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### From Frustration to Innovation: Exploring the Lived Experiences of E-Bike Users on Limited Charging Infrastructure

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#### Abstract

This abstract summarizes a phenomenological study exploring the lived experiences of electric bike (e-bike) users dealing with limited charging infrastructure. Through purposive sampling, 8 participants were interviewed, revealing three prominent themes. The first theme, "Technical Challenges and Solutions," delves into battery-related issues and coping strategies. Participants shared their stress caused by battery limitations and sensitivity to water, alongside coping strategies and the effectiveness of maintenance routines. The second theme, "Infrastructure and Accessibility," highlights concerns regarding the absence of

charging stations and the benefits they offer. Participants expressed worries about inadequate infrastructure while recognizing the important role of charging stations in facilitating e-bike usage. Lastly, "Cost-Effectiveness and Sustainability" highlights participants' perspectives on the economic benefits of e-bikes as sustainable transportation alternatives. This research illuminates the diverse experiences of e-bike users, shedding light on their challenges, adaptations, and aspirations amidst evolving charging infrastructure settings.

**Keywords:** Electric Bike, Electric Vehicle, E-bikes, Lived Experiences, Limited Charging Infrastructures, Battery-Related Issues

#### Introduction

With electric bikes' growing popularity and potential to replace traditional gasoline-powered vehicles, there is also an increasing demand for sustainable e-bike charging options. The missing component that connects hassle-free travel and range anxiety could be electric bike charging stations (Just Electric Bikes, 2024) <sup>[24]</sup>.

In the Philippines, electric vehicles (EVs), particularly electric bikes, are gaining popularity as an alternative mode or form of transportation. Electric bikes, sometimes called e-bikes, are vehicles equipped with electric motors and rechargeable batteries. According to Mrgx (2023) <sup>[35]</sup>, electric bikes, which can be classified into different types, are two—or three-wheeled transportation modes powered by an electric motor in the Philippines.

These vehicles provide an affordable and environmentally friendly alternative for its community users, particularly in consideration of the increasing price of gasoline. Furthermore, electric bikes are beneficial for the community, the environment, and the local government. E-bikes have been found to offer a feasible means of reducing the greenhouse gas (GHG) impact of a region's passenger transportation system (McQueen *et al.*, 2020) <sup>[32]</sup>. Furthermore, after considering e-bike emissions from electricity generation and induced e-bike trips, carbon dioxide (CO<sub>2</sub>) emissions from passenger transportation might decrease by 12%. A single e-bike could reduce 225 kilograms of CO<sub>2</sub> per year on average. These estimates suggest that e-bikes could help cities and regions achieve their climate change goals and targets. According to the data from Dr. Bernhard Isopp (2021) <sup>[14]</sup>, this indicates that bikes and e-bikes emit less carbon emissions compared to cars and electric cars. Still, this indicates there is no contest between the two.

With all of these advantages and benefits, utilizing electric bikes has become less feasible and convenient due to various problems and challenges. According to Deloitte Touche Tohmatsu Limited (2023) <sup>[12]</sup>, the 2023 Global Automotive Consumer Study results show that more than 26,000 consumers across 24 countries, including Southeast Asia, were surveyed to gather their perspectives on several crucial issues impacting the automotive industry. One of the critical aspects examined in the study was the consumer interest in adopting electric vehicles (EVs). The article contains graphs that display the survey's results. According to Catherine Talavera (2023) <sup>[43]</sup>, in The Philippine Star news article, the survey revealed that 72% of Filipinos are

interested in an internal combustion engine (ICE), sometimes a gas or diesel engine, for their future vehicle. This result exceeds 49% of Vietnamese and 59% of Indonesians. The study also revealed that the respondents' main reason for not buying a fully battery-operated EV in Southeast Asia was the need for more public electric vehicle (EV) charging infrastructure, except for Singapore.

Similarly, Corrales (2023)<sup>[11]</sup> reports that Senator Sherwin Gatchalian stated that the charging station is the most significant difficulty to the adoption of electric vehicles (EVs) during a speech at the 11th Philippine Electric Vehicle Summit hosted by the Electric Vehicle Association of the Philippines (Evap). The senator also stated that although there are many different brands of EVs available in the Philippines, some consumers are still hesitant to buy these electric vehicles because of the lack of a station, place, or infrastructure to charge their EVs.

One of the considerable factors influencing consumer behavior in buying electric bikes is the user's or rider's adoption behavior, which is also influenced by the capacity of the electric bike in comparison to a motorcycle or traditional vehicle. On a motorcycle, drivers can refill their gas tanks anytime because gasoline stations are everywhere. For this reason, under typical circumstances, their ride behavior might not be connected to their fuel demand. However, e-bike riders know that low or regular speed and battery capacity will affect their mileage capacity (Yasir *et al.*, 2022)<sup>[53]</sup>.

Many individuals believe that owning an electric vehicle only makes sense when they can easily access low-cost home charging options. However, considering the state of common public infrastructure, this is viewed by many as far more harmful. People complain that there aren't enough charging stations or they're not easily accessible overall. They add that there aren't many charging stations in rural and suburban areas, so this is only practical for electric vehicles in cities (Gopal, 2021)<sup>[21]</sup>.

Concerning these articles' findings and studies' gaps, the student researchers discovered and learned that MMDA has successfully built and opened a solar-powered charging station at its main office building in Brgy. Ugong, Pasig City, Philippines, in 2022. Romando Artes, chairman of the MMDA, stated that the project's goal was to lessen the public's burden when considering the high price of petroleum products by offering free services they could use whenever they needed to charge their electric vehicles. It also aimed to support green and renewable energy sources and alternate forms of transportation (PhilStar, 2022)<sup>[38]</sup>.

The evidence from published articles and previous studies indicates that this factor influencing users' behavior when consuming and using electric bikes needs to be highlighted and discussed more to fully utilize the feasibility and convenience of electric bikes as well as to encourage an environmentally friendly future. This study will also discuss how the charging station could potentially offer valuable information and insights about how these stations may be implemented or developed in Noveleta, Cavite.

The primary objective or purpose of this study is to understand the challenges electric bike users face in Noveleta, Cavite, due to a lack of charging infrastructure. The findings of the research can highlight the demand for charging stations in Noveleta and the impact of limited infrastructure on the feasibility and convenience of electric bike usage, which can help in planning the development and

establishment of strategically placed charging stations, including possibly solar-powered ones, around the area of Noveleta.

### Objectives of the Study

This study aims to explore and understand the challenges electric bike users face in Noveleta, Cavite, due to a lack of charging infrastructure. Specifically, it aims to (1) determine the lived experiences of electric bike users in terms of battery-related issues; (2) determine how do electric bike users cope with these issues; and (3) determine what context or situation influences their experience.

### Methods and Materials

The student researchers utilize the qualitative research design, specifically the phenomenological approach. Qualitative research is a study that delves deeper into issues that exist in the real world. Unlike quantitative research, which gathers numerical data points and introduces treatments or interventions, qualitative research generates hypotheses and conducts additional investigation (Tenny *et al.*, 2022). The main goals of a phenomenological research study are exploring the essence of human experiences and comprehending the significance of people attached to them. It does not impose ideas or explanations; instead, it aims to capture the fundamental elements and underlying structures of these experiences (Delve *et al.*, 2023)<sup>[13]</sup>.

The purposive sampling technique, also called judgmental sampling, will be employed by the student researchers to select the study's sample population. Using this non-probability sampling method, samples are selected exclusively from Noveleta, Cavite electric bike users, or participants based on non-random selection, convenience, or other criteria, allowing the student researchers to conveniently collect data. The quality and accuracy of the data gathered will improve with the use of purposive sampling, which is the deliberate selection of participants who possess particular knowledge, skills, or unique experiences that are relevant to the study and who can provide or offer rich data (SooleenAbbas, 2023)<sup>[42]</sup>.

The target population of this study is eight (8) participants, or eight (8) two—or three-wheeled electric bike users from the overall barangay in Noveleta, Cavite. These users are anyone who interacts with a two—or three-wheeled electric bike, including the owners and drivers who consume, ride, and travel utilizing electric bikes for their transportation. This study aims to explore electric bike users' lived experiences in limited charging stations. These target participants have much experience utilizing electric bikes for transportation, so the student researchers want to focus on or interview them. With them, we can gather credible, relevant, precise, and trustworthy data or insights to support the overall research study. Furthermore, the target participants, electric bike users, are located or reside within the barangays of Noveleta, a municipality in Cavite. The student researchers will exclude any electric bike users who are located outside of Noveleta's boundaries.

In the current study, the student researcher will conduct in-person interviews as the research instrument. An in-person interview is a survey method that lets interviewers interact with participants directly and personally. This type of survey method helps the interviewers clarify questions, get more information from the participants, and identify nonverbal signals such as body language, which improves discussion

of complicated issues or topics (Voxco, 2021) [46].

The student researchers will analyze the study's qualitative data using thematic analysis. Data coding, topic or theme searching, theme improvement, and presenting the findings are the basic principles of thematic analysis, and they also apply to other qualitative techniques (Naeem *et al.*, 2023) [36]. According to their study, the theme analysis method is referred to as "systematic" because of its organized and methodical approach towards analyzing study data. Every level builds on the one before it, giving the user a complete understanding of the data. This methodical approach provides more reliable and consistent findings, allowing for direct and clear connections to be made between the data, interpretations, and conclusions.

According to Caulfield (2023) [9], Virginia Braun and Victoria Clarke first developed the most popular thematic analysis method for psychological studies and research articles. This technique involves six steps: Familiarization, coding, creating or generating themes, reviewing themes, defining and naming themes, and writing up.

## Results and Discussion

### Theme 1: Technical Challenges and Solutions

The purpose of this theme is to analyze the battery-related issues encountered by electric bike users when utilizing their electric bike as their daily transportation, which causes them stress. These issues include rapid battery drainage, limited battery range, frustrations related to batteries, and the vulnerability of batteries to water exposure. Additionally, this theme aims to explore the effective adaptive techniques that electric bike users employ to cope with these battery issues. Analyzing this may provide insights into the factors contributing to battery-related issues. Understanding this would also inform electric bike users about the importance of addressing battery issues and promoting the adoption of effective coping strategies to improve the overall experience of utilizing electric bikes.

**Battery-Related Issues:** Batteries serve an important part in various applications due to their ability to store energy. Research has highlighted the benefits and advantages of battery utilization in several applications, such as energy storage systems, electric vehicles, and the integration of renewable energy sources (Erol, 2021; Gong & Wang, 2020; Probstl *et al.*, 2020) [16, 19, 39]. However, the usage of batteries also encounters various issues or problems that have a significant impact on its performance. According to Si *et al.* (2023) [41], the declining lifespan and performance of lithium-ion battery energy storage systems, as well as unexpected failures, are major factors influencing battery reliability.

According to Li *et al.* (2021) [28], it is commonly known that lithium-ion batteries serve as the main power source for electric vehicles, such as electric bikes. These batteries are essential for the safe operation of electric vehicles. Furthermore, many battery kinds are employed in electric bikes, such as lead, nickel-cadmium, NiMH, lithium-ion polymer, and lithium-ion, with the latter being the most often utilized because of its effectiveness and efficiency (Arango *et al.*, 2021) [3].

This study revealed that electric bike users were experiencing battery-related issues when utilizing their electric vehicle as their means of daily transportation, causing them stress and frustrations. Because their electric bikes' batteries are used so frequently, electric bike users

often encounter battery issues. According to Way *et al.* (2023) [48], users are frequently concerned about battery life and worry that the battery might run out of power when traveling.

Rapid battery drainage in electric vehicles has a major impact on their overall performance (Tavares *et al.*, 2022) [44]. In this study, the major concern or issue encountered by electric bike users when utilizing their electric vehicle is rapid battery drainage. Lyn stated that,

*"Ano, minsan mabilis ma lowbat yung ganon lang naman"*

Another electric bike user in this study also experienced the same battery issue. Emmie mentioned that,

*"Mabilis siya malowbat"*

Meanwhile, in Elise's situation, she shared that her electric bike's battery drains quickly, which she considers reasonable because it was purchased second-hand and not brand new. Elise said,

*"Yung sobrang bilis malowbat, kasi isang... reasonable siya for me kasi hindi naman siya bago, kumbaga nung binili namin siya second hand siya"*

As highlighted in the statements of electric bike users in this study, the major issue faced by electric bike users is the rapid depletion of its battery. Research conducted by Bourne *et al.* (2020) [7] further supports this concern, indicating that battery life is a significant barrier for electric bike users. The study highlights that users were concerned about various battery-related issues, including rapid drainage.

Moreover, Jirose shared that as time goes by, her electric bike's battery performance starts to slow down due to frequent use as her daily transportation. Jirose stated,

*"Mabilis naman sa una, kapag bago. Kapag habang tumatagal, kapag mag-one year na siya... ayun, bumabagal na yung takbo niya."*

This shows that the lifespan or aging process of electric bike batteries impacts their overall performance, leading to rapid battery drainage. Research by Xia and Qahouq (2021) [49] supports this, as it characterizes the aging patterns of batteries and illustrates how battery performance varies with battery age. Additionally, Conradt *et al.* (2021) [10] highlight that various aging factors affect the performance and reliability of batteries.

Limited battery range of electric bikes also plays a significant role in determining how far a rider can travel before needing to recharge the battery, particularly on longer trips or in areas where charging infrastructure is unavailable (Milo *et al.*, 2021) [33]. In this study, the limited battery range of electric bikes limits the distance that electric bike users can travel, which affects their usability, performance, and potentially leads to more problems. Lyn said that,

*"Kunware may pupuntahang malayo. Hindi pwedeng pumunta sa malayo kase hindi ako pwedeng pumunta sa malayo. Hindi ako pwedeng pumunta sa malayo kase syempre ma lolowbat. Edi ma stuck ako sa daan, mag papahila pako parang ganun."*

Lyn, in another statement, emphasizes that she is unable to travel long distances due to the limited battery capacity of her electric bike. She stated,

*“Ganun din lang hindi ako pwedeng pumunta ng malayo, kase may limit lang yung battery ko eh. Hindi siya yung hindi sya pwedeng dalhin dalhin sa malayo.”*

With the same concern, Alex explains that the distance that an electric bike can travel is limited by the amount of charge in its battery. He mentioned,

*“Syempre yung dahil nga ah chinacharge lang siya yung yung tawag dito yung tinatakbo nung e bike mo limited lang base dun sa naka charge dun sa battery mo”*

Furthermore, Mel expresses her frustration because she is unable to go further distance due to the limited battery range of her electric bike. Mel said,

*“Alam mo hanggang dito lang ang pwede mong gawin, e mas gusto mo pang pumunta sa ganto kalayo”*

This emphasizes that the distance an electric bike user can go or travel is limited due to the limited range or capacity of its battery. According to a study by Burani *et al.* (2022)<sup>[8]</sup>, an e-bike's battery capacity has a significant impact on how far it can travel. Furthermore, the study also explains that terrain can have a considerable impact on an e-bike's range depending on the remaining battery capacity. This means that the distance an electric bike can travel before needing to recharge its battery can also vary depending on the conditions on the road it travels.

Meanwhile, Alex mentioned that an electric bike's disadvantage is their limited speed compared to motor vehicles. He stated that,

*“Yung disadvantage naman limited yung speed nya hindi sya hindi sya pwedeng masyadong matulin na katulad nung motor vehicle.”*

This indicates that the battery capacity of electric bikes not only limits the distance they can travel but also limits their speed, which is viewed and considered as a disadvantage by the electric bike user in this study. The distance that e-bikes can travel is mostly dependent on their battery capacity, which also affects how fast they can go (Burani *et al.*, 2022)<sup>[8]</sup>. This is the same rationale in the research of Wang *et al.* (2020)<sup>[47]</sup>, which shows how an e-bike's battery capacity directly influences its speed capabilities. Additionally, the study also states that a larger capacity in batteries is capable of higher power output, which allows faster speeds and longer travel distances. This indicates that the speed and distance capabilities of an electric bike depends on its battery capacity.

Alex shares that electric bikes are equipped with indicators that display their battery charge level. These indicators serve as a guide for users to determine how far they can travel before the battery runs out. He also advises not to exceed the indicated range to avoid running out of battery during the travel or trip. Alex said,

*“makikita naman siya meron siyang mga monitor dun sa sa e-bike para malaman mo kung ilan ang charge mo yun dun sa dun sa nakalagay na yun yung indicator na yun malalaman mo kung hanggang saan ka lang pwede pumunta, wag ka lalampas dahil talagang mangyayari sayo yung mauubusan ka”*

The findings of research by Kusuma *et al.* (2021)<sup>[25]</sup> shows that an electric bike with a battery indicator provides riders real-time information on how much battery capacity is left, guiding them on how far they can travel before needing to recharge its battery.

Frustrations related to batteries are common among electric bike users (Behrendt *et al.*, 2021)<sup>[5]</sup>. These frustrations can significantly impact the overall experience of electric bike users and its usability. In this study, participants expressed frustration and fear due to battery-related issues with their electric bikes. Emmie stated that,

*“Nagaano kami ng, mangangamba kami, eh paano kung may pupuntahan kaming ibang lugar, check up ni nanay... malowbat kami...wala kaming... pano yun”*

Elise mentioned that the thought of her electric bike potentially experiencing a sudden battery drain while traveling was a hassle for her, rather than the hassle-free experience, as that is the purpose of having an electric bike. She said,

*“Hustle, kasi syempre ang hirap nmn yung aalis ka tas iisipin mo baka bigla kang matirikan ka ng battery, hustle sya kasi imbis na hustle free kaya ka nga may e-bike”*

Meanwhile, Jirose also shared her fear regarding the potential of her electric bike running out of battery while traveling. She expressed her concern about the inconvenience of having to push her electric bike manually if it were to run out of battery. Jirose stated,

*“Nahirapan din ako na natatakot na baka ma-lowbat, matirikan ako tapos magtulak.”*

With the same concern as Jirose, Emmie also expressed her fear and concern about the possibility of having to manually push her electric bike if it were to run out of battery during her travel. She is also concerned about where she would be able to charge her e-bike in this kind of situation. Jirose said,

*“Pag may pupuntahan kami, ayan ang kinakatakot namin na baka magtulak kami, san kami mag c-charge?”*

This indicates and shows that the battery capacity and the rapid battery drainage of electric bikes causes stress, fear, and frustration among its users. The fear associated with running out of battery power, particularly in remote areas, might negatively affect the overall experience of users and discourage people from using electric bikes as a dependable form of transportation (Afschrift *et al.*, 2022)<sup>[1]</sup>. Moreover, Emmie's statements emphasize her concern about the absence of charging stations in her area. This concern aligns with the findings of Boland *et al.* (2020)<sup>[6]</sup>, who highlighted

that frustrations with battery management can also be made worse by issues with battery charging stations, including their design, effectiveness, and geographic distribution. This suggests that the development and establishment of charging stations in remote areas would ease or reduce the frustrations and challenges faced and experienced by electric bike users. According to Bourne *et al.* (2020) [7], research has revealed how important it is to have the appropriate e-cycling infrastructure, such charging stations, to handle particular challenges with e-bikes, like weight and battery life, thus enhancing overall convenience for its users.

Vulnerability of batteries to water exposure may also result in damage through direct pressure on the mucosa, battery contents leaking, and electrical current generation, as demonstrated in cases of battery ingestion (Lorenzo *et al.*, 2022). In this study, electric bike users are aware of the possible damage that may occur if the battery of their electric bike is exposed to water or any liquid. As a result, they are cautious and take preventive strategies to avoid such situations. This shows that the concerns of electric bike users about battery-related issues includes the vulnerability of their batteries to water exposure. Lyn stated,

*“Di talaga sya pwedeng mabasa kase syempre, kase sira talaga sya pag nabasa. Isa pa di din talaga sya pwedeng i park sa baba. Kaya tong bahay namin medyo mataas, diko siya pwedeng i park sa baba, aabutin talaga siya ng tubig. Sira ang battery”*

Mel mentioned that if an electric bike is submerged in the flood, there is a possibility that the battery may be affected, which may cause another replacement of the battery due to the potential damage caused by the water exposure. She said that,

*“Once na nilusong sa baha, may possibility na...maabot yung battery mo, eh kung kapapalit mo lang, maaaring mag palit ka uli kasi, nasisira yung battery mo.”*

Meanwhile, Jirose emphasizes that it is necessary to take extra care of the electric bike when there is flooding. She also discusses the strategies she employs to prevent damage to the battery. Jirose shared,

*“Kapag bahain, ayun nga... kailangan talaga... ano... ingatan yung e-bike. Minsan, hindi ako nagamit kapag baha talaga yung sobra.”*

On the other hand, Lyn mentioned that she does not frequently clean her electric bike due to her concern that it might get wet and damaged in the process. She stated,

*“Kaya nga tong e-bike ko bihira ko lang din linisin yun nga baka mabasa, masira.”*

The potential damage in an electric bike's battery due to water exposure is one of the concerns of electric bike users in this study. Lead-acid batteries, which are commonly found in electric bikes, are particularly susceptible to water damage, which might lower riders' experience (Burani *et al.*, 2022) [8]. Therefore, employing and implementing preventive strategies among electric bike users is necessary and essential.

In summary, various issues related to batteries such as rapid battery drainage, limited battery range or capacity, and the vulnerability of batteries to water exposure causes stress and frustrations to the electric bike users in this study. These issues and challenges significantly impact their overall performance with electric bikes. Thus, in order to deal with the battery-related issues they encountered, the electric bike users in this study applied and implemented preventive strategies into practice.

**Coping and Maintenance Strategies:** Coping strategies play an important role for optimizing battery performance and resolving issues with electric vehicles. To ensure the safe and effective operation of electric vehicles' batteries, various coping strategies are essential (Park *et al.*, 2012; Yu *et al.*, 2022) [37, 54].

Proactive actions involve taking the initiative to handle issues before they become worse and improve productivity and efficiency. According to research conducted by Shang *et al.* (2023) [40], being proactive boosts an individual's confidence in their ability to solve problems and encourages others to take proactive action. This move toward proactive strategies reduces costs, improves performance, and increases operational effectiveness (Ahern *et al.*, 2022) [2]. In this study, proactive actions employed by electric bike users for battery issues prevents further damage and helps them in effectively managing these concerns. Lyn said that,

*“Ako ang ginawa ko sakin, nag palit ako ng battery. Yung ganon, nag papalit ako ng battery talaga kase syempre kung yung battery mabilis na talagang malowbat. Ibig sabihin ano na yun, kase ang battery may capacity yan”*

Mel mentioned that the batteries should be replaced after a couple of years of usage and if it is slowly losing its maximum battery capacity. She also suggests that if the battery is not performing well and requires frequent charging, it is necessary to replace it. Mel stated,

*“sa sobrang tagal, katulad nyan kasi sabi nila dapat after 5 years dapat papalitan mo na, syempre kapag ganung issue, yung ano, madali na siyang mallowbat dapat everyday ka nang mag aano, so kailangan mo na siyang palitan”*

Jirose also takes the same proactive action by replacing her electric bike's battery. She said,

*“Ginagawa ko... pinapalitan ko na siya ng battery.”*

Additionally, Alex suggests that consistently fully charging the battery of an electric bike is the best remedy or solution to always be prepared when using an electric bike. He stated,

*“Pinaka remedy mo o kaya para maging handa ka lagi yun nga dapat lagi mong full charge o alam mo kung saan mo gagamitin”*

With the same proactive action or solution as Alex, Emmie's practice is to fully charge the electric bike before leaving to ensure that they have maximum battery capacity for their trip. Emmie shared,

*“Kaya pinu-full charge na namin dito tapos malalaman na namin na... pag full charge na siya dun na kami umaalis”*

Jirose said that she charges her electric bike's battery whenever it reaches two bars of charge remaining to prevent any inconvenience or difficulty. She mentioned,

*“Ayun nga... kada ano... kada two bar siya, tsina-charge ko na para hindi ako mahirapan.”*

Furthermore, Anna emphasizes the importance of always having a fully charged battery and carrying a charger to address any potential battery-related issues that may arise. She mentioned that this is her regular practice, especially during long travels or trips. She stated that,

*“Kakailangan lagi meron kang... full charge ang battery mo at may dala kang charger... yun ang ginagawa ko palagi. Lagi kong dala yung charger ko kapag malayuan ang byahe ko”*

Moreover, Mel shares that the proactive solution she plans to employ just to cope with battery-related issues she may encounter along the way is to charge her electric bike for a short period of time in other, in order to reach their intended destination. Mel is willing to make a brief stop to charge her electric bike. She said that,

*“Siguro makiki charge muna ako, dun muna ako kahit one hour para makarating lang ako sa pupuntahan ko”*

The proactive solution that Mel plans to do in addressing battery-related issues in the middle of her trip was already taken and experienced by Anna. If her battery level reaches a critical point, Anna borrows or requests to charge their electric bike from someone she knows in each town or area. She mentioned that,

*“Nakiki-charge... kasi alam ko kung alam ko na fifty fifty na ko, di ako makakauwi. Sa bawat... siguro bawat bayan naman dito meron naman ako kakilala, dun nakikisuyo ako... nakiki-charge ako...”*

This indicates that some of the proactive actions or solutions taken by electric bike users in this study, such as replacing the battery, consistently fully charging it, carrying a charger, and seeking assistance to charge their electric bike, helps them in addressing and coping with the battery-related issues they encountered when using an electric bike as their daily transportation. This is further supported by the research of Le (2023) [27], which emphasizes that electric bike owners can prolong battery life and avoid problems like deep discharging, overcharging, and thermal runaway by implementing appropriate coping mechanisms, such as monitoring battery health, performing routine maintenance, and maintaining proper charging practices.

Effectiveness of proactive actions taken by electric bike users ensures them in effectively overcoming battery-related issues they encounter. According to Yang *et al.* (2020) [51], users can efficiently manage battery performance and prevent damage through implementing effective techniques into practice. In this study, the proactive actions taken by the

electric bike users, such as replacing the old battery with new one and consistently fully charging it, are effective in coping with the battery-related issues they have faced. Lyn stated that,

*“Epektibo sya syempre pag ka bili mo bago pa yan. Edi mabilis pa ang takbo, matagal tagal pa ma lowbat ganun”*

Alex mentioned that taking proactive actions serves as precaution and demonstrates proactive action. He said that,

*“Epektibo kasi dahil nga sa precaution ano yung ginagawa mo na yung dapat”*

Implementing effective techniques can positively impact the overall battery performance of electric vehicles (Yang *et al.*, 2020) [51]. The study supports this study's findings that effectively implementing or taking appropriate and effective actions have a positive impact on the overall performance of electric bikes and their batteries. It also reflects the proactive actions or solutions taken by users in addressing potential challenges and optimizing their electric bike experience.

Regular maintenance for electric bikes has a significant impact on their performance. Research by Ferreira *et al.* (2021) [17] have demonstrated that the application of condition-based maintenance strategies can improve the sustainability and overall performance of Electric Two-Wheelers with Integrated Battery Systems (ETICS) by enhancing their durability. In this study, electric bike users share their different maintenance practices they implement to ensure the optimal condition of their electric bike, which they rely on for their daily transportation. Alex shared that he regularly charges his electric bike as a maintenance practice. This practice allows him to have immediate access to his electric bike whenever he needs to use it. He said,

*“Syempre yung regular na pag cha-charge ah hindi ko siya pinapabaya na na nakagarahe sya ng lowbat para once na kailangan kong gamitin magagamit ko kaagad”*

Moreover, Terry mentioned that unlike other electric bikes that may appear dirty, her electric bike still looks new even after almost four years of use because of the diligent care in regularly cleaning. This emphasizes that cleanliness contributes to the electric bike's longevity and clean appearance. Terry mentioned that,

*“Kaya ang sabi ko sayo ang ebike ko di katulad ng iba na ang ebike eh madumi, yung ebike ko kakita na mag f-four years na ngayong august ah august nga mapag kakamalan pang bago. Kase nga alaga ko talaga yan sa punas, sa linis.”*

Regularly performing maintenance practices and maintaining proper charging practices can extend an electric bike's battery lifespan and help avoid potential problems or issues from arising (Le, 2023) [27]. The research study supports the electric bike users' statements by emphasizing that the proactive actions they take really helps them to maintain the overall performance of their electric bike, which they rely on for daily transportation.

In sum, the proactive actions and regular maintenance practices employed by electric bike users in this study to handle or address battery-related issues they encounter before they become worse or cause further damage ensures them in effectively overcoming these concerns. This contributes to improved overall productivity, efficiency, and positive impact on their electric bike's performance. Thus, indicating that these strategies are effective.

### Theme 2: Infrastructure and Accessibility

The purpose of this theme is to investigate the concerns of electric bike users in this study regarding with the lack of charging station within their area, the development of these charging stations, and the benefits of the charging stations that the users believe these infrastructures would offer them. Analyzing this may provide valuable insights into the challenges faced by electric bike users in accessing charging infrastructure and the potential benefits of the development of charging stations for electric bike users. Understanding this would contribute on understanding the needs of electric bike users regarding the accessible charging infrastructures within remote areas to improve and promote sustainable transportation option.

**Charging Station Concerns and Benefits:** Electric bike users who experienced challenge and hard time in finding charging stations may encounter various issues that negatively affect their overall travel experience. According to Franco *et al.* (2021) [18], one significant challenge and problem that can seriously hinder the adoption of electric bikes is the inconvenience and uncertainty of finding a charging station if needed. Thus, developing charging infrastructure can be beneficial among electric bike users in various ways. Users can easily and conveniently recharge their electric bike batteries with the help of charging stations. According to Moulid *et al.* (2020), accessibility ensures that users won't have to worry about running out of battery power while traveling by making it simple for them to locate an area to charge their electric bikes.

Concerns about inadequate charging stations in remote areas are common among electric bike users. One of the main issues of electric bike users is the inconvenience and difficulty of finding a charging infrastructure when needed, which can cause range anxiety and possibly disrupt trip plans (Jebril *et al.*, 2021) [23]. In this study, electric bike users expressed their concern about the lack of charging stations within their area, which causes them stress. Users also mentioned that the only charging option available to them is to charge their electric bikes at home because there are no charging stations for their electric vehicles in their area. Emmie stated that,

*“Eh syempre hindi nmn kami pwede mag ano sa ibang... dito sa Noveleta, wala kaming makitang charging station”*

Furthermore, Alex emphasizes the limitations of charging options for electric bikes compared to the convenience of refueling a motor vehicle. He also said that an electric bike can only be charged at their own home. Alex said,

*“Hindi katulad ng motor vehicle na gumagamit ng mga gasolina kung naubos siya pwede kang magpakarga ng gasolina pero dito sa electric bike syempre maghahanap ka ng pwede mong saksakan ng*

*kuryente na which is sa bahay mo lang magagawa”*

With the same concern as Alex, Mel also mentioned that the only available charging option for electric bike users who lack charging stations in their area is at their homes. Mel mentioned,

*“Kaya hindi ka makakasiguro, talagang bahay at bahay lang talaga ang pwedeng pag-chargehan”*

Compared to a motor vehicle, it is more convenient to restore its maximum capacity by refueling at a gasoline station. This convenience is in contrast to the charging options for electric bikes, especially in areas that lack charging stations. That's why the only available charging option for electric bike users in this study is at their own home. This is further supported by the research of Bajec *et al.* (2021) [4], which states that users' charging preferences and routines can be greatly influenced by the availability of charging stations, both at home and in public areas.

Concerns about the development of charging stations in remote areas may influence the possibility of establishing charging infrastructures within those areas. However, electric bike users perceive and view the potential development of charging infrastructure within remote areas differently. According to reasearch of Xu *et al.* (2022) [50], the convenience and user satisfaction have a big impact on how people feel about charging stations. In this study, electric bike users expressed their different opions and perceptions on the potential development of charging stations within their area. Emmie expressed her opinion that their mayor should establish charging station where users can at least pay a small fee, that would help users just to charge their electric bikes. She stated that,

*“Ayun nga ang pinag usapan namin ng papa ko dapat magpatayo sila mayor ng ganun yung charging station nga, kahit magbayad ka ng 5 pesos, 10 piso.”*

Meanwhile, in contrast to Emmie's opinion, Elise expressed her own opinion that the development of charging stations may not effectively address the problem of electric bike users if they suddenly encounter a battery run out during their travels. She mentioned that leaving and charging the electric bike there wouldn't automatically and immediately fully charge its battery. Elise said,

*“kasi kung may station tapos nag offer ng ganun, kasi syempre, anong use nun kung...ganto kasi kung maggets niyo, for example may station for e-biking eh natirikan ka nga along the way, hindi naman pag iniwan mo dun, hindi naman pag chinarge yun ok na agad”*

The findings of this study regarding the diverse perceptions and concerns of electric bike users about the development of charging infrastructures indicates that the development of these stations within an area should be well-planned and strategic to ensure convenience, efficiency, effectiveness, and benefits for electric bike users that would surely help them address any battery-related issues they may encounter with their electric bikes during their travel or trips. This is further supported by the research of Yang *et al.* (2022) [52], which have emphasizes that strategically establishing

charging infrastructure is necessary to efficiently respond to the needs of electric vehicle users. Well-planned establishment of charging stations can improve the overall user experience by reducing input and operating expenses while guaranteeing equipment capacity, service convenience, and user happiness or satisfaction (Yang *et al.*, 2022) [52].

Various benefits are offered by charging infrastructures to electric bike users. Electric vehicle users' overall experiences can be greatly improved by strategically allocating charging stations based on user satisfaction and convenience (Xu *et al.*, 2022) [50]. This indicates that accessible charging infrastructure benefits electric vehicle users by improving their overall experience. In this study, electric bike users expressed the potential benefits they believe that the development of charging stations within their area would offer them. Emmie emphasized that having a charging station would be beneficial for electric bike users like her who only have one battery. She also mentioned that these stations would help them to charge their electric bikes during long trips, alleviating frustrations and concerns about running out of battery. She also mentioned that she avoids situations where they have to rely on tricycles just to tow their electric bike when it runs out of battery. Emmie stated that,

*“Ayun nga magpatayo ng charging station... para sa e bike... para syempre yung mga katulad namin na isa lang ang battery... Magc-charge, tapos kapag malayo yung pupuntahan namin. Hindi na pangamba hindi na katulad nung... na ano nyong... interview na hinatak sa tricycle, ayun yung ayaw naming mangyari”*

With the same concern as Emmie, Jirose said that having a charging station is beneficial because it alleviates their worry or concern about running out of battery during their travel or trip. Jirose said,

*“Mas maganda talaga merong ano... charging station para lang ‘di ka mangangamba kapag malo-lowbat siya”*

Moreover, Lyn said that having a charging station is beneficial in case their electric bike runs out of battery while they are traveling on the road. She mentioned that it would be convenient for them to be able to push the electric bike to the nearest charging station and charge it enough to be able to go back home. She emphasized that these stations would be effective and help them in critical situations on the road. Lyn stated,

*“Siguro maganda pa rin kase, kunware nasiraan ka sa daan tapos itutulak mo lang sya sa malapit na charging station yon mag chacharge ka saglit para maka uwi ka parang ganun. Kase yung sasabihin mong, sabagay yung sinasabi nyu naman na charging station ano yun yung parang ano lang, yung parang kailangang kailangan mo lang talaga diba. Sabagay makakatulong din talaga yun kung nga pag nasiraan ka at least hindi mona kailangan maghila”*

Elise discussed that in the future, more people will likely patronize the use of electric bikes if there are available and accessible charging stations. She also said that unlike other

vehicles, where running out of fuel can be resolved by finding a gas station, electric bikes doesn't have cannot do that because there are no available charging stations. Elise suggests that having charging stations would make electric bikes more practical and usable in various situations. She said that,

*“Siguro yung future mas maraming mag p-patronize sa pag used ng ebike kung may ganun... kasi syempre hindi kasi siya tulad ng ibang vehicle na... ok lng na, for example running out kana ng diesel, ang sasabihin ng mga driver, ok lng yan meron naman tayong madadaanang gas station, siguro kung ganun yung e-bike mas ano den, mas magagamit sya sa...”*

This indicates that the electric bike users in this study perceived and viewed the development of charging stations as beneficial for them. These stations would help them charge their electric bikes during long trips or in critical situations on the road, such as when their battery runs out of charge while traveling. It would also address other possible issues they may encounter, alleviating their concerns and frustrations. Furthermore, the development of charging infrastructure would likely result in more people patronizing the use of electric bikes in the future. Additionally, the availability of charging stations for electric vehicles, including electric bikes, would provide a similar experience to users of motor vehicles that rely on fossil fuel resources. This is because gas stations are readily available to regain maximum power when the vehicle runs out of fuel. In sum, these charging stations would make electric bikes more practical and usable in various situations that would positively contribute to the overall performance or experience of electric bike users. This is further supported by the research such as Hou *et al.* (2021) [22], which have highlighted the impact and influence of charging stations on users' inclination to utilize electric vehicles, which indicates that strategically placed stations can have a positive impact on users' preferences and behaviors.

In summary, the lack of charging stations within an area is one of the problems faced by electric bike users in this study. Therefore, the development of charging stations within an area should be well-planned and strategic to ensure convenience, efficiency, effectiveness, and benefits for electric bike users. Despite diverse perceptions and concerns of electric bike users regarding the development of charging infrastructures, they still perceive and view the development and establishment of these stations as beneficial for them and would help them address any possible issues they may encounter during long trips or in critical situations on the road, and would provide or offer them another charging options, alleviating their concerns and frustrations. In other words, the well-planned establishment of charging stations can improve the overall experience, performance, and productivity of electric bike users, ultimately leading to more people patronizing or to increased adoption of the use of electric bikes in the future.

### Theme 3: Cost-Effectiveness and Sustainability

The purpose of this theme is to explore how electric bikes serve as cost-effective means of daily transportations for users. Analyzing this would provide valuable insights and highlight the sustainability of electric bikes as a viable mode of transportation. Additionally, investigating this would also



contribute to understanding the economic benefits of electric bikes, such as savings on transportation expenses and other financial benefits or advantages they offer.

**Economic Benefits:** Electric bikes offer economic benefits and advantages to its users that makes them a sustainable and alternative form of transportation. According to Lv *et al.* (2020) [30], electric bikes have economic benefits, including bike-sharing programs that provide savings on expenses, convenience, and flexibility compared with traditional transportation options. Moreover, electric bikes are essential for promoting transport resilience and reducing expenses related to traditional transportation networks (Liu *et al.*, 2021) [29].

Financial benefits or advantages are said to be valuable for users when using electric bikes as a form of daily transportation. Research by Lyu *et al.* (2021) [31] have emphasized the financial benefits of using electric bikes, including support for multimodal transportation connections and personal cost reductions. In this study, electric bike users expressed that using electric bikes as a mode of transportation offers financial advantages. They mentioned that it helps reduce transportation expenses and has minimal impact on their electricity bills, thus helping them in managing their daily expenses effectively. Elise mentions that the general performance of using an electric bike helps reduce transportation expenses, especially when compared to commuting by tricycle. She said that,

*“siguro kung yung e-bike in general, yung performance ng e-bike, nakakatulong siya in daily basis kasi mahal na kasi kapag nag commute ka e lalo na pag sa tricycle, nakakabawas sa gastos sa pamasaha.”*

Alex also highlights the financial benefits of using an electric bike as it helps them save money compared to traditional modes of transportation that rely on gasoline. Alex stated,

*“Ah instead na mag commute kami magbayad kami ng tricycle or gumamit kami ng motor vehicle na gumagamit ng gasolina mas may benefit samin tong ano tong e-bike na mas nakatipid kami kung electric yung ginagamit namin.”*

Jirose also finds using an electric bike more favorable because it helps her to save on transportation expenses. She also mentions that she relies on her electric bike as her daily means of transportation to EPZA, where she works. Jirose said,

*“Mas okay siya kasi nakatipid ako sa pamasaha, naipangpapasok ko ng EPZA.”*

Emmie mentions that owning an electric bike has made it convenient for them to travel to places like Noveleta and Rosario without worrying about the transportation expenses. She mentioned that,

*“Hindi na kami namamasaha papuntang Noveleta, kahit pumunta kami araw-araw, mamili kami, dati kasi di kami namimili sa Noveleta kasi yung pamasaha nga, tapos ngayon kahit pumunta kami ng Rosario okay lang kasi may e-bike na”*

Moreover, Lyn mentions that the cost of transportation fares has become expensive, emphasizing the financial benefits of using an electric bike as a more affordable alternative. Lyn said that,

*“Tapos kase sa totoo lang malaki talaga ang tulong ng ebike, kase ang mahal talaga ng pamasaha talaga ngayon sobrang ano”*

With the same concern regarding the expensive cost of transportation fares in the area, Terry concludes that having an electric bike is more convenient, presumably because it eliminates the need to spend money on high transportation fares nowadays. She stated,

*“Siguro kase convenient ang may ebike... unang una na sa mahal ng transpo natin ngayon. From here hanggang sa bayan nasa 25 pesos. From here hanggang Remelville 45 pesos. Mas convenient ang may e-bike”*

Furthermore, Anna shares that the estimated cost of an electric bike, presumably reflected in electric bills, is around eighteen pesos. Like other electric bike users in this study, Anna also emphasizes that electric bikes help reduce transportation expenses. She shared,

*“sa pamasaha nakakabawas... kasi magkano lang naman ang charge ng e-bike na makokonsumo mo sa isang araw, sabi nila eighteen pesos... sabi nila... pero siguro ganun nga... medyo makaka-less ka ng pamasaha sa e-bike”*

Compared to traditional modes of transportation that rely on gasoline and other fossil fuel, electric bikes provide financial benefits and advantages to its users. According to D'Acerno *et al.* (2022) [15] the use of micro-mobility solutions, such as electric bikes, can enhance environmental sustainability and provide cost-effective alternatives for traditional transportation systems in urban settings. Additionally, research has demonstrated that electric bikes offer a more cost-effective alternative for motorized modes of transportation than traditional, unaided bikes (Kwiatkowski *et al.*, 2021) [26]. According to Handy and Fitch (2020) [21], e-bikes offer a cost-effective and healthier mode of transportation that presents both financial and environmental advantages. The research supports the findings of this current study regarding the financial benefits and advantages of utilizing electric bikes as a daily means of transportation. This includes reduced transportation expenses amidst high fares nowadays. Thus, it helps and enables users to save their money, along with the minimal impact on their electricity bills when charging their electric bikes. All in all, these factors contribute to the overall convenience of using electric bikes as a cost-effective mode of transportation.

In summary, utilizing electric vehicles, such as electric bikes, as a daily means of transportation does really offer and provide benefits and advantages to its users compared to traditional modes of transportation that rely on gasoline and other fossil fuels. These benefits and advantages positively impact or contribute the overall convenience, usability, and feasibility of using electric bikes as daily means of transportation.

## Conclusion

To sum up everything that's been stated so far, the lived experiences of electric bike users reveal significant challenges related to battery issues, including capacity limitations, rapid drainage, and vulnerability to water exposure. These challenges impact users' overall performance and satisfaction with electric bikes as a daily transportation option. However, users employ proactive coping strategies such as battery replacement, consistent charging, and maintenance practices to mitigate these issues and ensure efficient bike performance. Additionally, the context of infrastructure and accessibility plays a crucial role in shaping users' experiences, with the availability of charging stations influencing their convenience and confidence in using electric bikes. While users express diverse perceptions and concerns about charging infrastructure development, they generally recognize its potential benefits in enhancing their electric bike usage, particularly in addressing battery-related issues during travel. Overall, the findings underscore the importance of strategic planning and investment in charging infrastructure to promote the practicality, usability, and adoption of electric bikes as a sustainable transportation solution. By addressing these challenges and improving infrastructure, communities can support the transition to electric bikes, ultimately contributing to enhanced mobility, reduced environmental impact, and improved overall quality of life for users.

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