Development of electric bicycle and its impact on the environment

Ali Ramadhan* and Rizky Dinata
Product Design, Faculty of Design and Creative Arts, Universitas Mercu Buana, Jakarta, Indonesia

*Email: ali.ramadhan@mercubuana.ac.id

Abstract. An electric bicycle is a tool that is produced from a combination of a bicycle as a means of transportation which is added with an electric component as its driving force. It is known that bicycles can still be used even without electrical components. However, with the presence of an electrical component, the human power that is expended can be minimized. The current environment has undergone various changes. This is intended because of changes that occur because of humans. By using a qualitative descriptive method, this study is expected to provide knowledge about the impact on the environment from using an electric bicycle. And the result is that currently, the diversity of electric bicycles does not only provide the development of the bicycle itself.

1. Background
Currently, there are many developments in the field of mobility and technology so indirectly it can encourage people to create tools that are often included with innovation [1]. Besides, the presence of various environmental issues has shifted human focus from using fuel oil to towards energy saving. This also has an impact on the presence of various kinds of transportation that are environmentally friendly and energy-efficient [2]. Due to the existence of environmental issues, humans can become aware of reducing the use of fuel oil because things can become difficult to find. With this, The presence of tools that use electricity, especially in the field of transportation, can provide options to the public regarding the presence of transportation that uses alternative energy in the form of electricity. One of them is an electric bike [3].

Today's electric bikes have developed and circulated. The use of electric bicycles as a means of transportation is to be able to support activities (mobility) related to the energy expended and the range obtained [2]. This is due to the presence of electric bicycles. Humans can reach places that are not close to the energy that is not much expended. Electric bikes can be used to help accommodate the needs for safe and comfortable transportation [4]. Its use around densely populated residential areas is believed to help reduce air pollution, which is currently getting bigger, which is mostly contributed by motor vehicle fumes [3].

The development of electric bicycles has now developed not only as a sporting tool. However, it has been transformed into a means of transportation. The use of an electric bike can cover a longer distance and makes it easier to pass through hills with relative ease and to get to a destination, such as work [3]. With the presence of features on the e-bike, it can overcome some common obstacles to cycling for all demographics [5]. the use of electric bikes is used to replace travel with human-powered bicycles or traditional motorized vehicles [6].
An electric bicycle is a combination and integration of an electric motor with bicycle that is used for propulsion. Today many types of electric bikes are available around the world [2], from electric bikes that only have a small motor to help power the rider to the stronger ones that are closer to functionality and style. The use of an electric bike applies the human ability to pedal [7].

**2. Method**

The research method used in this research is descriptive qualitative. This is because the qualitative method aims to understand social phenomena or phenomena by focusing more on a complete picture of the phenomena being studied [8] rather than breaking them down into interrelated variables. The hope is that a deep understanding of phenomena will be obtained and then a theory is produced [9].

The method of analysis is described as an attempt to decompose a problem or focus of study into parts (decomposition) so that the arrangement, order of the form of something that is parsed is clearly visible and therefore the meaning can be more clearly and clearly captured or can be understood more clearly the sit of the case [10].

**Figure 1. Research analysis methods**

And it is known that the method of analysis is a systematic identification of strategic factors to formulate a strategy which is a very important tool to achieve goals. The data analysis method in this study consisted of several stages [8], namely:

- Data processing is a process for obtaining summary data based on a group of fundamental and unclassified data. With data processing, it can be given useful meaning for solving research problems. Data processing is carried out in the form of data selection through categorization of the data that will be used for this research or based on improving data through a reduction process.
- Presentation of data is known as the process of gathering information organized according to the required categories. And it is known as the result for improvements from previously performed data processing.
- Data interpretation is known as the process to understanding the meaning of data that has been presented, that does not only see something was written, but rather to understands what is implied in the data that has been presented.

One of alternative propulsion energy is the presence of electricity to drive a device. And in this case also directly presents a means of transportation that has a diversity of driving energies [5]. One of the means of transportation that comes with the use of alternative energy is bicycles [11].

It is known that the bicycle is a means of transportation that has a driving force from humans. This actually does not affect the use of fuel oil energy. However, along with the development of technology use [12]. Bicycles are one of the objects of design that make it possible to be studied and developed for the better. Because as a means of transportation, bicycles can directly provide convenience for users to be able to access a place [7]. In fact, it is an option for transportation to carry out work activities. So that the presence of electric bicycles can be an option in using the maximum means of transportation [6].
3. Results

3.1 Electric bike

The electric bicycle can be described as a means of bicycle transportation. But in its development, existing bicycles are generally developed later with the addition of a battery element and an electric motor as the driving force [13]. An electric bicycle is a combination of bicycle components and an integrated electric motor to produce propulsion. In terms of the overall shape [14]. Electric bicycles consist of two types, namely those that use pedals, namely that the shape is not much different from an ordinary bicycle so that it can be run either with pedals or with a dynamo. And those who don't use pedals. Therefore, it has a physical form like an automatic motor system and the driving force comes from a dynamo [15].

![Figure 2. Model electric bicycle](image)

The shape of the electric bicycle still retains the ability to be pedaled by the rider. This is so that you can find out the difference between an electric motorcycle. It is intended that the development of transportation means can be distinguished even though they use the same work and driving system [11]. Because in its application. Electric bicycles and electric motors have the same characteristics, namely a series of means of transportation that are driven using batteries [13]. Because the use of batteries in electric bicycles is intended to enable cyclists not to get tired while pedaling and to reach the desired place in a shorter time compared to using an ordinary bicycle.

The use of electric bicycle transportation has started to develop. An electric bicycle is a series of bicycles that have been combined with a motor that has the propulsion in the form of a rechargeable battery [15]. With the characteristics of bicycles and motorbikes. As the presence of handlebar and wheels with the same number.

It needs attention to know the difference between an electric bicycle and an electric motorbike. Apart from being able to distinguish the basic components, it is also necessary to make adjustments to the prevailing road traffic regulations [3]. Due to the ambiguity between the two. Will make it does not affect the applicable traffic regulations.

![Figure 3. The geometry of bicycle and motorcycle frames](image)

Based on the geometry of the two. The difference lies in the special parts of the basic components between a bicycle and a motorcycle. The fundamental difference is in the component placement.
Because in terms of shape which affects the dimensions. The shape of the bicycle frame is flatter than the motorbike frame [16]. This fundamental difference will also affect the operation of the vehicle. What is known is that motorbikes are engine-driven vehicles, while bicycles use human power. Which results in different vehicle classifications [17].

3.2 Forms and variations of electric bicycles

Electric bikes are presented as an option from the current two-wheeled driving models. Electric bicycles are presented as a result of the development of bicycles that are powered by electricity [6]. By not removing the basic driving components from the bicycle. In appearance, electric bikes often feel the same when compared to motorbikes. With the difference in shape, the adjustment of an electric bicycle can be seen from a slimmer appearance. Because this display can directly explain the power capacity generated will tend to be small [15].

Because with the placement of electrical components on the bicycle. It can be a sign that the bicycle power is not as complete as an electric motorbike. Even with the presence of certain motor components, such as the speedometer [18]. Currently, there are many variations of the existing electric bikes. However, with the display of the battery as a power source attached to the frame. But not infrequently the battery component is also placed in a special container [6].

![Figure 4. Battery compartment as a characteristic of an electric bicycle](image1)

As one of the characteristics of an electric bicycle component. It is known that not all forms of electric bicycle containers are conventional [11]. Even with the conditions combined with the motor drive, the electric bicycle battery case emphasizes the capacity of the battery used. Due to the shape adjustment applied to the bicycle frame. The container design must provide a unity value from the existing form [13].

Not only the unity of the frame. The container form of an electric bicycle battery is also able to produce a system that is interconnected between the battery as a driving force with other components that are applied to an electric bicycle [16]. Also, the power generated functions like the power to move the wheels when not in the pedaling position [7].

![Figure 5. The battery as a propeller other than the pedal on an electric bicycle](image2)

In its application, an electric bicycle is not much different from a motorbike with a small power capacity [7]. The application of the power generated can result in reduced output from human power using it. So that it will indirectly affect the results of the distance obtained [18]. Also, the presence of
electric bicycles will add to individual modes of transportation that are generated from the direct combination of human and machine power [19].

3.3 Electric bike function
The electric bicycle is known as a means of transportation that combines human power, bicycle components, and the use of electricity. With human power, electric bicycles can be run using pedals connected by a chain to the rear wheels [11]. The existing bicycle component also determines that the bicycle can move like a bicycle which is known by pedaling [6]. And the battery element is used as additional power to move the wheels and other components. Even though it is considered the same as a motorbike. However, in terms of appearance and electrical components found on electric bikes, they still have differences [5]. Because the use of these components is connected to the controller components of the electric bicycle.

The function of an electric bicycle is not much different from a bicycle in general. With the use of batteries as part. It does not immediately take value off the bike [11]. Because electric bikes still use human power for pedaling and do not replace the user's function of the bicycle [2]. With the presence of an electric bicycle, a person's journey will be managed through user power management. And can carry out further journeys [14].

3.4 Work principle
Electric power can be used for almost all sectors. Not only as a light source, but electricity can also be used as a driving force. Because it is known that the use of a battery allows it to produce motion in an object [20]. As a driving force, electric power is generated from the process that has been passed, because by using indirectly the power generated by the battery can be allocated according to the connection made through the path made. And until now, the development of battery usage is not only on objects that have a small shape and size [21]. But it has reached objects that have a shape and size larger than the battery, one of which is an electric bicycle.

The working principle of an electric bicycle is simply starting from a stationary state to move. Electric bicycles are known to use an electric power source from a battery that is already charged with electricity to be able to drive the motor [11], in this case as a driving force. In its workflow, an electric bicycle is to regulate the power that will enter the electric motor so that it can move. So that the bicycle can move without having to be pedaled [6].

![Figure 6. Schematic of an electric motor [3]](image)

In simple terms, the movement of an electric bicycle is the result of a change in electrical energy that starts from the battery into motion energy to the dynamo which produces rotation [14]. Then the rotation of the energy of the motion is used to move the bicycle wheels. With a simple mechanism such as the result obtained from an electric current, it produces a force [5].

3.5 Effect of electric bicycles
Currently, it is known that many developments have been made in terms of generating energy conversion related to transportation means. The development that is being carried out does not only function for technology transfer [12]. But it can also be linked to a better life. In this case, it is
intended to provide comfort and health to the community. Because it is known that many environmental issues are associated with the pollution produced by vehicle exhaust as a means of transportation [18].

![Figure 7. Electric bicycles and the environment](image)

The electric bicycle is the result of the development of a means of transportation which is basically zero emissions. This is because electric bicycles emit combustion resulting from the movement of fuel to the engine [7]. The current consideration is that oil-fueled transportation has produced carbon emissions to the environment. So that the existence of an electric bicycle can minimize the environmental impact.

In line with the concept of cycling. Electric bikes also come in a variety of options. Because not only for road conditions [22]. Electric bikes also come in a variety of choices. It is known that the development of electric bicycles also followed the presence of bicycle variants [11]. Therefore, it is not uncommon to find electric bikes whose designation is not only for roads. But it can also be used in mountainous areas. This is adjusted to the use of similar bicycle components with added battery components [12]. Although on the one hand, irreplaceable waste batteries will be the next focus. Because it is known that one of the wastes that cannot be recycled is waste batteries. And in certain cases, it can contaminate the environment if not disposed of properly [3].

Bicycles are not only present as a tool to move places. but under certain conditions, bicycles are also present as a means to support activities such as sports. The bicycle as a sporting tool [2]. Not only as an outdoor sport. Bicycles also come in the form of indoor sports equipment. This is because, at this time, there are not a few explanations about the benefits of cycling [15]. Because at this time it is believed that cycling movements that are carried out help shape, strengthen, and tone the thighs, calf muscles, and the pelvic area [4]. Electric bicycles that are not much different from electric motors are present in conditions as a means of transportation. With the use of human energy, it can indirectly be present as a sporting tool. But on the one hand, there are obstacles that when cycling [7]. The user is conditioned to a sitting position by different methods. And in this case, it tends to be at risk of experiencing spinal problems or injuries, due to the use of a bicycle if it is carried out at high speed and on an unusual path [19].

![Figure 8. Electric bicycles and means of transportation](image)
Bicycles are known as a means of land transportation. Apart from a motorbike, bus, car, or train transportation. It is also known that bicycles have many shortcomings compared to other means of transportation [23]. Even with the explanation that cycling has been combined with the calorie-burning process. However, for the time achievement model, bicycles still have problems. Although many activities can be done through cycling. However, in practice, environmental conditions will be constrained [24].

The use of electric bicycles at this time has begun to reach people who use electric bicycles as a means of transportation. This can be seen from the use of electric bicycles to accommodate activities to go to work [23]. Increasing the use of electric or non-electric bicycles will also have an impact on the traffic that will be faced. Because it is known that bicycles have steep lanes which should be followed. And in this condition, electric bikes that are motorized will be able to use conventional lanes. So that it can produce an accident risk [25].

4. Conclusion
Electric bicycles have developed into a means of transportation that is used to travel short distances. The shift from using transportation equipment that uses fuel oil to alternative energy has also resulted in assessments that have changed people's habits. The development presented by electric bicycles shows a change in the way people think about the means of transportation used. This also includes the people's perspective on the environment. Because of the shift in the meaning of the bicycle as a sporting tool, which is a means of transportation. Can influence the way people think about the tools and the environment.

The potential of using electric bicycles can also indirectly provide changes to the wider community. Because, if at present it is not uncommon for conventional bicycle repair shops to be present, in the future there will be opportunities for repair shops to have facilities to repair electric bicycles. This directly affects the expertise possessed by a person so that it demands the presence of new human resources.

References
[1] Ramadhan A and Pertiwi Y M 2019 Ragam Modifikasi Ruang Dalam Angkutan Kota Untuk Meningkatkan Pelayanan Dan Kenyamanan NARADA J. Desain dan Seni vol 6 no 1 97–128.
[2] M James C 1977 Pedal power in work, leisure, and transportation. Pennsylvania: Rodale Press.
[3] Dill J and Rose G 2012 Electric bikes and transportation policy: Insights from early adopters Transp. Res. Rec vol 2314 no 1 1–6.
[4] W Zhongxia X, Ruifen X, Yan B and Xiaofan 2011 Optimal Design of Bicycle Parameters Considering Biomechanics Chinese J. Mech. Eng. vol 24 no 1.
[5] Johnson M and Geoff R 2015 Extending life on the bike: electric bike use by older Australians J. Transp. Heal. vol 2 no 2 276–283.
[6] Matey S, Prajapati D R, Shinde K, Mhaske A, and Prabhu A 2017 Design and fabrication of electric bike Hand vol 27 no 250 40.
[7] Ramdahan A and Sihombing J P 2018 Kajian ergonomi desain sepeda fixed gear (fixie) Prod. J. Desain Prod. (Pengetahuan dan Peranc. Produk) vol 3 no 1 8–21 Feb. 2018.
[8] Lambert V A and Lambert C E 2012 Qualitative descriptive research: An acceptable design Pacific Rim Int. J. Nurs. Res. vol 16 no 4 255–256.
[9] Vaismoradi M, Turunen H and Bondas T 2013 Content analysis and thematic analysis: Implications for conducting a qualitative descriptive study Nurs. Health Sci. vol 15 no 2 398–405.
[10] Kim H, Sefcik J S and Bradway C 2017 Characteristics of qualitative descriptive studies: A systematic review Res. Nurs. Health vol 40 no 1 23–42.
[11] Sharma Y, Banker P, Raiwar Y, Chauhan Y and Sharma M 2018 R&D on Electric Bike IRJET vol 5 no 2 610–614.
[12] Wei L, Xin F, An K, and Ye Y 2013 Comparison study on travel characteristics between two
kinds of electric bike Procedia-Social Behav. Sci. vol 96 1603–1610.

[13] M Hatwar N, Bisen A, Dodke H, Junghare A and Khanapurkar 2013 Design approach for electric bikes using battery and super capacitor for performance improvement in 16th International IEEE Conference on Intelligent Transportation Systems 1959–1964.

[14] Gabor R, Kowol M, Kołodziej J and Mynarek P 2018 Steady State Analysis of Switched Reluctance Motor with Modified Geometry of the Stator Designed for an Electric Bike in International Symposium on Electrical Machines (SME) 1–5.

[15] Lin C-H, Liu H-W, and Wang C-M 2010 Design and implementation of a bi-directional power converter for electric bike with charging feature in 5th IEEE Conference on Industrial Electronics and Applications.

[16] Maleque M A and Dyuti S 2010 Materials Selection of A Bicycle Frame Using Cost Per Unit Property and Digital Logic Methods, International J. Mech. Mater. Eng. vol 5 no 1 95–100.

[17] SNI 09-0542-1998 Rangka Sepeda. DKI Jakarta, 1998.

[18] Niki H and Murakami T 2005 An approach to self stabilization of bicycle motion by handle controller in Transactions on Industry Applications 125.8 779–785.

[19] Sharp R L, Costill D L, Fink W J and King D S 1986 Effects of eight weeks of bicycle ergometer sprint training on human muscle buffer capacity Int. J. Sport. Med. vol 7 no 1 7–13.

[20] Jordehi A R 2019 Optimisation of demand response in electric power systems, a review Renew. Sustain. energy Rev. vol 103 308–319.

[21] Weedy B M, Cory B J, Jenkins N, Ekanayake J B and Strbac G 2012 Electric power systems. New York: John Wiley & Sons.

[22] Ramadhan A, Soedarwanto H and Medina R 2020 Utilising the Helmet as a Drawing Field and the Application of Drawing Knowledge Int. J. Innov. Creat. Chang. www.ijicc.net vol 10 no 12 2020.

[23] Lugo A E 2018 Bicycle/Race: Transportation, Culture, & Resistance Portland: Microcosm Publishing.

[24] Golub A, Hoffmann M L, Lugo A E and Sandoval G F 2016 Bicycle justice and urban transformation: Biking for all? Abingdon: Routledge.

[25] Schleinitz K, Petzoldt T and Gehlert T 2018 Risk compensation? The relationship between helmet use and cycling speed under naturalistic conditions J. Safety Res. vol 67 165–171.