A General Review of EBs and an Analysis of Their Problems and Solutions

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***Abstract*—Two global problems that require attention are the depletion of fossil fuels and the rise in pollution caused by internal combustion engine vehicles. The implementation of electric vehicles is a potential solution to these issues concerning environmental degradation and energy security. With numerous advantages, Electric Bicycles (EBs) have become a popular type of electric vehicle attracting much attention. This article provides an account of the electric bicycle's history, including the development of its basic structure and its various classifications. The article then delves into the issues that EBs are currently facing, along with the solutions to these problems. After reading some past papers, journals, and articles, I've come to some conclusions: today's EBs are at their best, but there are still some intractable problems. In this information, this paper summarized the history of EB development, and its possible problems and gave some solutions. As a result of this analysis, it can be concluded that EBs have attained a relatively stable state in their development. There is a growing number of individuals who have started to focus on EBs due to the increasing trend of environmental protection. They are light, environmentally friendly, easy to learn, and reasonably priced. But although riding EBs is becoming a popular way to travel, they still have many safety hazards. And many EB users do not have good safety awareness, which often leads to accidents. There are also design problems with some EBs that can directly or indirectly lead to accidents or pose a threat to a person's health. So we should think about solutions and actively solve these problems. Thus, this paper has analyzed the information given in some articles and summarized some solutions that I hope will make some contribution to the future development of EBs.**

***Keywords*—electrical-bicycle, development, problems, solutions**

I. Introduction

Exhaust emissions from vehicles utilizing traditional fuels such as petrol and diesel discharge Hydrocarbons (HC), Nitrogen Oxides (NOx), Carbon Monoxide (CO), and Particulate Matter (PM). These pollutants are contributing to environmental issues globally, and their impact is anticipated to significantly increase by 2020 [1]. The automobile is the leading consumer of fossil fuels, aimed at resolving traffic congestion. Substituting Electric Bicycles (EBs) for automobiles can reduce car usage, thereby achieving environmental protection goals. An electric bicycle refers to a two-wheeled device equipped with an electric motor used for propulsion or to assist pedaling, as defined by SBQTS (1999). Gaucho [2] highlights the advantages of EBs for human health and the environment, including the ability to travel greater distances in less time. Secondly, e-bikes make commutes less tiring and disheveling. Additionally, compared to conventional bicycles, e-bikes are easier to ride up steep hills and over rough terrain. Furthermore, e-bikes are environmentally friendly as they emit no hazardous pollutants. Moreover, e-bikes have a lightweight construction that reduces damage to roads and decreases traffic volumes compared to other common modes of transportation.

The EB market is a rising market and is expected to further grow in the future. With their many benefits, EBs are attracting more attention from potential users, and are becoming one of the strategic business areas for many companies worldwide [3]. Many auto companies are also interested in the EB field, including Ford, Honda, Peugeot, Mercedes, BMW, Volkswagen, Opel, Hyundai, Lexus, and General Motors [4]. Jamerson and Benjamin [4] estimate that EB sales will rise to 130 million by 2025 and 800 million by 2100. According to a report from Navigant Research [5], China is predicted to become the world's largest EB market, with an average sale of about 30 million units from 2016 to 2025, which is much higher than in the rest of the world.

EBs are set apart from traditional bicycles and petrol scooters by their three primary components, namely motors, batteries, and controls. Electric Bicycles (EBs) can be classified into three distinct categories: bicycle-style, scooter-style (e-scooters), and hybrid-style EBs. The majority of EBs can be divided into the aforementioned three categories. It is worth noting that hybrid-style EBs fall somewhere in between bicycle-style and scooter-style EBs [6].

While there are benefits to utilizing Electric Bicycles (EBs), numerous drawbacks also arise. One issue is that EB users often contravene regulations. Furthermore, EBs lack ergonomic design and may lead to discomfort. Additional concerns include overweight batteries and the possibility of spontaneous combustion. Nonetheless, ensuring the safety of cyclists in traffic remains a crucial consideration. This involves conducting comprehensive research into prospective risk factors and safety outcomes. Therefore, for a shift from passive to active forms of transportation to take place, improvements to cycling safety are essential.

This paper would like to contribute some solutions to these problems. Firstly, there are ways to make EB users more aware of the rules, and just as importantly, to expand non-motorized lanes. Secondly, we could decrease the strain on the human body by including more ergonomic seats in EBs. Lastly, we could select safer batteries.

II. A Review of EBs

This section will analyze the history of EBs, how they are classified, and some of the specific problems that have arisen with EBs.

A. History

1) The start of EBs up to 1900

In the 1890s, EBs were created for the first time. 1895 saw Ogden Bolton in the 1890s, EBs were created for the first time. Bolton [7] created an EB integrated with a six-pole Direct Current (DC) hub motor installed in the back wheel in 1895. With a 10-volt battery, for instance, this DC hub motor can manage a high current at a low voltage of 100 A. A year later, to improve the efficiency of automobiles in general and bicycles specifically, Theryc [8] designed a wheel with an electric motor hub. Libbey [9] designed an EB with a twin electric motor in 1897. His creation demonstrated that twice as much traction could be gained and the EB could be moved more readily by using a rear double-treaded wheel as the driving wheel. Scott [10] created an EB in 1898 that ran on a generator rather than a battery. Through the use of a pulley and a flexible belt, the rider would pedal to rotate a generator (dynamo), which would subsequently be used to power a tiny motor. Nonetheless, the design of this device was seen to be inefficient.

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2) From 1900 to 1990

EBs saw continued development from 1900 to 1990. In 1900, Hänsel [11] invented an EB employing a non-hub motor located in the centre of the vehicle. Hänsel utilized intermediary bars in the vehicle's frame to support the electric motor, with the upper tube of the bicycle frame serving as a storage battery holder. By pedaling through the switch, pulley, and belt systems, the electric motor charged the battery. When climbing hills, the circuit connecting the electric motor and battery was closed and the motor would receive current to aid pedaling. The first electric bicycle, invented by McDonald [12], utilized an electric hub motor mounted in the front wheel. McDonald's electric bike was equipped with primary and secondary electric batteries, which were placed centrally in a low position. Argyris's [13] revolutionary invention utilized a cylindrical motor whose shaft extended along the length of the bicycle frame. The motor ran parallel with the chain to bolster the rider's pedaling efforts.

3) The improvement of EB in efficiency

From the 1990s to the end of the twentieth century, EBs underwent several notable improvements over their previous iterations. The first commercial EBs became available during this period [14]. Gannon [15] developed an EB with an electric propulsion system and a solar charging device that allowed the driver to travel further and faster while encountering fewer obstacles than previous designs. Chou [16] improved the EB by adding an output bevel gear from a DC motor that meshed with a larger bevel gear to drive the hub forward without changing the function of the pedal, which could still drive the hub. Chou's invention used a cylindrical motor, similar to the one developed by Argyris [13]. A group of researchers from Taiwan [17] have developed a power transmission and pedal force sensing system for an Electric Bicycle (EB) that can achieve higher transmission efficiency with reduced volume and weight. The system uses a pedal force sensor to measure the magnitude of the pedal force and sends the control signal to a controller to regulate the auxiliary output power of the electric motor. James R. Turner developed an Electric Bicycle (EB) by using an electric motor in conjunction with the mechanical gears of an exemplary electric motor assembly. The primary aim of the EB was to reduce the required torque and increase battery life. The motor used a 4.5:1 gear ratio in the electric motor assembly, which resulted in a fourfold increase in wheel torque without increasing current or compromising efficiency. The author incorporated a torque sensor to allow the motor torque to be set as a simple multiple of the rider's torque. In addition, the motor could be instructed to start turning as soon as the rider began to turn the pedals at a certain rate per revolution, resulting in efficiency gains in battery consumption.

4) Further improvement in the 21st century

From the early 21st century to the present, EBs continue to be studied and developed with advanced technologies to significantly improve their operational performance. Lin [18] from Taiwan invented an EB that can be conveniently folded and wheeled by hand. This new design uses two small wheels instead of the traditional two large wire-spoke wheels, resulting in reduced storage space requirements. In addition, the auxiliary wheels have been designed to be positioned above the ground when the bike is in use or folded, making it more suitable for urban environments with limited space. In addition, Huber [19] developed a chainless electric bicycle that allows the rider to generate electric power for transmission by pedaling to a connected generator that either charges the battery or partially powers a hub motor installed in the front wheel. A team of innovators from Taiwan [20] developed an electromechanical control system for an electric bicycle by integrating a smart mobile device and cloud services. The device displays cycling and bicycle data on the mobile device for easy recording and management during cycling.

B. The Classification of EBs

By reading previous papers, I have found that there are three types of EB. The dissertation describes three distinct classifications of e-bikes: bicycle-style e-bikes, hybrid-style e-bikes, and scooter-style e-bikes [6]. All three variants share common characteristics including two wheels, electric-assistance, and low speeds. Please note, that electric motorcycles are not included in this study. The Scopus database was primarily utilized to review relevant literature, employing keywords like "electric bicycle", "electric bike", "e-bike", and "electric two-wheeler vehicles".

EBs can also be categorized according to their functions. The functions of e-bikes, such as autonomous, manned, and unmanned, as well as structural characteristics, such as frame types (e.g., fixed frame vs. e-bike folding frame), frame materials, and the number of wheels (e.g., two-wheel, three-wheel), can also be classified. To help the rider overcome the resistance of the mountainous terrain, EBs used for hill climbing often have a light, stable frame and robust motor power. The mobility of EBs used for urban transport is often high, allowing the rider to move freely around the city, even in congested areas. These scooters can also be smaller than other scooters and have foldable frames, allowing the user to carry the scooter themselves. EBs can include storage compartments to meet the needs of longer trips.

1) The classification of electric motors

Electric motors, which are categorized based on their placement and purpose on EBs, are crucial for driving EBs [3]. Either Brushless DCs (BLDC) or brushed DCs are used in EB motors. Compared to BLDC motors, brushed DC motors are more reliable and reasonably priced, but they also require more regular maintenance, are heavier, and produce more noise. BLDC motors require less maintenance, are lighter, and quieter. Furthermore, their size is often lower than that of brushed DC motors, making them suitable for compact EB designs. However, the drawbacks of BLDC motors include their cost and complexity of control.

Motors on electric bicycles are classified by their function and location on the bike. In general, motors are positioned in the mid-drive, rear wheel (rear wheel hub motor), or front wheel (front wheel hub motor) positions. Front wheel-hub motors are easily installed and removed, making maintenance a convenient task. Furthermore, these motors balance the weight distribution between the front and rear of the electric bicycle better than the rear wheel hub motor. Nonetheless, positioning the front wheel hub engenders several limitations, including the possibility of front wheel slippage on slick and hilly terrains, likely hindrance to EB control and steering, and lower power in contrast to a rear wheel hub motor.

The weight distribution at the back of the EB seems to prevent wheel slippage when using a rear wheel hub motor, as opposed to a front wheel hub motor. However, the rear placement of the motor unbalances the EB's front and rear, potentially placing excessive strain on the back wheel. When using rear-wheel hub motors, there are several options for power and control.

Better weight balancing is produced by the mid-drive motor's low, central location on the EB compared to the hub motors on the front and back wheels. It is simpler to remove the front and back wheels of the EB since the motor is positioned in the centre of the vehicle. Mid-drive motors are often smaller than hub motors of the same power and may be mounted directly into the EB's frame. In addition, mid-drive motors perform better on hills than hub motors of equivalent power. Nevertheless, when incorporated, mid-drive motors need specially made frames, and their cost is often higher than that of hub motors.

2) The classification of battery

The batteries of EB in the present market are mostly divided into three categories, they are lead acid batteries, silica gel batteries, lithium batteries, and others. These three types of batteries are the most popular ones in the current e-bike market in China.

a) Lead battery

In 1859, French physicist Gaston Planté created the first rechargeable battery by using a reverse current [21]. The battery comprises a lead negative electrode and a lead dioxide positive electrode, both of which react with sulfuric acid in the electrolyte during discharge to produce energy, water, and lead sulfate. To charge the battery, an external electric source electrolytically converts the lead sulfate and water to lead dioxide and sulfuric acid. This method offers the advantage of being inexpensive and easily recyclable. Furthermore, they are available in a wide range of sizes and capacities. They come in a variety of sizes and capacities, and have multiple suppliers worldwide, making delivery easy for customers. A drawback to consider is that the Lead-acid battery is significantly heavier than other battery types, causing a risk of injury when lifted. Additionally, its energy-to-weight and energy-to-volume ratios are low, with a potential reduction in its operating performance due to lead sulfate crystals causing insulation on the negative electrode. Moreover, it has the potential to pose risks such as chemical burns to the skin and the production of flammable gases. Additionally, the negative electrode is made of lead, a hazardous metal for the environment.

b) Nickel-cadmium battery

The initial NiCd battery was developed by Waldemar Jungner – a Swedish scientist – in 1899. rechargeable battery comprising a nickel oxide-hydroxide positive electrode plate, a cadmium negative electrode plate, a separator, and an alkaline electrolyte (potassium hydroxide). The electrodes, separated by a membrane, are coiled in a jelly-roll configuration within a metal casing. This design permits the delivery of a more substantial maximum current than an equivalent-sized alkaline cell [22]. The NiCd battery boasts a greater capacity when compared to the lead-acid battery. However, the battery has a few disadvantages. It can operate within a broad temperature range and boasts a long operational life, along with straightforward transportation and storage. Additionally, it offers an extended lifespan and ease of transportation and storage. The NiCd battery comes in several sizes, tailored to different performance requirements. Despite its advantages, the NiCd battery has significant drawbacks. Specifically, it contains cadmium, a toxic metal that is difficult to recycle. Despite possessing the same capacity, this battery is costlier than a lead-acid battery. One of the key drawbacks of the NiCd battery is its memory effect, in which it gradually loses its maximum energy if it is repeatedly recharged after being partially discharged [23].

c) Lithium-ion battery

The Sony Corporation [23] announced the world's first commercial lithium-ion battery. These rechargeable batteries function by allowing lithium ions to shift from the negative electrode to the positive electrode upon discharge and then return during charging [24]. Typically, lithium-ion cells have negative electrodes made of carbon and positive electrodes made of metal oxide. The electrolyte, which is composed of a lithium salt in an organic solvent [25], complements the Li-ion battery. The Li-ion battery is a highly sought-after rechargeable battery type with impressive sales in the battery market. It boasts a lighter weight compared to other rechargeable batteries, considering battery capacity. In addition, it possesses a high energy density and negligible memory effect [24]. Its self-discharge rate is significantly lower than that of NiCd and NiMH batteries. Since there is no memory effect, maintenance is unnecessary. Furthermore, due to its superior energy efficiency, it is well-suited for use in electronic devices. However, Li-ion batteries are more expensive than NiCd and NiMH batteries, which is considered a drawback. However, the battery could be damaged if it overheats, is overcharged, or over-discharged, and therefore, protection is necessary to ensure safe operating limits. The aging of the Li-ion battery is a drawback that depends on the number of charge-discharge cycles it undergoes [26].

III. The Issues and Solutions of EBs

Due to concerns about the safety of e-bikes, some studies have looked at possible solutions to e-bike safety.

A. The Issues of Present EB

The aspects of EBs that consumers feel need to be greatly improved are overweight, slow speed, poor battery performance, difficult maintenance, lack of diversity models, and insensitive controllers. They also have the following disadvantages: When riding an electric bike and encountering dangerous road conditions and bad weather, it is difficult to deal with potential hazards. In addition, electric bicycles pose significant safety risks, causing physical pain and other problems during long-distance rides [3]. The disadvantages of today's batteries are also critical. The batteries are heavy and have a long but short life cycle. They are expensive and still have quality problems such as self-discharge, slow charging, and safety issues. They are also difficult to maintain.

Safety seems to be a major concern with the use of e-bikes, especially given the behavior of e-bike users who break traffic laws. Both e-bike users and non-e-bike users complained about the phenomenon of e-bike users violating traffic laws.

1) Accidents

E-bikers are often involved in individual accidents, according to a comprehensive survey of the whole country and the rural area studied, both of which were similarly distributed. In the urban area, e-bikers were involved in more accidents, the majority of which were caused by bicycles crossing the road. Thus, it was found that there were statistically significant differences between the distribution of e-bikers and cyclists in the nation as a whole and the urban area studied. Compared to e-bikers in the rural region, urban e-bikers experienced more switching and other crashes and fewer single and intersection crashes. Irrespective of the injury severity group, the head and lower limbs were the two most commonly injured parts for both pedestrians and e-bike riders [27].

Some may believe that if people switch from cycling to driving, this will help to reduce the number of accidents. However, the research shows that if all e-bike riders switched to driving, the total number of traffic fatalities might be higher. The data on e-bike collisions used to study e-bike-related injuries come mainly from traffic police and hospital records. Feng *et al.* [28] used police collision data between 2004 and 2008 to present the first investigation of the relationship between the rapid growth of e-bikes and an increase in injuries. They found that fatalities and injuries increased 6.5-fold in 2004 and 3.7-fold in 2008, but injuries and fatalities per 100,000 registered e-bikes decreased slightly between 2004 and 2008. The authors then suggested that current standards should be modified to improve safety levels.

2) Traffic violations by EB users

Yang *et al.* [29] used a hazard-based duration approach to investigate when and why riders of bicycles and e-bikes run red lights at signalized intersections. They found that waiting time was associated with the majority of red light running violations, over 50% of cyclists waited 49 seconds; 25% of motorcyclists waited 97 seconds; 21% of e-bike and motorcyclists rode through red lights without waiting. Compared to other motorcyclists, e-bike riders had a higher risk of violation and shorter waiting times. Compared to female motorcyclists, male riders were more likely to exhibit violating behaviors.

Bai *et al.* [30] collected information on aberrant behavior from all riders. They used raw data from video-based observation, which was then categorized into 16 types of conflict movement based on the risk-taking behavior of cyclists and e-bike riders, before using Poisson regression to predict conflict models. They found that e-bike riders were more likely to violate red lights (6.53%) than cyclists (4.66%). They found that motorized vehicle drivers accounted for 75% of the 16 types of conflicting movements, with cyclists and e-bike users contributing the remaining 25% of the behaviors. However, e-bike users had a higher incidence of conflict than ordinary cyclists.

According to Christensen *et al.* [31], married individuals exhibit a higher propensity for running a red light compared to older e-bike riders or individuals possessing a college degree. The study also indicates that social norms and self-identity play a significant role in reducing the intention to engage in such behavior, whereas attitude and perceived behavioral control have beneficial effects. Notably, the subjective norm, a fundamental TPB variable, is found to bear no discernible effect on intention.

3) Discomfort

Based on personal experience, its feel discomfort in the buttocks and waist when riding an electric bike. According to the online answer, it is difficult to adjust the seating position due to the long riding time or the large space taken up by the battery. We can see that most e-bikes on the market use a seat design in Fig. 1 where the front seat is connected to the back seat and the battery is located under the seat. Several studies have investigated the impact of e-bikes on health, in particular their ability to increase physical activity. An earlier study in the Netherlands investigated the physiological characteristics of e-bike riding in three different settings (no assistance, eco mode, and maximum assistance). All three power settings provided the appropriate increase in physical activity to reduce the likelihood of developing sedentary disorders.

Fig. 1. Photo of EBs from a web search.

4) Inadequate battery life and overweight.

Lead-acid batteries typically last one to two years. After that, lead-acid batteries need to be replaced with fresh ones to maintain their endurance. As a result, an e-bike may require five to seven batteries during its lifetime [3]. Short battery life is an inconvenience with relatively high costs.

We also mention this in our battery classification: Lead-acid batteries with an average weight of 10 kg are typically used in e-bikes and hybrid e-bikes. With an average weight of 18 kg, scooter-style e-bikes are often supplied with 48 V or 72 V battery packs. As the lead component accounts for 70% of the total weight of the battery, a bicycle-style or hybrid-style e-bike carries 7 kg of lead, while a scooter-style e-bike carries 14.7 kg of lead. This means that we need to constantly replace the battery to ensure the performance of the EB.

5) Auto-ignition of batteries

Thermal runaway emerges as the primary scientific challenge in battery safety research as electric car safety concerns grow, and improving battery safety is becoming more and more crucial for the advancement of electric vehicle technology [31]. A jet of flammable gases is released from the battery case during thermal runaway, and after mixing with the surrounding air, it may catch fire—possibly due to contact with a heated surface. Given that hot surface ignition is the same as a homogenous gas-phase auto-ignition process, a comprehensive reaction model that has undergone thorough validation is necessary to evaluate the possibility of auto-ignition of the gas ejected following thermal runaway.

Studies have shown that electric vehicle charging may increase the risk of spontaneous combustion. A poster promoting electric bicycles in Chaoyang District, Beijing, advises against parking them in corridors and stairwells or charging them indoors. This is because a short circuit in the battery can generate a spark, and within 30 seconds, the temperature of the flame can reach around 310 degrees. After three minutes and 30 seconds, the indoor temperature can exceed 660 degrees, making it extremely hazardous.

According to the National Fire and Rescue Service (NFRS), 18,000 fires involving electric bicycles (e-bikes) were reported in 2022, an increase of 23.4% in 2021, and 3,242 fires caused by faulty batteries (most of which are rechargeable for e-bikes) were reported in residential premises, an increase of 17.3% on 2021.

Ideas for the future development of e-bikes were also sought. The response categories are drawn from the literature on e-bike research and the interview results. For example, some research on the factors influencing the growth of e-bikes in China provides some recommendations for future e-bike development. The first is to increase e-bike riders' knowledge of road safety; the second is to increase the number of bicycle lanes to avoid incidents between e-bike riders and cyclists; and the third is to speed up the development of e-bike technology. To investigate the future development of e-bikes, the question "Which suggestions are important for the future development of e-bikes? The categories of responses included increasing cycle lanes, building e-bike lanes, building charging stations, increasing e-bike parking spaces, increasing e-bike speed, banning fast e-bikes, increasing road safety awareness, and speeding up the development of e-bike technology.

B. Solutions to These Issues

1) Safety education for e-bike users

We can offer talks on e-bike safety and invite e-bike users free of charge. During the seminar, we can convince users to follow the rules of the road correctly by using real and valid data. Other forms of publicity can also be used, such as making beautiful posters, posting the rules of the road on billboards in different places, or using videos and songs for publicity purposes. More importantly, these rules should be observed not only by users of electric vehicles but also by pedestrians and car drivers. Creating a safe travel environment is the responsibility of everyone in society.

We can promote the following points in our lectures [32]:

1. Always wear an approved helmet.
2. Know and follow the vehicle code, such as stopping stop signs and red lights, using appropriate lanes, and using turn signals or hand signals when appropriate.
3. Understand the rules for E-bikes in your area, such as the minimum ages for E-bike riders, helmet requirements for E-bike riders, and the trail access restrictions on where E-bikes can be ridden.
4. Perform a "pre-flight" check on your E-bike before you ride, we can squeeze each brake lever while rolling the bike forward and backward to confirm that the brakes engage and stop the movement. Ensure that the wheels are firmly attached to the bicycle frame and fork.
5. Take extra care before you decide to ride at night.
6. Don't carry passengers if your E-bike isn't designed for it.

2) Replacing more ergonomic e-bike seats

Either the battery takes up too much space or the seat is too uncomfortable, which leads to serious discomfort when riding an e-bike for long periods. It is possible to reduce the size of the battery, which will increase the seating position and also increase the storage space to some extent. Fatigue during long rides can also be reduced by changing the material of the seat. As shown in the Fig. 2.

Fig. 2. An ergonomic EB seat for both men and women.

Pros of the seat in the Fig. 2:

1. Ergonomic design is suitable for men and women.
2. Seat opening for better breathability.
3. Fatty gel seat which increases comfort.
4. Reflective stripes for better visibility at night.

Cons:

1. Bolts that come with the seat can rust easily.
2. Might not fit all bikes.

3) On spontaneous combustion of batteries

We can choose safer batteries, add flame-retardant devices, and increase insurance. Install electric vehicle charging stations and place fire extinguishers around them. Penalize those who charge their e-bikes in dangerous areas, such as inside buildings, kitchens, utility rooms, and other places where fires can easily start. These can be added to the safety talks mentioned above to educate the whole community about the dangers of spontaneous combustion of e-bike batteries and how to prevent it. Add a monthly fire safety seminar to teach the use of fire extinguishers.

C. Some Questions about My Solutions

Based on the few solutions that have been proposed, this paper would like to make some points that may be questioned.

For the solution of providing free lectures for EB users mentioned in the previous section, several factors may lead to the failure or unsatisfactory implementation of the program:

1: EB users do not come to the free lectures, so the aim of publicity is not achieved. As EB users may be busy with their work or life, they do not have free time to attend the safety seminars, and as a result, safety awareness is not popularized.

2: EB users attended the seminars, but the effect was minimal. It is assumed that EB users have the time to attend the seminar, but due to their reasons, the safety awareness mentioned in the seminar is not deeply understood. When they ride EBs, they don't remember the rules and knowledge, so accidents still happen.

3: The lectures are not effective. As it is a free seminar, the budget will not be very big, so we may not be able to invite experts to popularize safety awareness, so some important basic safety awareness will not be mentioned in the seminar. And if the seminar is not effective, the residents will not give good feedback.

For the program to create some promotional videos to promote safety awareness, several problems make it difficult or impossible to achieve the desired situation:

1: These commercials may be shown or placed in places that EB users do not often come into contact with, such as buses or train stations. When they use these means of transport, they will not be concerned about the safety of EBs but will be more interested in the safety factor of the transport they are using.

2: These promotional videos or advertisements may be too simple or not eye-catching to warn EB users.

3: These advertisements may not deepen people's awareness of EB safety, and if they appear too often, people may become rebellious.

For the lane improvement solution mentioned in the previous section, several factors could make this solution impossible or unsatisfactory:

1: The budget was not sufficient, resulting in an unsatisfactory situation.

2: EB users will continue to occupy other lanes and take over the path of other motor vehicles, causing accidents.

When it comes to replacing more ergonomic seats as a solution to physical discomfort, several issues make it difficult or impossible to achieve the desired situation:

1: Everyone is different in height and weight, so the parameters needed for a comfortable seat are different for each person, creating problems that can still lead to discomfort when the driver is changed.

2: A more ergonomic seat means more money spent on discussion and design implementation. This adds to the cost of the EB. The audience for scooters is generally low-income people, so these better-designed scooters won't be very popular.

3: The physical discomfort caused by prolonged use of EBs is not eliminated by the seat change, it is only partially alleviated. The discomfort caused by prolonged use of an EB includes not only soreness in the lower back and hips but also discomfort in the legs and soreness in the neck from maintaining a forward leaning position for long periods. These parts of the problem do not go away with a change of seat.

Several issues make the option of reducing the size of the battery in exchange for more space difficult or impossible to achieve:

1: Batteries need a safe, isolated place to sit. If batteries are placed haphazardly to save space, this can lead to safety hazards.

2: The basic structure of the battery is fixed and it is a technical difficulty to ensure performance while reducing the size of the battery. The battery can be shrunk, but the range of the EB will be greatly reduced, which will lead to new problems.

As for the possibility of replacing the battery to reduce the risk of spontaneous combustion, several problems make it difficult or impossible to achieve the desired result:

1: It would be both a waste and an economic loss to replace all the common batteries on the market with safe batteries. As these batteries have already been manufactured, recycling them will also cause a degree of contamination.

2: Other batteries also have the unavoidable possibility of spontaneous combustion.

3: If other batteries are used, there will be a higher cost, which will lead to an increase in the cost of the EB, and the user will choose a cheaper model if the performance (i.e., range, driving speed, etc.) is the same.

IV. Conclusion

Firstly, this paper has reviewed different ways of classifying EBs, there are ways of classifying EBs based on their function and structure, there are different types of EB motors, and there are different types of batteries used in EBs.

Secondly, this paper has discussed the current problems of EBs based on some previous papers, such as the occurrence of accidents and their causes, the disregard of traffic rules by EB users, and their low awareness of the rules. There is also the issue of physical discomfort caused by EB seats. It also discussed some of the problems with EB batteries, such as overweight batteries and the problem of spontaneous combustion.

Some solutions have been proposed to the problems of EBs and their shortcomings. Regarding the lack of awareness of rules among EB users, it can provide them with safety seminars that can educate them about EB safety. The problem of uncomfortable EB seats can be solved by replacing the seats with more ergonomic ones and listing their advantages and disadvantages. For overweight and spontaneous combustion of batteries, this paper advocates replacing them with safer types of batteries. However, several of these solutions have the disadvantage of being underfunded or taking longer and not curing the problem, so these areas still need improvement.

Conflict of Interest

The author has claimed that no conflict of interest exists.

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