargo or post for one or more trips from an airport to another airport or several airports.

b. Energy Efficient Transportation

Energy-efficient transportation is transportation created to protect the environment from global warming, which means air this vehicle does not cause pollution or environmental pollution. Energy-efficient transparency was created to reduce our dependence on fossil fuel consumption. Energy-efficient transportation typically substitutes fossil fuels with electricity, biofuels, fuel cells and natural gas.

B. Related Research

Based on the literature review, related researches as follow:

1. Janriko B Manalu (Final Project, 2017). Electric Motorcycle Design. Department of Electrical Engineering, Faculty of Engineering. USU: Medan. (In this study, 2 testing methods were carried out, namely (1) the funds

needed to assemble an electric motorcycle, (2) energy consumption in one trip).

2. Januar Ishak Wijaya (Thesis, 2015). Design and Selection of Electric Bike Drive System Components with Composite Material Frames. Department of Mechanical Engineering, Faculty of Engineering. Pasundan University: Bandung. (In this study, the components of the electric bike drive system use a Brushless geared hub DC type electric motor with a power of 350 Watt, with an average speed of the bike is 27 km / hour with the position of the electric motor in the back, and using a lithium ion battery with a voltage of 12 vilt with a current of 8.8 Ampere which makes the bike can be used properly and comfortably.

CHAPTER III

RESEARCH METHODOLOGY

A. Research Design

This study is an experimental method to design and manufacture proper electric bike. The preparation is conducted by selecting the main components in the electric bike drive system. There are many factors that affect the ability of the tool to be designed. Therefore, many references and additional information are needed from books, articles, and other sources related to the study to get significant results.

B. Time and Place

Study was conducted in a period of time (January - September 2019), starting from submitting title, supervising, preparation of proposals, planning, manufacture, analysis of tool capabilities, and report. Workshop Mechanical Engineering, Faculty of Engineering, Universitas Negeri Padang was choosen as place of study.

C. Tools and Materials

1. Tool

The tools used in this study include:

a. Welding machine

b. Grinding machine

c. Measuring instrument

d. *Timer*

e. Key set

2. material

The materials used in this research are:

a. Bike frame

b. Pipe iron

c. Electric motor

d. Battery

e. Steering system

f. Controller

g. Monitoring tools

h. Gears

i. Chain

j. Wheels

k. Speed control

D. Electric Bike Design and Manufacture

1. Design of Electric Buike in a Functional manner

The functional design describes functions of each tool.

Table 1. Design of electric bikes in a functional manner

No.	Tools section	Function
1	24V 250W MY1016Z electric motor	The main component of an electric bike, serves to produce rotation.
2	24 V 12 Ah battery	The battery is the main component of an electric bike that transmits electrical energy to the electric motor.
3	Steering system	Set the direction of movement of the electric bike as we want.
4	Controller	Regulating the current and voltage from the battery to the electric motor.
5	Monitoring tools	Information center of electric bikes that can inform the condition of electric bikes.
6	Gears	Components that function as a power transfer.
7	Chain	The main component in the electric bike drive system.
8	16 inch wheels	As an electric motor, the electric motor is channeled through the power transfer system.
9	Speed regulator	Components that can regulate speed power on an electric bike.
10	Bike Frame	Locations of all components.

2. Structural Design of Electric Bikes

This electric bike consists of four important components, namely: dynamo, controller, battery, bike frame.

The structure of the electric bike includes:

a. Dynamo

The dynamo used is a 24V 250W MY1016Z dynamo type as a driving device on an electric bike.

b. Controller

The controller is as an electrical control system on an electric bike. All electricities are regulated by the controller.

c. Battery

The battery is used as a source of energy to produce electricity that makes movement of electric bikes with 12V 12Ah battery.

d. Bike Frame

The frame of the bike is very influential on the position of the battery and dynamo.

3. Component Assembly

All components that have been prepared are assembled in series according to what has been planned. All components are assembled properly and correctly according to the initial design. Each component is assembling into united electric bike. This assembly has an assembly procedure, including:

a. Frame Assembly

In this case the frame assembly is to form a pre-planned frame. The frame is adjusted to an existing prototype.

b. Arrangement of Tool Components

The arrangement of electric bike components in this case is to assemble each

component on an existing frame.

E. Testing and Data Analysis

The design of an electric motor in this study starts from calculating the mass of the system and determining the minimum torque to move the bike using the aerodynamic drag and rolling resistance approaches shown in Eq. 2 and E. 3.

1. Mass Vehicle Systems

Mtot = bike ride + rider weight..... (Eq1.1)

Wtot = Mtot× Earth's gravitational force (9.81)..... (equation 1.2)

Where :

Mtot = total mass of electric bike (kg)

Wtot = total weight of an electric bike (N)

2. Mechanical power

a. Normal force

FN = Mtot× Earth's gravitational force (9.81) ..... (equation 2.1)

b. Static friction

FS = FN S (0.7)× μ ..... (equation 2.2)

c. Kinetic friction

FK = FNK (0.6) .... (equation 2.3)× μ

d. The torque required to move the bike must be greater than that

TS> FS Rroda .... (equation 2.4)×

3. Electric motor torque

P = ...$T_{motor} \times \frac{2 \times \pi \times n}{60}$(Equation 3.1)

$Tmotor = \frac{60 \times P}{2 \times \pi \times n}$..... ..... (equation 3.2)

Where :

P = power motor (Watt)

n = motor shaft rotation (Rpm)

4. Bike Travel Speed

$V = \frac{S}{t}$..... ..... (Equation 5)

Where :

S = distance traveled (m)

t = travel time (s)

5. The power generated by an electric motor to drive a bike

Pout = 9.81 Mtot Average ..... (Equation 4)$\times \mu \times\times\times \eta$

Where :

Mtot = total mass of the bike

μ = shear coefficient (0.06)

η = machine work efficiency

V avg = bike speed (m/s)

F. Research Flowchart

A flow chart is a brief depiction of a process. Flowcharts are made to make it easier to understand a process. To clarify the stages of making an electric bike and analyze the performance of an electric bike, a flow is made which is shown in the Figure 8.

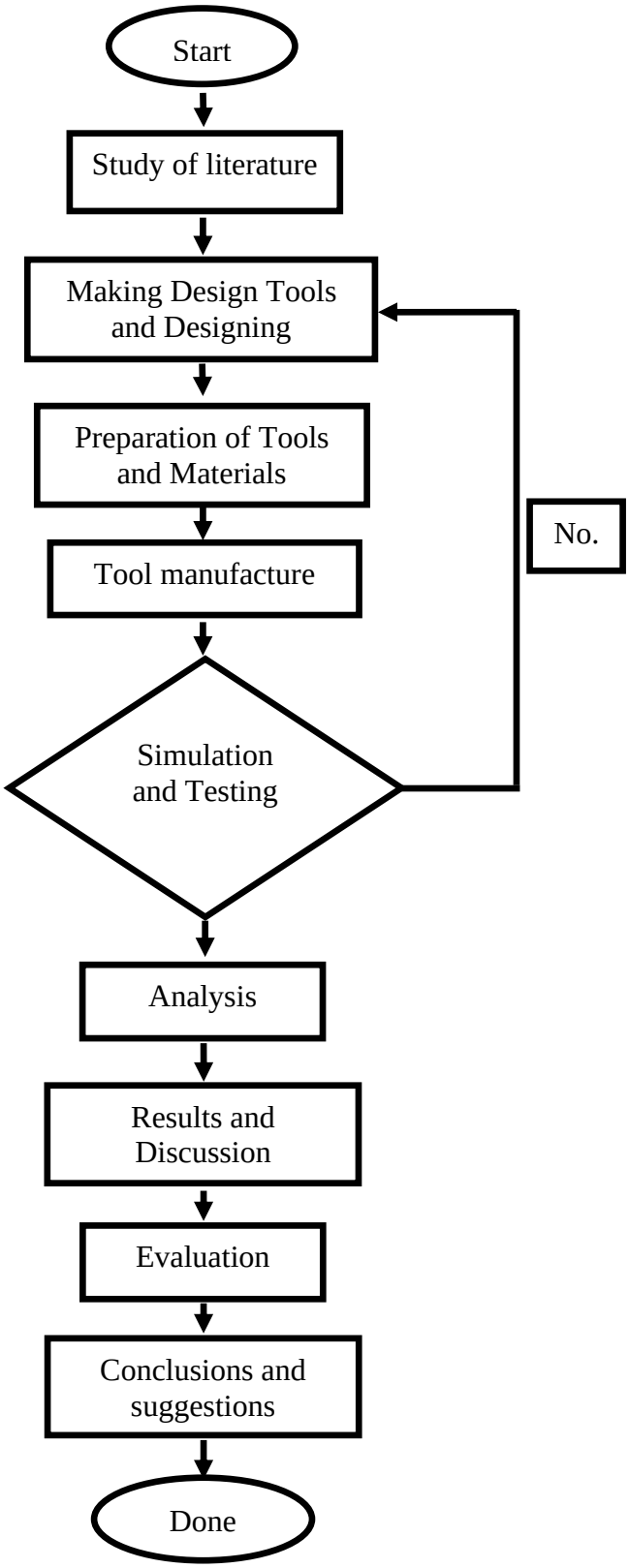

Figure 8. Research Flowchart

CHAPTER IV

RESULTS AND DISCUSSIONS

A. Electric Bike Manufacturer

The electric bike is a manifestation of the human need for a means of transportation that combines advantage in terms of needs and is environmental friendly (Benny Setiyawan, 2012). Meanwhile, according to Januar Ishak Wijaya (2015) an electric bike is a vehicle without fuel that is driven by a dynamo and an accumulator.

The concept of an electric bike is actually very simple. Electric bike can be moved with the gas pedal without any power from humans. The battery is a electric current supply to the dynamo. The amount of current and the amount of voltage required by the motor or dynamo is regulated by the controller. The main components needed are: bike, frame, battery, and controller.

Figure 8. Electric Bike

This electric bike has four main components, namely: bike frame, bike, battery and controller. Everything is designed in such a way that it becomes a complete unit to form an electric bike. Table 3 will present the specifications of the electric bike that is made.

Table 3. Electric Bike Specification

Bike Specifications		
Tool	Type	Specifications (cm/kg/volt/watt)
Bike Frame	Bike length	140 cm
	Bike width	65 cm
	Bike height	90 cm
	Bike wheel diameter	32 cm
	Bike tire diameter	50 cm
	Left side gear diameter	7.8 cm
	Right side gear diameter	7.8 cm
	Foot pedal gear diameter	15 cm
	Bike weight	7.5 kg
Electric motor	Electric motor length	13 cm
	Electric motor width	13 cm
	Electric motor height	10 cm
	Shaft diameter (gear)	4 cm
	Electric motor weight	2.5 kg
	DC motor mains voltage	24 volts
	DC motor power	250 watts
Batteries / Batteries	Battery / battery length	32 cm
	Battery / battery width	9.5 cm
	Battery / battery height	20 cm
	Battery voltage / battery	24 volts
	Battery / battery weight	8 kg

When the bike has been arranged into a complete unit, the bike has a weight of 18 kg.

C. Electric Bike Performance

In the manufacture of this electric bike, a driving engine is used in the form of a 250W 24V MY1016Z electric motor with a 24 volt 12 ampere battery. Electric bikes can be used on flooded roads and can also be washed. The working system of this electric bike is the same as an ordinary bike, except that an electric motor is added as an additional drive besides the pedals. The main difference is that human power is replaced by an electric motor. As result, the distance that can be covered by bike is 36 km with a duration of 130 minutes. The main components and working principles of a bike are as follows:

1. Main component

a. DC Electric Motor

The electric motor has a significant impact in designing and manufacture on an electric bike. An electric motor has a lot of power impacts to the bike speed. More power supply, more higher speed and vice versa.

Figure 9. DC Electric Motor

b. Battery

The battery will affect significantly to the millage of electric bike. More power the battery has, the farer millage.

c. Controller

The controller used is in accordance with motor power and battery power. Choosing the wrong controller causes unoptimal bike performance.

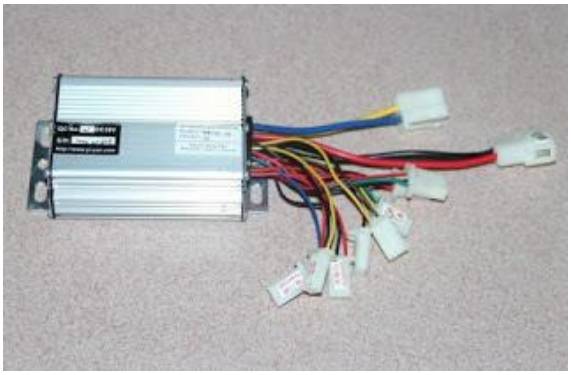

Figure 10. Controller

d. Order

The selected bike frame should have a light weight, thus to minimize the overall weight of bike.

2. Working Principles of Tools

a) The electrical energy stored in the battery is supplied to the motor in order the motor can rotate.

b) Before the electric current is supplied to the motor, firstly passes through the controller which regulates the current requirements needed by the motor.

c) The controller also as a regulator of electric current to all components that require an electric current.

d) Then the battery also provides a terminal/port for charging the battery using electricity from power generator (PLN).

D. Planning Calculation Analysis

The calculation analysis carried out is an analysis of riders who weigh 60 kg, 65 kg and 70 kg. The result of analysis is as follows:

Table 3. Results of data analysis

No.	Rider weight (kg)	millage (m)	Time (s)	Speed (m/s)
1	60	100	20.23	4.95
2	65	100	21.78	4.59
3	70	100	23.48	4.25

1. The mass of the vehicle system with a rider weight of 60 kg

Mtotal = total bike weight + rider weight

= 18 + 60

= 78 kg

Where :

Wtot = 78 × 9.8

= 764.4 N

2. Mechanical power

a. Normal force (FN)

FN = Mtot 9.8×

= 78× 9.8

= 764.4 N

b. Static friction (FS)

FS = F_N× μS (0.7)

= 764.4 x 0.7

= 535.08 N

c. Kinetic friction

FK = F_N × μK (0.6)

= 764.4 x 0.6

= 45.64

d. The torque required to move the bike must be greater than that

TS> FS x Rroda

= 535.08 x 0.2 = 133.77 N

3. Electric motor torque

$$\text{Tmotor} = \frac{60 \times P}{2 \times \pi \times n}$$

$$= \frac{60 \times 250}{2 \times 3.14 \times 3000}$$

$$= 0.7961 \text{ Nm}$$

4. Bike speed

$$V = \frac{S}{t}$$

$$= \frac{100}{20.23} = 4.94 \text{ m/s}$$

5. The power generated by an electric motor to drive a bike is

$$\text{Pout} = 9.81 \times \mu \times \text{Mtot x V avg} \times \frac{100}{\eta}$$

$$= 9.81\text{x } 0.06 \text{ x } 784.94 \times \frac{100}{85}$$

$$= 266.679 \text{ Watt}$$

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

A. Conclusion

The conclusion from the study on the design and manufacture an electric bikes as energy-saving vehicles as follows:

1. In the design of an electric bike as an energy-saving transportation, several compliment components are used to drive an electric bike using: Series DC Motor, Battery, Controller, Trottel, and PLN Charger. The motor used is a 24 Volt DC motor, 250 watts, 3300 rpm. The controller used is a 12 A, 24 Volt controller. To drive the motor, a 24 Volt battery, 12 Amper is used as a source of electrical energy.

2. Power supply to the bike with DC electric motor is a battery. A controller is used to connect the battery and DC motor is a controller. The torque of the nonloaded electric motor is: 0.7961 Nm. The average speed of a bike with a load of 78 kg is 4.94 m/s, the average speed of a bike with a load of 78 kg is 4.59 m/s, the average speed of a bike with a load of 88 kg is 4.25 m/s. Output power to drive an electric bike with a load of 78 kg is 266.679 Watt, 83 kg load is 263.810 Watt, load 88 kg is 258.984 Watt, respectively.

B. Recommendation

1. Further research on electric bikes should consider the DC generator as a charger when the wheels rotate.
2. Proper pedal is required to avoid dropping on the bike during the initial movement.

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ATTACHMENT

1. Manufacturing

2. Data Collecting