Article

Factors Influencing the Adoption of Electric Jeepneys: A Philippine Perspective

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Abstract: The implementation of e-jeepneys stands as a change process that will eventually transition to the modernization of the public transport system in the Philippines. To address concerns about jeepneys' effects on the environment, energy use, society, the economy, and policies, their acceptability in the Philippines must be considered. This research study aims to identify the sources of influence on Filipinos' adoption of e-jeepney utilization as a mode of transportation using the extended Pro-Environmental Planned Behavior (PEBP) model. A total of 502 commuters voluntarily answered the survey questionnaire. Based on the findings, perceived environmental concern (PEC) is the most significant determinant influencing attitude (AT) and, thus, affecting the Filipinos' behavioral intention (BI) towards the adoption of e-jeepneys. Conversely, AT was the primary determinant of BI, which strongly supported the notion of AT as a strong driving force shaping behavioral decisions. Moreover, perceived authority support (PAS) emerged as a strong predictor of subjective norms (SNs), demonstrating the influence of institutional support on societal perceptions. As a result, more environmentally conscious people are more likely to view e-jeepneys positively and intend to use them as a mode of transportation. The endorsement or support from authoritative figures or institutions notably influences subjective norms, which are individuals' perceptions of social pressures regarding the use of e-jeepneys.

Keywords: e-jeepneys; PEPB; PLS-SEM; behavioral intention

1. Introduction

The Philippine transportation system plays a vital role in developing and evolving the economy and the country's society. The Philippine economy depends heavily on transportation to connect its significant population and commercial centers [1]. An effective transportation system is essential to improving the country's investment, economic, and climate growth [2]. A country's development, sustainability, and economy can be significantly measured by how well its public transportation system functions in terms of reliability and safety [3].

Jeepneys are of significant economic importance in the Philippines, as they sustain the daily income of countless mechanics, drivers, and traders [4]. Additionally, jeepneys are a cost-effective, convenient, and readily available mode of public transportation, particularly for individuals lacking the financial means to acquire and maintain private transit [5]. They play a vital role and contribute to the Philippines' economy. However, due to the detrimental impacts of diesel jeepneys on the environment and human health, the government decided to replace the traditional ones with a modernized and more sustainable jeepney that will make thousands of drivers unemployed [6].

The transition from diesel vehicles to EVs, such as e-jeepneys, is being gradually implemented in the Philippines. This new technological advancement supports the government's efforts to enhance commuter mobility by guaranteeing the public a safe, clean, and efficient public transportation system [7]. E-jeepneys are electric vehicles designed based on diesel jeepneys. They are a much more environmentally friendly electric-powered version of diesel jeepneys. They can mitigate the environmental impact of smoke-producing automobiles [8]. These electric jeepneys require an internal electric motor. They must have closed-circuit television cameras (CCTVs), Wi-Fi and USB connections, GPSs, safety features such as speed limiters, accessibility features including ramps and seatbelts, and a dashboard camera [9]. The design and engineering of these electric jeepneys are much more closely similar to minibuses than traditional jeepneys.

In the Philippines, addressing the acceptance of e-jeepneys is a critical issue, as it aligns with the government's program to modernize public utility vehicles, mainly traditional jeepneys. The jeepney modernization program aims to replace these conventional vehicles with safer, more efficient, and eco-friendly alternatives [10]. Many traditional jeepneys are notorious for emitting harmful smoke and are often in poor condition, leading to accidents [11]. According to Transportation Secretary Jaime Bautista, modernizing jeepneys will strengthen the CASA (Convenient, Accessible, Safe, Secure, and Affordable) program in the transport sector. Moreover, this initiative is expected to generate employment opportunities for mechanics, dispatchers, administrative staff, and others [12].

While the government needs to proceed with jeepney modernization, it is crucial to consider the impact on drivers, whose livelihoods depend on traditional jeepneys, and commuters, who rely on affordable transportation. Therefore, understanding the acceptance of e-jeepneys, a specific type of electric vehicle tailored to the unique needs of Filipino transportation, becomes paramount. This research aims to explore the factors influencing the acceptance of e-jeepneys compared to other electric vehicles, providing insights crucial for policymakers, stakeholders, and the general public.

2. Review of Related Literature

2.1. Challenges and Opportunities of E-Jeepneys

Electric jeeps face specific challenges and opportunities compared to other types of electric vehicles. Challenges include their limited range and smaller battery capacities, making them suitable mainly for short- to medium-distance trips [13]. Maintaining or increasing payload capacity while transitioning to electric power can also be challenging due to the weight of batteries [14]. Moreover, the rough terrain in many Philippines areas impedes electric jeep performance. However, there are significant opportunities as well. Electric jeeps offer environmental benefits by reducing air pollution and greenhouse gas emissions. They can also provide cost savings over time due to their lower operating costs than traditional vehicles [15]. Additionally, electric jeeps can improve passenger experience with quieter and smoother rides [16]. Developing electric jeep technology can lead to battery technology and vehicle design innovation. With proper government support and incentives, electric jeep adoption can contribute to a more sustainable transportation system in the Philippines.

2.2. Jeepney Modernization Program

The Department of Transportation (DOTr) implemented the Jeepney Modernization Program, also known as the Public Utility Vehicle Modernization Program (PUVMP), in 2017, according to Malasique and Rosete [6]. Its primary objective is to enhance the efficiency and environmental friendliness of the nation's public transportation system. To improve service quality, the program intends to modernize public fleets, streamline franchising procedures, restructure public transportation route planning, and encourage professionalization. The DOTr suggests an unprecedented shift in the nation's direction by extending the lives of public transportation vehicles. Consequently, maintenance services for PUVs older than 15 years would be discontinued, and all operators would be obligated

to utilize brand-new vehicles that adhere to Philippine National Standards and Euro IV emissions standards.

According to the research by Agaton et al. [17], compared to diesel jeepneys, e-jeepneys offer more financial potential. The results exhibit reliability in all investigated scenarios. Additionally, the results indicate that, in light of the prevailing business environment, it is advisable to proceed with an imminent investment rather than delaying or postponing one, as doing so could potentially lead to missed prospects. The modernized jeepney initiative is supported by conventional financial tools and environmental interests, including the internal rate of return, payback period, and return on investment. Other investment analyses, including public opinion, health and non-health benefits, and economic ramifications on employment and taxation, support the conclusions drawn from the research analysis employing the suggested return on assets for the e-jeepney project. Furthermore, this research proposes further measures from the government, including augmenting the subsidy amount accompanied by flexible payment terms, raising jeepney base fares to facilitate a quicker and more profitable return on investment, strategically placing charging infrastructures while considering the interplay between charging decisions and travel, and maintaining endeavors to depend on cleaner, more affordable, and renewable energy sources.

2.3. Adoption of E-Vehicles in International Setting

A comprehensive review by Verma et al. [18] in India identifies various factors influencing the adoption of electric vehicles (EVs), including environmental concerns, government incentives, and technological advancements. It highlights the potential of EVs to reduce greenhouse gas emissions and dependency on fossil fuels, thus supporting their adoption as a sustainable transportation solution. In addition, a study by Sovacool [19] in the United Kingdom reviews existing literature on electric vehicle adoption and proposes a conceptual framework to understand the key drivers of adoption. It emphasizes the importance of vehicle performance, cost, infrastructure availability, and government policies in shaping consumer attitudes towards electric vehicles. Another study by Guo et al. [20] examines the potential impact of electric vehicle adoption on air quality in Beijing, China. Contrary to expectations, the authors find that widespread adoption of electric vehicles may lead to slight air quality improvement due to increased electricity demand and emissions from power generation. Similarly, research by Nanaki & Koroneos [21] in Greece analyzes electric vehicles' costs and environmental impacts compared to conventional vehicles. While electric vehicles offer potential benefits regarding reduced carbon emissions, the authors highlight challenges such as high battery costs and emissions associated with electricity generation, which may limit their widespread adoption.

Several Chinese cities, such as Shenzhen and Beijing, have replaced large portions of their conventional bus fleets with electric buses. Shenzhen, for instance, boasts the world's largest electric bus fleet, with over 16,000 electric buses operating in the city. The Chinese government's solid incentives and subsidies for electric buses have facilitated this transition [22]. In contrast, the Philippines has focused on replacing traditional jeepneys with electric jeepneys. The government's jeepney modernization program aims to gradually phase out old, polluting jeepneys and replace them with environmentally friendly electric jeepneys. This approach addresses the needs of the Philippines' unique public transportation system, which relies heavily on jeepneys for intracity travel.

Also, many European cities, such as Amsterdam and Zurich, have extensive electric tram networks that support their public transportation systems [23]. Trams offer efficient, high-capacity transportation with zero emissions, contributing to cleaner air and reduced traffic congestion [24]. While electric trams are common in Europe, the Philippines' urban areas, particularly Metro Manila, face challenges, such as narrow streets and informal settlements, making tram systems less feasible. Instead, electric jeepneys are a more flexible and adaptable solution for the Philippines' transportation needs, providing door-to-door service in densely populated areas.

Norway, a pioneer in adopting electric vehicles, including electric taxis, has seen a rapid increase in electric taxis, supported by government incentives such as tax exemptions, toll exemptions, and access to bus lanes [25]. In the Philippines, electric jeepneys serve as a mode of public transportation rather than individual taxis. Electric jeepneys provide a shared ride service, similar to conventional jeepneys, but with the added benefit of zero emissions and lower operating costs.

In Japan, an extensive network of electric trains, such as the Shinkansen (bullet train) and urban commuter trains, offers fast, reliable, and energy-efficient intercity and intracity travel [26]. While electric trains are a vital part of the Philippines' transportation infrastructure, particularly in Metro Manila (e.g., LRT and MRT), electric jeepneys complement these systems by providing last-mile connectivity to areas not serviced by trains. Electric jeepneys bridge the gap between major transportation hubs and smaller communities, enhancing accessibility and connectivity.

Prior studies also addressed various aspects of energy management and optimization related to transportation, including microgrids within buildings and vehicle-to-grid systems. They propose innovative techniques and methodologies to improve energy operations' efficiency, reliability, and security in transportation systems. For instance, the study by Li et al. [27] investigates optimization techniques for microgrids, particularly in the context of energy management in buildings. While not directly related to transportation, the optimization methodologies explored in this study can be adapted to improve the operational efficiency of e-jeepneys. By applying similar stochastic-weighted, robust optimization techniques, e-jeepney operators can optimize their energy usage, considering factors such as battery degradation and varying thermal loads, to enhance overall performance and reliability. Another study by Shang & Li [28] focuses on federated learning techniques for real-time vehicle-to-grid (V2G) dispatch, addressing security concerns and non-independent and identically distributed (non-IID) data challenges. Although the primary focus is V2G systems, federated learning and real-time dispatch optimization can be applied to e-jeepneys in the Philippines. By implementing security-enhanced federated learning algorithms like FedPT-V2G, e-jeepney fleets can optimize their dispatch operations in real time, considering traffic conditions, passenger demand, and energy availability, leading to more efficient and reliable transportation services. Finally, Shang et al. [29] propose a dispatching mechanism for vehicle-to-grid (V2G) systems using distributed edge computing and attention-based long short-term memory (LSTM) networks. While the focus is on V2G systems, efficient and adaptable dispatching principles can be applied to optimize the operations of e-jeepneys in the Philippines. By leveraging distributed edge computing and attention-based LSTM networks, e-jeepney operators can enhance their dispatching strategies by considering route optimization, energy management, and real-time demand forecasting. This can improve efficiency, reduce energy consumption, and enhance service reliability for e-jeepney transportation networks.

While prior studies have considered the complex interplay of factors such as environmental concerns, government incentives, and technological advancement, a critical gap exists in understanding the socio-technological influences that impact the adoption of e-jeepneys, such as perceived safety, infrastructure, and sustainability. This missing information represented a vital aspect of the study, as it can shed light on the nuanced dynamics that shape the acceptance of e-jeepneys in the Philippines.

2.4. Theory of Planned Behavior (TPB) and Pro-Environmental Planned Behavior (PEPB) Model

Previous investigations have widely applied the Theory of Planned Behavior (TPB). The TPB has been utilized to examine how individuals engage in specific actions that are influenced by their subjective norms and attitude towards the behavior in question [30]. Individuals are more likely to intend to engage in the behavior under consideration when they have a favorable attitude and a subjective norm. [31]. The TPB is regarded as one of the most practical social and behavioral sciences theories.

One is the study by La Barbera and Azjen [32], which used a sample that explores the antecedents of voting for European integration to explain how one's behavior is affected by attitude. The study's method was to provide a set of open-ended questionnaires to assess the behaviors of two sides, young and old respondents. Upon examination of the structural equation model of voting intentions, supported by the TPB, it showed that individuals' behavioral and control beliefs significantly impacted the latent constructs regarding their way of voting. In addition, the results demonstrated that the respondents' beliefs regarding the difficulty of exercising direct democratic control via citizenship and voting influenced their intentions to vote, thereby establishing perceived behavioral control.

Another study using the TPB model by Asare [33] aimed to determine the behavioral intention of condom use among college students. The findings of the study also indicated that attitudes towards perceived behavioral control and subjective norms predicted intentions to use condoms. Another study by Pourmand et al. [34] assessed the factors influencing self-care behaviors for managing hypertension. The TPB was also utilized, and results showed that obtaining perceived behavioral control influenced self-care routines for female patients with hypertension. The results also show that subjective norms positively affected younger patients. All studies showed accurate and positive results by applying the TPB model.

Several research studies have extended the TPB model to examine people's attitudes regarding environmental behavior. The concept extension of the Theory of Planned Behavior, known as the Pro-Environmental Planned Behavior (PEPB) model, has also commonly been used in past studies assessing factors influencing behavioral state. The model considers four factors, perceived behavioral control (PBC), subjective norms (SNs), attitude (AT), and behavioral intention (BI), utilized in the Theory of Planned Behavior, which were eventually augmented by two more factors. The only concepts not part of the TPB model are perceived authority support (PAS) and perceived environmental concern (PEC), added in this extended model to deeply comprehend and forecast environmental behaviors.

Many studies have used the Pro-Environmental Planned Behavior (PEPB) model as an assessment model. One study by Mufidah [35] determined the behavioral intention of using ecolabelled products of citizens in developing regions in Taiwan and Indonesia. The same procedure was used with the TPB model; the study provided questionnaire surveys to briefly assess the respondents' behavioral intentions from the two regions. Structural equation modelling (SEM) was also included to analyze the model further, and it was found that the behavioral intention is 49% in Taiwan and 72% in Indonesia. The results concluded that behavioral intention and attitude determined those numbers in both regions.

Overall, both models showed their accuracy and reliability to be utilized to identify and predict behavioral intentions, primarily including pro-environmental behaviors. Moreover, the current study will also use these models to examine influential factors in adopting e-jeepneys that are yet to be explored. By confirming the relevant influence of PEPB factors on the adoption of e-jeepneys, the conceptual framework developed for this research study contributed to consumer behavior modelling. For sustainable energy growth and the advancement of the Philippines' economic and environmental well-being, research on the country's acceptance of e-jeepneys is essential.

This paper addresses a critical aspect of transportation modernization by focusing on the acceptance of e-jeepneys in the Philippines. It provides insights into the factors influencing the adoption of these vehicles, which is crucial for policymakers, stakeholders, and transportation authorities. The paper extends the traditional PEPB (Pro-Environmental Planned Behavior) model by incorporating additional factors such as affordability, infrastructure, and perceived safety. This extension allows for a more comprehensive understanding of the factors shaping acceptance, providing practical guidance for interventions and policy development. The paper employs SEM to analyze the relationships between various factors influencing the acceptance of e-jeepneys. SEM allows for the simultaneous examination of complex relationships among multiple variables. Using SEM, the paper

provides a robust statistical framework for exploring the interplay between affordability, infrastructure, perceived safety, and other factors in determining acceptance.

Thus, incorporating extended factors such as affordability, perceived safety, and infrastructure into the PEPB model represents a methodological innovation. This integration allows for a more nuanced understanding of acceptance behavior, going beyond the traditional predictors of attitude, subjective norms, and perceived behavioral control. The paper applies these methodological approaches within the specific context of the Philippines, where traditional jeepneys are a prominent mode of transportation. This contextualization enhances the relevance and applicability of the findings to the local transportation landscape.

This present study represents a novel approach to addressing public transportation challenges in the Philippines, particularly in urban areas, where traditional jeepneys dominate the landscape. The introduction of e-jeepneys presents a sustainable alternative, offering reduced emissions and improved energy efficiency compared to conventional vehicles. By focusing on the adoption dynamics of e-jeepneys, we contribute to the growing body of literature on sustainable transportation solutions tailored to the Philippine context.

One of this study's primary contributions lies in applying the extended PEBP model to analyze the factors influencing Filipinos' adoption of e-jeepneys. While the PEBP model has been widely used in environmental psychology research, its application to transportation adoption in the Philippines is relatively unexplored. By extending this model to encompass the specific socio-cultural and contextual factors relevant to e-jeepney adoption, our research offers a novel framework for understanding consumer behavior in the transportation sector.

The novelty of our study is twofold: first, in its contextual adaptation of the PEBP model to a specific transportation mode within the unique socio-cultural environment of the Philippines, and second, in its focus on e-jeepneys, a relatively new concept in the realm of sustainable urban transport. Additionally, our methodology is designed with replicability in mind, allowing it to be adapted and applied to other contexts beyond the Philippines. By detailing the steps and considerations involved in our approach, other researchers can replicate and modify our methodology to explore transportation adoption dynamics in different regions or with other sustainable vehicle types. This enhances the utility and impact of our research, offering a versatile framework for comparative studies and broader applications in diverse settings. This approach not only underscores the novelty of our research but also positions it as a valuable resource for future studies in various regions facing similar transportation challenges.

3. Conceptual Framework

Understanding the factors impacting the acceptance and adoption of e-jeepneys becomes essential as the Philippines works to solve environmental issues and reduce its carbon footprint. The extended Pro-Environmental Planned Behavior (PEPB) model served in the same way as the foundation for this conceptual framework, as shown in Figure 1, which aimed to thoroughly explain Filipinos' intents and behaviors concerning using e-jeepneys. The PEPB model extends the TPB model to include additional variables unique to pro-environmental behaviors. This framework consists of the following elements when examining Filipinos' acceptance of e-jeepneys: perceived authority support (PAS), perceived environmental concern (PEC), attitude (AT), subjective norms (SNs), perceived behavioral control (PBC), affordability (AF), behavioral intention (BI), perceived safety (PS), and infrastructure (IF). This framework thoroughly explained the variables impacting the use of sustainable transportation in the Philippines. The use of e-jeepneys is encouraged, and the formulation of policies and initiatives to advance sustainable mobility in the nation is supported by these data.
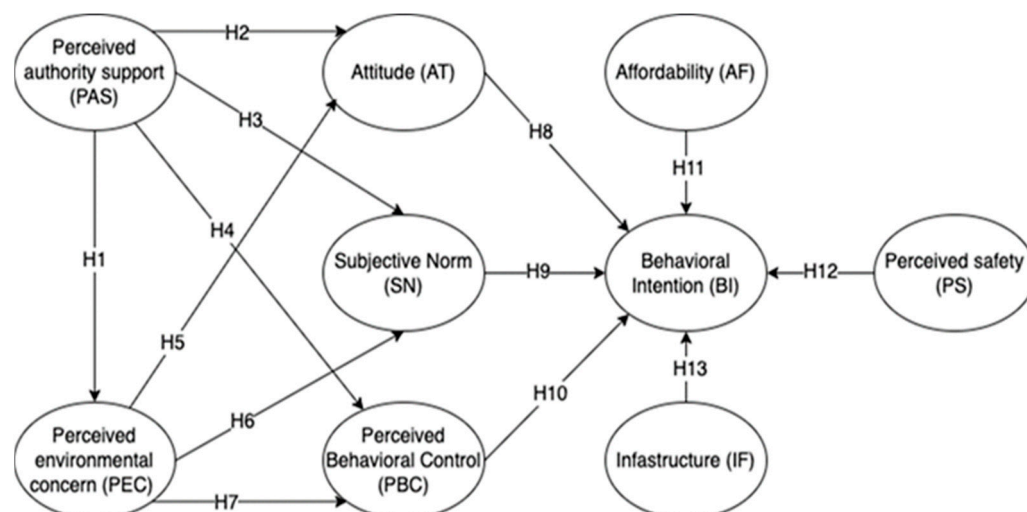
Figure 1. Proposed conceptual framework based on the Pro-Environmental Planned Behavior (PEPB) model.

Perceived authority support (PAS) represents the influence of governmental and institutional support on public perceptions and behaviors [36,37]. PAS is included based on social influence theories, which suggest that support from authoritative figures or institutions can significantly shape subjective norms and behaviors. The government's initiative to promote electric jeepneys instead of traditional jeepneys is anticipated to impact public preference for using electric jeepneys as a mode of transportation. The government's initiative to encourage the usage of e-jeepneys as a mode of transportation may affect consumer demand for e-jeepneys. According to numerous studies, government policies are crucial in boosting e-jeepney usage. For example, a study by Frisnedi and Angeles [38] discovered that while the e-jeepney appeared popular among commuters, the drivers required differing dispositions. The pandemic has hampered modernization efforts, as most motorists suffered the consequences of the quarantine. It is no longer necessary to advertise the e-jeepney to commuters; instead, the government should provide a more robust support system, including a communication channel between the relevant agencies. Another study by Agaton et al. [17] also recommends that the government take steps to boost the number of base fares and subsidies, set up charging terminals in public places, and keep working to increase reliance on more affordable, clean, and renewable energy sources, to increase the appeal of the e-jeepney to transportation operators. Studies have shown that support for environmental initiatives from those in positions of power benefits people's willingness to engage in ecological activities [39]. Commuters will be more inclined to utilize e-jeepneys as a means of transportation if the government conducts and implements the use of the vehicles perfectly. Thus, the following were hypothesized:

H1. *Perceived authority support (PAS) has a positive and significant impact on perceived environmental concern (PEC).*

H2. *Perceived authority support (PAS) positively and significantly impacts attitude (AT).*

H3. *Perceived authority support (PAS) positively and significantly impacts subjective norms (SNs).*

H4. *Perceived authority support (PAS) positively and significantly impacts perceived behavioral control (PBC).*

Perceived environmental concern (PEC) was selected due to its strong theoretical and empirical linkage to pro-environmental behavior, as demonstrated in numerous studies on environmental psychology and sustainable transportation. It reflects the public's awareness

and concern about environmental issues, which significantly influence their adoption of eco-friendly technologies. Individual self-interest towards the environment is expressed through environmental concern. Compared to environmental consequences, PEC can be considered an indicator of an individual's perception [36,40]. The present study's perceived environmental concern (PEC) represents commuters' attitudes towards e-jeepneys. Commuters' experiences while riding in e-jeepneys were expected to influence their decisions. If commuters believe using e-jeepneys is beneficial and sustainable, they will utilize them. Studies have revealed that environmental concerns influence consumer behavior [41,42]. How individuals feel and think about environmental protection is at the center of the broad and all-encompassing worldview known as environmental concern. Environmental concern significantly impacts how situation-specific cognition is seen and assessed, particularly concerning personally important behavioral implications [43]. In the extended PEPB model, attitude (AT), subjective norms (SNs), and perceived behavioral control (PBC) regarding pro-environmental behaviors, such as e-jeepneys, are influenced by perceived environmental concern [44]. Those with a vital concern for the environment are more likely to view e-jeepneys as a strategy to lessen air pollution, greenhouse gas emissions, and the total ecological footprint of transportation [45]. This increased concern may favorably impact their attitudes and intents to utilize e-jeepneys, which could ultimately result in their increased adoption. Thus, the following were hypothesized:

H5. *Perceived environmental concern (PEC) positively and significantly impacts attitude (AT).*

H6. *Perceived environmental concern (PEC) positively and significantly impacts subjective norms (SNs).*

H7. *Perceived environmental concern (PEC) positively and significantly impacts perceived behavioral control (PBC).*

Grounded in the Theory of Planned Behavior (TPB), attitude is a well-established determinant of behavioral intention. It was selected because it encapsulates individuals' positive or negative evaluations of using e-jeepneys, which is crucial for predicting adoption behavior [36,46]. It encompasses their beliefs about the positive or negative consequences of using e-jeepneys as a mode of transportation. Commuters will undoubtedly use the e-jeepney as a form of transportation if they positively perceive it. According to Ajzen [46], attitude (AT) indicates how positively or negatively other people see the action or behavior. Numerous studies have repeatedly found a relationship between consumers' propensity to use sustainable items and their attitudes towards sustainability. A positive attitude suggests that Filipinos perceive e-jeepneys as environmentally friendly, cost-effective, and convenient alternatives to traditional jeepneys [33]. It has been demonstrated that attitude (AT) favorably impacts the subjective norm (SN) for participating in environmental impact assessments [18]. Thus, the following was hypothesized:

H8. *Attitude (AT) positively and significantly impacts behavioral intention (BI) when using e-jeepneys.*

Subjective norms capture the perceived social pressure to perform or not perform a behavior. This variable is grounded in the TPB and is crucial for understanding how societal expectations influence the adoption of e-jeepneys [30]. It includes perceptions of what significant others, including family, peers, and society, expect regarding e-jeepneys. The Theory of Planned Behavior (TPB) states that SNs greatly influence behavioral intentions, which reflect perceived social pressure and influence [47]. Perceived social support and encouragement for adopting e-jeepneys can benefit intentions to embrace this mode of transportation in the context of sustainable transportation [48]. Eriksson and Forward's assessment of studies on environmental behavior [49] also highlights the significance of subjective and societal norms in determining pro-environmental intentions. They point out

that people are more likely to adopt environmentally conscious actions when they sense and believe that others have confidence and support them, such as driving electric vehicles like e-jeepneys. If Filipinos perceive that their social network values and encourages e-jeepney usage, they are more likely to consider adopting this sustainable mode of transportation. Thus, the following was hypothesized:

H9. *Subjective norms (SNs) positively and significantly impact the behavioral intention (BI) to use e-jeepneys.*

Perceived behavioral control (PBC) addresses circumstances in which individuals may not fully control the behavior of interest [50]. PBC is included in the model based on its role in the TPB and PEPB models, reflecting individuals' perceived ease or difficulty in performing the behavior [51]. PBC is crucial for understanding barriers and facilitators to the adoption of e-jeepneys [52]. PBC reflects Filipinos' beliefs about their ability to use e-jeepneys effectively. It considers factors such as familiarity with the technology, accessibility of e-jeepney services, and financial feasibility [53]. It was predicted that passengers' perceptions of their inclination to take an e-jeepney would influence their intention. When presented with environmental limits, commuters' confidence and belief in their ability to make decisions and their positive outlook on the future intention of using e-jeepneys are essential factors that support their perceived behavioral control (PBC) [54]. High perceived behavioral control indicates that individuals believe they have the resources, opportunities, and skills to embrace e-jeepney use. Thus, the following was hypothesized:

H10. *Perceived behavioral control (PBC) positively and significantly impacts the behavioral intention (BI) to use e-jeepneys.*

Affordability is a crucial factor influencing individuals' decisions to adopt such modes of transportation. With the increasing prices of fuels and diesel for transportation, some transport groups sought a fare hike to cope with the price hike of fuels. According to studies, people are more likely to consider adopting e-jeepneys if they believe they are more affordable than other types of transportation [17,33]. This view finds an advantage in cheaper fuel prices, fewer maintenance costs, and prospective government subsidies for environmentally efficient cars [55]. In sustainable transportation, people's intentions to use electric vehicles, especially e-jeepneys, are significantly influenced by affordability [45]. High initial costs or recurring expenses can hamper adoption. Still, their intention can also be encouraged by factors that make adoption more affordable, such as subsidies, tax breaks, or decreased operating costs. Thus, the following was hypothesized:

H11. *Affordability (AF) positively and significantly impacts the behavioral intention (BI) to use e-jeepneys.*

One crucial aspect influencing people's intention to use e-jeepneys as a mode of transportation is their perception of safety. Research has consistently shown that individuals are more inclined to use e-jeepneys or electric vehicles when they perceive them as safe modes of transportation [17]. Safety perception includes vehicle design considerations, accident rates, and overall safety features [56]. According to studies, prospective customers are more likely to use and adopt e-jeepneys when considering these vehicles to be low-risk and high-benefit solutions [17,57]. Studies have also revealed that safety standards and government restrictions influence people's sense of safety [58,59]. People are more likely to view e-jeepneys as safe and reliable modes of transportation when they comply with safety laws and benchmarks. Thus, the following was hypothesized:

H12. *Perceived safety (PS) positively and significantly impacts the behavioral intention (BI) to use e-jeepneys.*

Infrastructure, including charging stations and related facilities, is crucial in determining individuals' behavioral intentions for EV adoption, such as e-jeepneys. The physical and logistical components that enable electric jeepneys to be a sustainable means of transportation are called infrastructure [1]. The infrastructure for e-jeepneys consists of several parts and services that use electricity more effectively and practically. Studies have repeatedly demonstrated that the accessibility and availability of e-jeepney charging infrastructure substantially impact people's inclinations to use them [60,61]. When charging stations are nearby, people are less likely to worry about running out of power while traveling, making e-jeepneys more appealing as a realistic option [62]. Intentions to use e-jeepneys can also be favorably impacted by the availability of information on charging infrastructure, such as the locations of charging stations and their current availability, according to studies [63,64]. The availability of information increases users' confidence in the viability of e-jeepney adoption. Thus, the following was hypothesized:

H13. *Infrastructure (IF) positively and significantly impacts the behavioral intention (BI) to use e-jeepneys.*

4. Materials and Methods

4.1. Setting

The study determined the factors affecting Filipinos' acceptance of e-jeepneys, specifically commuters in Metro Manila, Philippines. The region was considered the target locale for data gathering to achieve the study's goals since the researchers were designated in populated areas to assess respondents based on their availability. One study by Coz et al. [65] also considered assessing the workspaces and conditions of jeepney drivers near the University of the Philippines Diliman to maintain the availability of the UP student researchers who would conduct their study. However, due to the unknown number of routes of e-jeepneys and the population of commuters who ride and travel using e-jeepneys daily, this study will employ a convenience sampling technique for data collection. The technique was appropriate for this study since it will select a sample for a broad population mainly based on convenience [66]. The research study's target respondents were commuters aged 18 and above who have experienced or are traveling using e-jeepneys within Metro Manila.

4.2. Participants and Sampling Technique

This research study employed a non-probability sampling technique. More precisely, convenience sampling was employed through an online survey questionnaire. Convenience sampling selects participants according to their accessibility, willingness, and availability [67]. Through this sampling method, researchers can gather data quickly and efficiently [68]. Convenience sampling was used in this study due to the limitations of the researchers. Because of the limited availability of participants and financial and time restrictions, the convenience sampling technique was expected to acquire varied responses consistently in a set period. An online survey questionnaire was used for ease of distribution, completion, and collection of the survey. The participants would only require an internet connection and a smart device to complete the survey. Responses were collected instantly after completion, unlike traditional surveys, which require a logistical approach for collection.

This research study aimed to acquire and gather responses from adult commuters within Metro Manila. The projected minimum sample size was 400 in the research study, as according to Yamane's research [69], a minimum sample size of 400 is required to obtain a 5% margin of error. This basis was used by Illescas et al.'s study entitled "Online or Traditional Learning at the Near End of the Pandemic: Assessment of Students' Intentions to Pursue Online Learning in the Philippines" [70]. It states that convenience sampling is a non-probability method with an easy and cost-efficient way to gather data. It allows researchers to collect the target samples easily and in an accessible manner. Also, this study proves that this technique enables the relationship between researchers and participants

with rarer complications. Therefore, the dataset gathered for this study will likely indicate commuters who have experience with or often use e-jeepneys as a mode of transportation.

4.3. Data Gathering Tools

The researchers decided to conduct their research study via a self-administered type of online survey questionnaire using Google Forms to ensure that the survey questionnaire would reach as many potential volunteers as possible without having to go through the trouble of meeting face-to-face. Additionally, this helped speed up the data-gathering process by surveying multiple participants at once at their convenience. The survey questionnaire was presented in English.

The survey questionnaire was adapted from the paper's literature review and aimed to examine the factors that affected Filipinos' acceptance of the e-jeepney as a mode of transportation. The survey questionnaire included multiple-choice questions with responses that ranged from "strongly disagree" to "strongly agree" on a 5-point Likert scale to evaluate the responses. The survey contained ten sections that affected the acceptance of commuters and consisted of 42-item questions. The first section of the questionnaire consisted of (1) a six-item question used to determine the respondent's demographic information, such as gender, age, educational background, residential area in Metro Manila, monthly allowance/salary, and the frequency of their use of e-jeepneys (weekly). The following sections of the survey questionnaire consisted of indicators and dependent variables based on the extended Pro-Environmental Planned Behavior (PEPB) Model: (2) Perceived Authority Support (PAS), (3) Perceived Environmental Support (PEC), (4) Attitude (AT), (5) Subjective Norm (SN), (6) Perceived Behavioral Concern (PBC), (7) Affordability (AF), (8) Behavioral Intention (BI), (9) Infrastructure (IF), and (10) Perceived Safety (PS). Table 1 shows the summary of the construct and measurement items adopted from literatures.

Table 1. Construct and Measurement Items.

Items	Measure	Supporting References
	Perceived Authority Support	
PAS1	I strongly believe that government authorities support and endorse the use of e-jeepneys as a sustainable mode of transportation.	
PAS2	I feel that local transportation authorities provide clear information and guidance on using e-jeepneys for my daily commute.	[36,37,71]
PAS3	I perceive that regulatory agencies and relevant authorities actively promote the safe and efficient use of e-jeepneys in my area.	
PAS4	I believe that the government is committed to providing necessary infrastructure and support for e-jeepney users.	
	Perceived Environmental Concern	
PEC1	I am concerned about the impact of pollution in my environment.	
PEC2	I believe that reducing carbon emissions is essential for sustainable future.	[35,36,44]
PEC3	I am willing to use e-jeepney as an eco-friendly mode of transportation.	
PEC4	I think e-jeepneys could help reduce air pollution in my city.	
	Attitude	
AT1	I strongly believe that using e-jeepneys is a positive step toward a more sustainable and eco-friendly mode of transportation.	
AT2	I have a positive attitude towards using e-jeepneys because I consider them to be an environmentally responsible choice.	[71–73]
AT3	I see using e-jeepneys as a smart and forward-thinking decision, and I have a positive attitude toward them.	
AT4	I strongly believe that using e-jeepneys is a convenient and efficient way to commute while minimizing environmental impact	

Table 1. *Cont.*

Items	Measure	Supporting References
	Subjective Norm	
SN1	I strongly believe that people whose opinions matter to me support the use of e-jeepneys for daily commuting.	
SN2	I feel social pressure from family and friends to use e-jeepneys as a more environmentally responsible mode of transportation.	[37,71,74]
SN3	I believe that influential people in my life, such as parents or close friends, have a positive view of using e-jeepneys for their own commutes.	
SN4	I am encouraged by my social circle to choose e-jeepneys as a mode of transportation because they see it as the right thing to do for the environment.	
	Perceived Behavioral Control	
PBC1	I strongly believe that using e-jeepneys is within my control, and I have the ability to use them for my daily commuting.	
PBC2	I feel confident in my ability to use e-jeepneys effectively and navigate their routes and schedules without difficulty.	[73–75]
PBC3	I believe that using e-jeepneys is convenient and manageable for me, and I have the necessary resources and information to do so.	
PBC4	I perceive that I have the necessary skills and knowledge to use e-jeepneys as a mode of transportation, and it is well within my capability.	
	Affordability	
AF1	I strongly believe that using e-jeepneys is an affordable transportation option for me.	
AF2	I perceive that the cost of using e-jeepneys is reasonable and within my budget.	[76,77]
AF3	I find e-jeepneys to be a cost-effective way to commute, and their fares are reasonable for the service provided.	
AF4	I believe that using e-jeepneys is a financially responsible choice, and it does not strain my budget.	
	Infrastructure	
IF1	I believe that there is a well-developed infrastructure in place to support the use of e-jeepneys in my area.	
IF2	I believe that the e-jeepney infrastructure, including charging stations and stops, is easily accessible and convenient for users.	[78,79]
IF3	I perceive that there is a sufficient number of e-jeepney stops and charging stations to make using them a viable option for daily commuting.	
IF4	I find that the e-jeepney infrastructure is well-maintained and dependable, ensuring a smooth commuting experience.	
	Perceived Safety	
PS1	I strongly believe that using e-jeepneys is a safe mode of transportation for my daily commute.	
PS2	I perceive e-jeepneys as a secure and reliable means of commuting, and I don't have concerns about my safety when using them.	[80–82]
PS3	I feel confident that the safety features and precautions in place for e-jeepneys make them a safe choice for daily transportation.	
PS4	I believe that e-jeepneys are well-maintained and equipped with safety measures to ensure the well-being of passengers.	
	Behavioral Intention	
BI1	I strongly intend to use e-jeepneys for my daily commuting needs in the near future.	
BI2	I am highly motivated to use e-jeepneys as my primary mode of transportation, and I plan to start using them soon.	[35,37,73]
BI3	I have a strong intention to include e-jeepneys as a regular part of my daily commuting routine.	
BI4	I firmly believe that I will use e-jeepneys in the coming months, and I am committed to this mode of transportation.	

4.4. Research Procedures

The online survey questionnaire was created and provided via Google Forms. The survey questionnaire served as the instrument for data collection, consisting of a series of questions that assessed the perspective of the target participants regarding the current study. The researchers evaluated the questionnaires' relevancy, applicability, and accuracy by first providing 100 participants with a consent form to execute the data-gathering procedure

officially. After receiving the consent, the researchers approached the targeted respondents with the survey questionnaire on commonly used online platforms, notably Messenger and Microsoft Teams. The researchers provided the online questionnaire to 400 targeted respondents who assessed the forms, and the answers were easily collected. Furthermore, the procedure was considered a success that gave the signal to conduct data analysis of the gathered data. The researchers applied principal component analysis (PCA), which analyzed and provided a summary of information regarding the results obtained from a vast number of respondents.

4.5. Data Analysis

The survey data that was gathered was subjected to multivariate analysis. The present investigation employed the structural equation modelling (SEM) methodology. SEM is an increasingly multivariate technique used in various studies to examine and evaluate multivariate causal relationships. Because SEM examines both direct and indirect effects and impacts on hypothesized causal relationships, it is distinct from other modelling techniques. SEM is a statistical technique developed over three generations and used for almost 100 years. The first generation of SEM used path analysis to construct the logic of causal modelling. The social sciences later transformed SEM to incorporate factor analysis. The second generation of SEM saw an increase in capacity. In 2000, the third generation of SEM started, with Judea Pearl creating the "structural causal model," followed by Lee's (2007) incorporation of Bayesian modelling [83].

According to Beran and Violato [84], applications of SEM include examining fundamental relationships between variables and more intricate examinations of measurement equivalence for first- and higher-order constructs. SEM also presents a versatile framework for showcasing the relationships between multiple variables [85]. This allows researchers to utilize empirical models to assess the validity of their theories. The capacity to control measurement error, one of the most considerable constraints of most studies, may be SEM's significant benefit [86].

Confirmatory factor analysis and path analysis were statistical methods combined to form SEM. The goal of confirmatory factor analysis, which has its roots in psychometrics, is to examine hidden emotional and cognitive qualities like attitude and satisfaction. The causal connections between several variables can be explained via path analysis [87].

5. Results

5.1. Profile of Demographics

Table 2 illustrates the overview of the study's breakdown of the participants' profile population. Based on the numbers, 502 individuals partook in the survey from 2 January 2024, until 31 January 2024. The profile takes notes of their sex, age, place of residence in Metro Manila, educational attainment, monthly income, and daily utilization of electric jeepneys. It was observed that among the 502 respondents who answered the survey, 45% were male, 53.8% were female, and 1.2% of the respondents preferred not to say their sex. The breakdown of the age brackets circulated on the participants that were around 18 to 29 years of age, with a percentage of 94.4%, then grown-ups aged 30 to 39 years of age at 2.4%, 40 to 49 years of age at 2.2%, 50 to 59 years of age at 0.8%, and 60 years of age and beyond at 0.2%.

The survey only covered the residents of Metro Manila (NCR), accumulating the most substantial percentage of individuals coming from the City of Manila at 30.9%, followed by Quezon City at 26.5% and Caloocan City at 7%. The residences with the lowest number of respondents were Pateros at 0.2%, followed by Navotas City at 0.3%, the City of San Juan at 0.5%, and there was a tie between Mandaluyong City and the City of Malabon at 1.4%. Additionally, most respondents were senior high graduates at 55%, followed by junior high graduates at 25.1%, college graduates at 17.5%, post-graduates at 2%, and elementary graduates at 0.4%.

Table 2. Profile of demographics.

Profile of the Participants (*n* = 502)	Classification	Number	%
Age	18–29	474	94.40%
	30–39	12	2.40%
	40–49	11	2.20%
	50–59	4	0.80%
	60 and above	1	0.20%
Sex	Male	226	45%
	Female	270	53.80%
	Prefer not to say	7	1.20%
Residence in Metro Manila	Caloocan	35	7%
	Las Piñas	25	5%
	Marikina	19	3.80%
	Makati	18	3.60%
	Mandaluyong	7	1.40%
	Manila	155	30.90%
	Malabon	7	1.40%
	Muntinlupa	10	2%
	Navotas	3	0.60%
	Parañaque	15	3%
	Pasay	10	2%
	Pasig	12	2.40%
	Pateros	2	0.40%
	Quezon City	133	26.50%
	San Juan	5	1%
	Taguig	19	3.80%
	Valenzuela	27	5.40%
Education	Graduates of elementary school	2	0.40%
	Graduates of junior high school	126	25.10%
	Graduates of senior high school	276	55%
	College graduate	88	17.50%
	Post-graduate	10	2%
Monthly income	Fewer than 15,000	397	79.10%
	15,001–30,000	64	12.70%
	30,001–45,000	23	4.60%
	45,001–60,000	7	1.40%
	More than 60,000	11	2.20%
Frequency of use of e-jeepneys (monthly)	0	130	25.90%
	1–5	182	36.30%
	6–10	83	16.50%
	11–15	33	6.60%
	16–20	21	4.20%
	More than 20	53	10.60%

Furthermore, 79.1% of the respondents received less than PHP 15,000 for a monthly salary/allowance, followed by receiving PHP 15,001–PHP 30,000 at 12.7%. As for the rest of the percentages, individuals who receive PHP 30,001 to PHP 45,000, more than PHP 60,000, and PHP 45,001 to PHP 60,000, correspond to the following rates: 4.6%, 2.2%, and 1.4%. Lastly, it was observed that 36.3% of the respondents only use e-jeepneys 1 to 5 times monthly as a mode of transportation, followed by 0 times at 25.9%, 6 to 10 times at 16.5%, more than 20 at 10.6%, 11 to 15 times at 6.6%, and 16 to 20 times at 4.2%.

5.2. Results of SEM

The overall results of the initial SEM as shown in Figure 2 were demonstrated regarding relationships between various factors affecting Filipinos' acceptance of utilizing e-jeepneys. The model assessed the required accurate measurement of the observed indi-

cators and latent variables used in the data-gathering procedure of the findings gathered from the 502 respondents. Upon observation of the initial SEM model, results displayed significant values showing adequate reliability and validity, determining the accuracy of relationships of the 13 hypotheses proposed that influence Filipinos' acceptance of e-jeepneys. However, minor modifications must be addressed before the final SEM model is concluded.
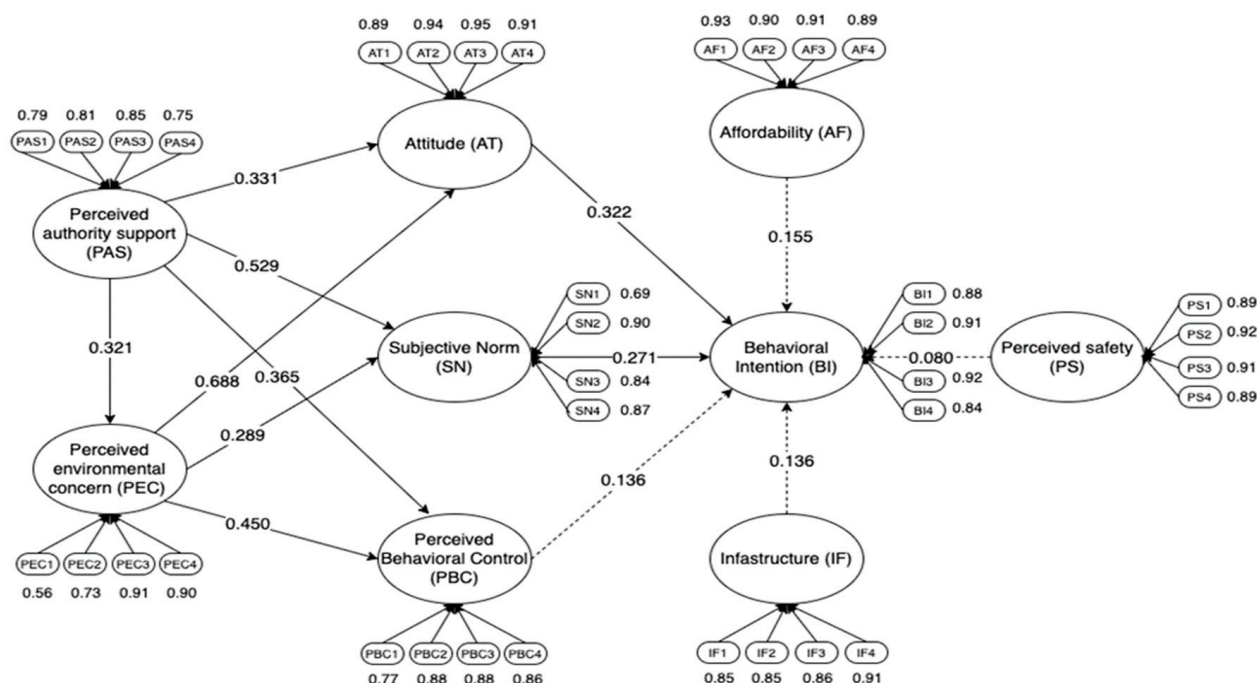

Figure 2. Initial structural equation modelling (SEM).

To identify the factors influencing the acceptance of Filipinos of electric jeepneys, the extended PEPB model consists of thirty-six indicators and nine latent variables. The model's validity is detailed in Table 3. It was imperative to perform this reliability analysis before undertaking the initial SEM. The breakdown of the overview of the model of behavioral intention was conducted using Cronbach's alpha (*i*), with additional validation provided by Factor Loading (FL), Composite Reliability (CR), and Average Variance Extracted (AVE). The Cronbach's alpha, FL, and CR values must all be more significant than 0.7. Considering its role in the SEM methodology, CR assesses the dependability of the latent variables.

In contrast, the AVE ought to be greater than 0.5. The AVE calculates the amount of variance the construct has accumulated compared with the degree of variance attributable to measurement error [88]. Table 3 reveals that two of the thirty-six indicators, SN1 and PEC1, did not meet the minimum value requirement for FL. Only the remaining 34 factors that have surpassed the requisite threshold are valid and dependable. At its core, this analysis investigates the correlation between each measure and the constructs and its internal consistency.

The study's overall reliability factors were determined through tests provided in Tables 4 and 5. Using the discriminant validity values of the Fornell–Larcker criterion and the Heterotrait–Monotrait correlation ratio, the tables display the distinct relationships between the given factors and determine the model recommended by [89]. Based on the statements of Hooper et al. [90], discriminant validity is demonstrated when assigned constructs have a greater value than all other construct loadings for Fornell–Larcker and, when referring to the Heterotrait–Monotrait ratio for given constructs using variance-based SEM, the threshold should be less than 0.85. The degree of difference between the overlapping constructs is measured by discriminant validity [91]. When a study uses latent variables, it is essential to evaluate the discriminant validity to ensure the model's constructs are distinct [92]. The square root of the average variance extracted (AVE) in

the Fornell–Larcker criterion must be considerably higher than the correlations between constructs to be considered valid and reliable [93].

Table 3. Reliability and convergent results.

Construct	Items	Mean	S.D.	FL ($\geq$0.7)	α ($\geq$0.7)	CR ($\geq$0.7)	AVE ($\geq$0.5)
Perceived Authority Support (PAS)	PAS1	3.48	1.14	0.791			
	PAS2	3.14	1.23	0.812			
	PAS3	3.18	1.16	0.849	0.882	0.828	0.666
	PAS4	2.91	1.26	0.751			
Perceived Environmental Concern (PEC)	PEC1	4.44	0.84	0.561			
	PEC2	4.50	0.79	0.729			
	PEC3	3.96	1.02	0.910	0.896	0.821	0.757
	PEC4	3.82	1.09	0.903			
Attitude (AT)	AT1	3.81	0.96	0.890			
	AT2	3.71	1.03	0.939			
	AT3	3.65	1.04	0.954	0.936	0.921	0.757
	AT4	3.68	1.04	0.910			
Subjective Norm (SN)	SN1	3.56	1.03	0.692			
	SN2	2.55	1.27	0.901			
	SN3	3.37	1.08	0.838	0.924	0.943	0.767
	SN4	3.01	1.17	0.874			
Perceived Behavioral Control (PBC)	PBC1	3.81	1.06	0.773			
	PBC2	3.50	1.11	0.883			
	PBC3	3.59	1.09	0.879	0.899	0.904	0.714
	PBC4	3.78	0.99	0.856			
Affordability (AF)	AF1	3.29	1.28	0.930			
	AF2	3.43	1.20	0.899			
	AF3	3.37	1.21	0.910	0.932	0.934	0.787
	AF4	3.34	1.24	0.889			
Infrastructure (IF)	IF1	3.04	1.20	0.846			
	IF2	3.00	1.21	0.851			
	IF3	2.86	1.24	0.849	0.889	0.923	0.750
	IF4	3.16	1.19	0.911			
Perceived Safety (PS)	PS1	3.78	0.93	0.891			
	PS2	3.62	0.99	0.919			
	PS3	3.67	0.94	0.908	0.923	0.931	0.812
	PS4	3.59	1.00	0.888			
Behavioral Intention (BI)	BI1	3.47	1.11	0.881			
	BI2	3.27	1.15	0.910			
	BI3	3.37	1.14	0.919	0.902	0.905	0.773
	BI4	3.31	1.15	0.838			

Results shown in both Tables 4 and 5 demonstrate convergent validity and reliability since the cumulative numbers fall within the test-established acceptable structure. The conclusion has been made that the total results for every construct were valid, reliable, accurate, and adequate. The constructs in the model ought to be smaller than the squared AVEs of those constructs. Fornell and Larcker developed and cited this procedure for comparing the squared AVEs to the specified latent variables [94]. Based on the results and findings, most of the structures are approved. The conventional metric connects each latent variable's squared AVE to every other latent variable that underwent reflective evaluation. The variances of all model constructs should not be more critical than their squared AVEs [95]. Furthermore, Tables 4 and 5 demonstrate the most significant number in the table, which is positioned above the corresponding column. It can also be seen that all the data fit within the expected range. In general, no issues were encountered with

discriminant validity, convergent validity, or reliability, and they are all in order. All the following values within the desired range properly demonstrated the structure's reliability. According to the results in Tables 4 and 5, the researchers concluded that the model is significantly accurate because valid convergences with the discriminants are present.

Table 4. Discriminant validity: Fornell–Larcker criterion.

	AF	AT	BI	IF	PAS	PBC	PEC	PS	SN
AF	0.905								
AT	0.587	0.916							
BI	0.600	0.710	0.879						
IF	0.663	0.623	0.654	0.866					
PAS	0.437	0.531	0.565	0.653	0.808				
PBC	0.667	0.656	0.640	0.673	0.497	0.850			
PEC	0.448	0.611	0.527	0.446	0.329	0.585	0.785		
PS	0.716	0.720	0.608	0.698	0.526	0.676	0.575	0.901	
SN	0.487	0.690	0.681	0.675	0.600	0.657	0.473	0.600	0.798

Table 5. Discriminant validity: Heterotrait–Monotrait ratio.

	AF	AT	BI	IF	PAS	PBC	PEC	PS	SN
AF									
AT	0.623								
BI	0.648	0.771							
IF	0.723	0.679	0.726						
PAS	0.496	0.591	0.652	0.762					
PBC	0.733	0.723	0.720	0.759	0.579				
PEC	0.426	0.752	0.558	0.446	0.347	0.663			
PS	0.770	0.769	0.661	0.758	0.595	0.747	0.588		
SN	0.551	0.792	0.791	0.789	0.738	0.676	0.533	0.690	

5.3. Model Fit Analysis

In Table 6, the final structural equation modelling (SEM) model revealed that nine hypotheses exhibited significant correlations. To assess the validity of the proposed model, a model fit analysis was conducted using the Standardized Root Mean Square Residual (SRMR), Chi-square (χ^2) with degrees of freedom (dF), and the Normal Fit Index (NFI), in accordance with the methodologies suggested by Hu & Bentler [96] Hooper [97], and Baumgartner & Homburg [98].

Table 6. Model fit analysis.

Model Fit for SEM	Parameter Estimates	Minimum Cut-Off	Recommended by
SRMR	0.062	<0.08	Hu & Bentler [96]
(Adjusted) Chi-square/dF	4.03	<5.0	Hooper [97]
Normal Fit Index (NFI)	0.921	>0.90	Baumgartner [98]

Table 6 indicates that the SRMR parameter is approximately 0.062, the Chi-square value is 4.03, and the NFI is 0.921. These results demonstrate that all parameter estimates

exceed the minimum cut-off values recommended for model fit indices. Specifically, an SRMR value below 0.08, a Chi-square value within acceptable limits, and an NFI value above 0.90 collectively support the validity of the model. Consequently, these findings confirm that the proposed SEM model is a robust representation of the underlying data, providing strong support for the hypothesized relationships.

5.4. Final SEM's Findings

The thirteen hypotheses' examination revealed that nine showed statistical significance, indicating a significant impact on the acceptance of e-jeepney modernization and its service quality approach among Filipinos as shown in Table 7. This discovery highlights the importance of these aspects influencing public perception and utilizing modernized transportation systems. Furthermore, the positive correlation between the significant hypotheses and the variables emphasizes the constructive relationship between various elements of e-jeepney modernization and service quality perceived by Filipino commuters. Hypotheses H10, H11, H12, and H13 are invalidated, suggesting that they did not produce significant results in the study. This result provides valuable insights into the factors influencing acceptance. It emphasizes the necessity for further research to delve into the intricacies of public attitudes towards e-jeepney modernization in the Philippines.

Table 7. Testing of hypotheses.

No.	Relationship	Beta Coefficient	*p*-Value	Result	Significance	Hypothesis
1	Perceived Authority Support → Perceived Environmental Concern	0.340	<0.001	Positive	Significant	Accept
2	Perceived Authority Support → Attitude	0.311	<0.001	Positive	Significant	Accept
3	Perceived Authority Support → Subjective Norm	0.539	<0.001	Positive	Significant	Accept
4	Perceived Authority Support → Perceived Behavioral Control	0.366	<0.001	Positive	Significant	Accept
5	Perceived Environmental Concern → Attitude	0.707	<0.001	Positive	Significant	Accept
6	Perceived Environmental Concern → Subjective Norm	0.207	0.002	Positive	Significant	Accept
7	Perceived Environmental Concern → Perceived Behavioral Control	0.462	<0.001	Positive	Significant	Accept
8	Attitude → Behavioral Intention	0.495	<0.001	Positive	Significant	Accept
9	Subjective Norm → Behavioral Intention	0.365	0.002	Positive	Significant	Accept
10	Perceived Behavioral Control → Behavioral Intention	0.136	0.160	Positive	Not Significant	Reject
11	Affordability → Behavioral Intention	0.155	0.216	Positive	Not Significant	Reject
12	Perceived Safety → Behavioral Intention	0.080	0.597	Positive	Not Significant	Reject
13	Infrastructure → Behavioral Intention	0.136	0.285	Positive	Not Significant	Reject

The SEM model in this study examines the relationships between perceived environmental concern (PEC), attitude (AT), perceived authority support (PAS), subjective norms (SNs), and behavioral intention (BI) towards adopting e-jeepneys. The final SEM analysis shown in Table 7 and Figure 3 revealed the following vital relationships. (1) PAS to PEC (b = 0.340, *p* < 0.001) indicates a positive relationship. This implies that perceived authority figures, such as policymakers and government authorities, lend credibility to information about environmental issues. Their influence can educate the public, shape social norms, and legitimize the importance of environmental concerns, ultimately fostering greater environmental awareness. This could encourage the public to be more mindful of environmental problems and embrace this effort by cutting emissions and adopting sustainable

transport alternatives, such as e-jeepneys. (2) PAS also positively impacts attitude (AT) (β = 0.311, $p < 0.001$) and subjective norms (SNs) (β = 0.539, $p < 0.001$); as a result, we accept H2 and H3. This implies that authority support has heavily affected Filipinos' attitudes and subjective norms regarding the use of e-jeepneys. Different programs and policies must be implemented to increase the interest and willingness of Filipino commuters to use alternative modes of transportation that are sustainable and eco-friendly for the environment. The adoption and demand for e-jeepneys among public preferences of commuters, drivers, and operators are impacted and encouraged by government authorities' initiatives and influence to promote their use as a form of transportation. (3) Perceived environmental concern (PEC) has a positive influence on attitude (AT) (β = 0.707 and $p < 0.001$). Yichen et al. [99] emphasize the importance of promoting responsible environmental behavior (REB) to mitigate threats to the marine environment from human activities. Their study suggests that perceived behavioral control is critical in influencing attitudes towards responsible marine environmental behavior (M-REB), offering valuable insights for policymakers and educators. Their study supports the hypothesis that perceived environmental control is relevant to attitude. (4) PEC was also observed to significantly influence subjective norms (β = 0.207, $p = 0.002$). This suggests that Filipinos' level of environmental awareness will drive them to engage in pro-environmental behaviors. Influence occurs through internalizing societal norms, shaping social interactions and communication, and influencing perceived social pressure. Individuals with higher levels of perceived environmental concern tend to adhere to subjective norms promoting environmentally responsible actions [99]. (5) Perceived environmental concern (PEC) positively influences perceived behavioral control (β = 0.462, $p < 0.001$). The results imply that environmental concern significantly affects behavioral control by enhancing motivation, providing access to resources and information, fostering social support and influence, expanding the availability of sustainable alternatives, and reinforcing personal values related to environmental responsibility. Additionally, a study by Agaton et al. [17] suggests that Filipinos perceive e-jeepneys as environmentally friendly, cost-effective, and convenient alternatives to traditional jeepneys. (6) Attitude (AT) also showed a direct significant effect on behavioral intention (BI) (β = 0.495, $p = <0.001$). The results show that Filipinos' attitudes significantly correlate to people's potency in performing behavior directed towards utilizing e-jeepneys. This is parallel to the research of Devika et al. [100], which examined the psychological factors affecting passengers' modes of transportation. The results showed that among all the factors, attitude was the most significant factor influencing the passengers' intention to utilize public transportation. (7) Subjective norms (SNs) appear to have a notable effect on behavioral intention (BI). The results showed that subjective norms significantly affect the purpose of purchasing, increasing considerations of the country's society.

The model fit indices indicate a good fit: SRMR = 0.062, NFI = 0.921, and Chi-square/df = 4.03. These values suggest that the model adequately represents the observed data and the hypothesized relationships. The results indicate that environmental concern is critical in shaping positive attitudes towards e-jeepneys, which drives the intention to adopt them. This underscores the importance of environmental education and awareness campaigns. Additionally, perceived support from authorities enhances societal norms, suggesting that government endorsements and policies can significantly influence public acceptance of e-jeepneys.

In conclusion, this study highlights the crucial role of environmental concern and authoritative support in shaping attitudes and societal norms towards adopting e-jeepneys. By focusing on these factors, policymakers and environmental advocates can effectively promote the transition to more sustainable public transportation. Future research should explore additional factors that may influence the adoption of e-jeepneys and assess the long-term impacts of these interventions.
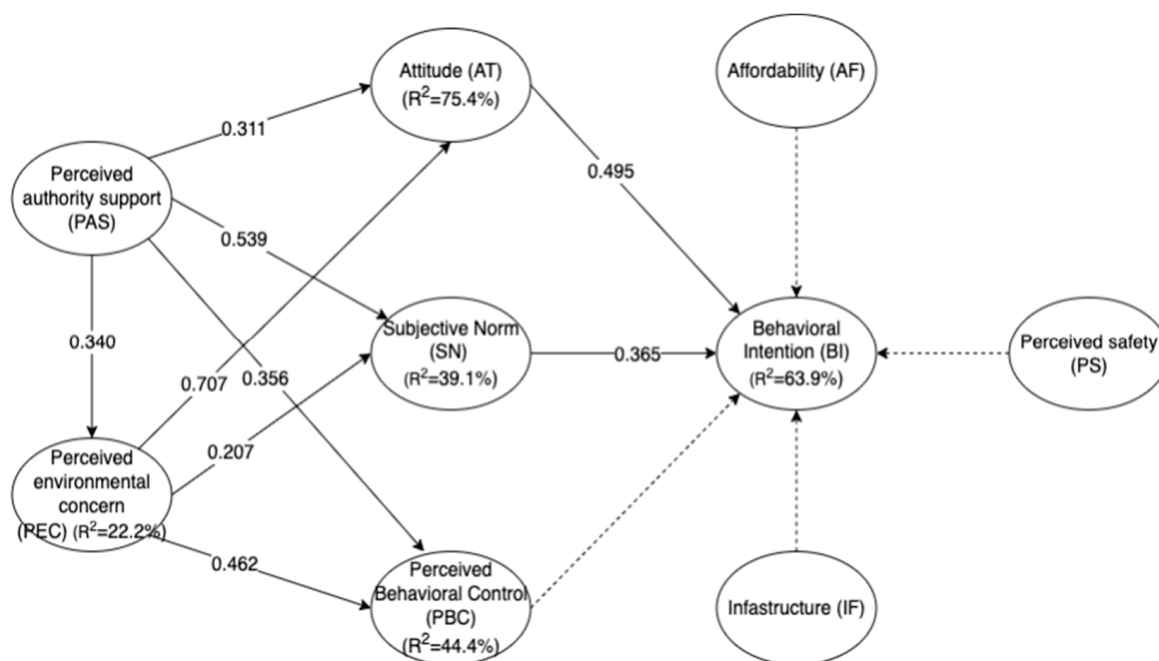
Figure 3. Final SEM model.

6. Discussion

Introducing e-jeepneys represented a shift to modernize the Philippines' public transportation infrastructure. To address concerns regarding jeepneys' impact on the environment, energy use, society, the economy, and policy, it is necessary to consider their acceptability in the Philippines. This study aimed to identify the critical components influencing Filipino commuters' acceptance of e-jeepneys, employing Partial Least Squares Structural Equation Modelling (PLS-SEM). With the help of the extended PEPB framework, nine latent factors were considered, namely perceived authority support (PAS), perceived environmental concern (PEC), attitude (AT), subjective norms (SNs), perceived behavioral control (PBC), behavioral intention (BI), infrastructure (IF), perceived safety (PS), and affordability (AF).

As seen in the results, perceived authority support (PAS) positively affects perceived environmental concern. This result is supported by several sustainability-related studies that proved the effect of perceived authority support (PAS) on perceived environmental concern (PEC) in transportation and other green mode acceptance. Ong et al. [75] examined the effects of governmental endorsements and policies on public opinion on hybrid car use in the Philippines. The study results showed that higher government support and clear policies focusing on the development of EV adoption were positively related to increased public attention and concern about the environment related to the transport sector. Also, research by Song et al. [101] investigated the effect of local government leadership and regulatory provisions on the public's perception of electric buses in Chinese cities. The researchers observed that relaying government policies and bus deployment support enhanced environmental concerns and awareness among residents. This suggests the benefit of advocating for policies and initiatives that support adopting and promoting e-jeepneys as environmentally friendly transportation options.

PAS also positively impacts attitudes and subjective norms. Several sustainability-related research studies that demonstrate the impact of perceived authority support (PAS) on attitude (AT) and subjective norm (SNs) in transportation support this conclusion. Even if the market for electric vehicles (EVs) is receiving more attention, EV penetration is still low globally. That is why the research by Srivastava et al. [102] observed the adoption of battery-powered vehicles from the perspective of subsidy and taxation policies to create a sustainable and viable ecosystem of electric vehicles. In a similar study by Li et al. [103], the

study's results investigate and examine the efficacy of several policies and initiatives that have contributed to the EV sector's explosive growth in China, the country with, by far, the largest EV market globally. The researchers concluded that when government authorities implement policies that support electric vehicles, there is an increase in demand for EVs. Enacting the same policies and initiatives can increase the demand for e-jeepneys.

Furthermore, perceived authority support significantly impacted perceived behavioral concern (PBC). When trusted authorities endorse behaviors or express concern about an issue, it validates individuals' concerns, reinforcing the importance of addressing the problem and potentially resulting in increased awareness and behavioral change. In the research conducted by Gumasing et al. [82], the investigation focused on understanding the components influencing Filipinos' acceptance of clean energy applications, utilizing the Pro-Environmental Planned Behavior (PEPB) model as a framework. Their findings revealed that increased authority support positively impacted perceived behavioral concerns among Filipinos regarding renewable energies. This implies that when there is more significant support from authoritative figures or institutions, individuals are more likely to see environmental issues as substantial and feel compelled to act.

Furthermore, by encouraging preferences for sustainable products, cultivating brand devotion and trust, boosting eagerness to pay higher prices, and endorsing environmental initiatives, it is inferred from the data that buyers who prioritize environmental sustainability will become more prepared to hold favorable perceptions of environmentally friendly brands and products, consequently stimulating market demand. This is supported by the finding that perceived environmental concern (PEC) positively influences attitude (AT).

PEC was also observed to influence subjective norms significantly. This finding is evidenced by related studies that confirmed the significant influence of perceived environmental concern (PEC) on subjective norms. One research study by Buhmann et al. [104] examined the factors influencing consumers' intention to use battery-powered vehicles (BEVs). The study showed an indirect positive effect of environmental concern on consumers' subjective norms on fully adopting BEVs. German et al. [73] also identified the factors influencing consumers' intention to select a delivery carrier in the Philippines during the COVID-19 pandemic. The study determined the positive effect of perceived environmental concern on the subjective norms of Filipino consumers. These results suggest that consumers are concerned with pro-environmental matters, obliging them to uphold pro-environmental behaviors.

A significant direct correlation was also observed, that perceived environmental concern (PEC) positively influences perceived behavioral control. There are related studies supporting the credibility of the gathered findings. A survey aligned with the findings conducted by Wang et al. [105] examined the factors influencing the willingness of Chinese millennials to purchase green cars. The study provided similar conclusions, stating that consumers' perceived environmental concern significantly positively affects their perceived behavioral control. Another study by Zhou et al. [106] examined the determinants influencing Chinese taxi drivers to adopt battery-powered vehicles for their daily livelihood. The study's results showed that environmental concerns positively affected the willingness of taxi drivers to purchase electric cars. The results imply that people's ecological concern affects their behavioral control, concluding with positive pro-environmental behavior. Therefore, it is advised that extensive public awareness efforts be launched to inform Filipino commuters about electric vehicles' financial and environmental advantages and promote their adoption by providing incentives like tax breaks or subsidies.

Attitude (AT) also significantly affected behavioral intention (BI). The study's findings confirmed the considerable influence of attitude (AT) on one's behavioral intention (BI). The researchers observed that passengers' strength of intention to use public transportation is driven by their satisfaction. This suggests supporting transportation services and initiatives that provide satisfaction and a good impression to support acceptance of e-jeepneys and the intention to utilize e-jeepneys.

Subjective norms (SNs) have a notable effect on behavioral intention (BI). The results showed that subjective norms significantly affect the purpose of purchasing, considering the benefit to the country's society. Jayasingh et al. [107] studied the factors influencing buyers' intentions to adopt electric bikes. The results revealed that social influence significantly affects consumers' intention to purchase electric bike vehicles, providing helpful information for administrations and two-wheeler companies to better understand consumer behavior towards purchasing electric two-wheeler vehicles. This suggests that administrations should improve the publicity of EVs, thus supporting the promotion of the sustainable growth of EVs.

Meanwhile, perceived behavioral control (PBC) shows an indirect effect on behavioral intention (BI) ($\beta = 0.136$, $p = 0.160$), rejecting H10. The result implies that the perceptions of Filipino commuters' inclinations do not significantly affect their behavioral intention while utilizing e-jeepneys as a form of transportation. The insignificant relationship between the variables addresses the circumstances in which people might not have complete control over their behavior or interests [50]. The demand for and adoption of e-jeepneys are dependent on citizens' perceptions. According to the study by Thompson et al. [52], prior experience, modelling, anticipated assistance, and possible challenges can all affect commuters' perceptions of using e-jeepneys as a form of transportation. The researchers concluded that commuters' perceived behavioral control (PBC) is greatly supported by their confidence in their ability to make decisions, their positive outlook on the future use of e-jeepneys, and environmental limitations.

In examining the acceptance of e-jeepneys, it is essential to critically analyze our findings, particularly the significant influence of affordability, perceived safety, and infrastructure on e-jeepney acceptance compared to the existing literature.

Contrary to our expectations, our study did not find a significant influence of affordability on the acceptance of e-jeepneys. This contrasts with several previous studies that have identified affordability as a critical factor influencing the adoption of electric vehicles (EVs). For example, research by Egbue & Long [108] and Tarei et al. [109] found that the high upfront cost of EVs compared to conventional vehicles was a significant barrier to their adoption. The lack of influence of affordability in our study may be attributed to several factors. Firstly, government subsidies and incentives aimed at promoting e-jeepney adoption have mitigated cost concerns among respondents, thus diminishing the perceived barrier of affordability. Additionally, the relatively lower operating costs of e-jeepneys compared to traditional vehicles could have influenced respondents' perceptions, leading to the insignificance of affordability as a determining factor.

Affordability is an important issue influencing people's decisions to use alternative transportation. The support for subsidies and support of this alternative mode of transportation may account for the insignificant connection between the factors. Some transport groups looked to raise fares to offset the rising cost of fuels, particularly diesel, for their vehicles. Studies show that if consumers think e-jeepneys are more cost-effective and affordable than other forms of public transportation, they are more inclined to consider adopting them [110,111]. Thus, it is recommended that the government provide substantial investments, subsidies, and support for electric vehicles (EVs) to overcome this obstacle and encourage Filipino commuters to use e-jeepneys as a mode of transportation.

Similarly, our study did not find a significant influence of perceived safety on e-jeepney acceptance, despite safety being a commonly cited concern in EV adoption literature. Previous research by Gong et al. [112] and Li et al. [113] highlighted safety concerns related to battery technology, vehicle stability, and crashworthiness as deterrents to EV adoption. However, our study's finding of the insignificance of perceived safety suggests that respondents may perceive e-jeepneys as sufficiently safe or that safety considerations are overshadowed by other factors such as environmental benefits or cost savings. It is also possible that the sample population in our study, primarily urban adults, may have different safety perceptions compared to other demographic groups or regions, influencing the overall results.

Furthermore, our study did not find infrastructure availability to be a significant factor in e-jeepney acceptance, contrary to previous research that emphasized the importance of charging infrastructure and range anxiety in EV adoption. Studies by Kumar et al. [114] and Engel et al. [115] have identified limited charging infrastructure as a significant barrier to EV adoption, particularly in regions with inadequate infrastructure development. However, in our study, the lack of influence of infrastructure may indicate that respondents perceive existing infrastructure to be adequate for e-jeepney operation or that factors such as the convenience and accessibility of charging stations are less critical in urban settings, where e-jeepneys predominantly operate.

Overall, the lack of significant influences of affordability, perceived safety, and infrastructure in e-jeepney acceptance highlights the complexity of EV adoption dynamics and the need for context-specific analysis. While our findings may diverge from the existing literature, they provide valuable insights into the unique considerations shaping e-jeepney acceptance in the Philippines. Addressing these nuances is crucial for policymakers and stakeholders in devising effective strategies to promote e-jeepney adoption and accelerate the transition to a sustainable transportation system.

7. Conclusions

The present study adheres to rigorous methodological standards to ensure the validity and replicability of the findings. A large-scale survey methodology was employed, with responses gathered from 502 commuters across different demographic groups in the Philippines. The use of standardized survey instruments and statistical analyses enhances the reliability of the results and facilitates their comparability with future studies. Furthermore, detailed documentation of the research methodology, including the survey questionnaires and data analysis procedures, was provided to enable other researchers to replicate the present study and validate its findings.

The insights generated from this research have significant implications for policymakers, urban planners, and transportation stakeholders in the Philippines. By identifying the critical determinants of e-jeepney adoption, the study's findings can inform the development of targeted interventions and policy measures to promote the widespread adoption of sustainable transportation solutions. Moreover, the study underscores the importance of public awareness campaigns and stakeholder engagement initiatives to facilitate the transition towards e-jeepney-based transport systems. Through these efforts, the study aims to contribute to the realization of a more sustainable and environmentally friendly transportation landscape in the Philippines.

7.1. Practical and Managerial Implication

Given the sustainability benefits of e-jeepneys, commuters may want to use the vehicles for transportation. The constructs also showed a travel intention regarding e-jeepneys, showing a future intention to use them. Further, the findings demonstrated how authority support, attitude, and safety, environmental, and economic concerns have influenced the decisions of the present generation to use e-jeepneys. Developers and manufacturers of e-jeepneys should also consider sustainability when advertising their products. Standard advertisements should highlight and focus on safety, the consumption of electricity, and the technical components and features of the e-jeepney. With the evident establishment and development of vehicles at present, the utilization of fuel depicted in advertisements must be decreased when it comes to car technology's noticeable effects and advancement, and advertisements should focus more on electric consumption. Therefore, the sustainability aspects of the economic and environmental benefits must be utilized. Given how cars are developing and advancing technologically, ads highlighting fuel usage should be lessened; instead, they should emphasize the use of electric cars. Employing and utilizing the components of sustainable economic and environmental benefits is essential.

The government should prioritize Filipino commuters' willingness, attitude, and support in embracing e-jeepneys as an option for transportation. Because this study

examined the beneficial effects of aid from the government on Filipino citizens' desires and attitudes to utilize transportation, the study's key findings and results may be used by the authorities as the primary grounds for current initiatives and strategies in the jeepney field. To accomplish the desired level of sustainability, the authorities must consider the possible effects and impacts of higher fares on its citizens due to the purchase and acquisition of new e-jeepney models that require a significant amount of the government's budget.

E-jeepneys are one of the rising forms of transportation in the Philippines. Thus, manufacturers and developers need to continue improving their quality and services. Understanding these circumstances could help guide transportation groups and the transportation system in providing a safe and comfortable journey for the Filipino people. It is recommended that the government, operators, and manufacturers further enhance safety measures inside and outside the e-jeepneys to increase the satisfaction and safety of the Filipino people with the service these automobiles provide. Their service incorporates routine supervision of e-jeepney units to prevent issues such as mechanical concerns that could cause accidents and mishaps. Furthermore, a higher degree of security and customer fulfilment throughout the entire service would result from guaranteeing passenger safety throughout loading and unloading stops. The country should consider the community, the government, utilities, and the infrastructure of the e-jeepneys for the Philippines to adjust to this condition. The government should support and promote effective and functioning transportation and resources as developing nations showcase their plans. In the end, this would help the country's overall sustainability.

7.2. Theoretical Implication

Using the PEPB model, the study showcased a thorough structure for assessing the behavioral intentions of Filipino commuters regarding the use of e-jeepneys as a mode of transportation. Compared to previous studies, a significant difference this study delivers is a broader investigation of various factors relating to the acceptance of e-jeepneys. In a manner identical to the prior studies' results, the factors examined in this study show influential correlations, with the exclusion of correlations of perceived behavioral control, affordability, safety, and infrastructure to behavioral intention. These results presented a relevant and reliable outcome, adding insights to our understanding of the relationships between public awareness, government initiatives, knowledge of environmental issues, and concerns about commuters' behavior towards adopting e-jeepneys as a modern approach to the transportation system. Furthermore, the study's developed framework may be a basis for future researchers wishing to explore different sections or areas of the transport system, regardless of the industry and process.

7.3. Limitations and Future Research

The study was administered with a limited scope, potentially overlooking various factors influencing commuter acceptance that needed to be accounted for by the researchers, indicating a need for further investigation into the broader aspects of commuter preferences. Additionally, the study took place amidst controversy surrounding e-jeepneys, which could have influenced respondents' perceptions of the vehicles. We acknowledge the importance of conducting research in contexts free from external biases for its validity. Lastly, convenience sampling was utilized in the study, which allowed a larger pool of respondents; however, this method may have resulted in a lack of diversity in participant demographics and experiences, suggesting a need for more diverse sampling techniques to capture a broader range of perspectives. Hence, future researchers must consider obtaining samples from more varied geographic environments and regions to further accurately articulate Filipinos' acceptance of e-jeepneys and their service quality approach. Additionally, it is recommended that future research analyze the gender-specific needs and challenges associated with e-jeepney use to ensure that this mode of transport is equitable and accessible to all users. Since this study relies on a sample of commuters who voluntarily answered the survey questionnaire, this self-selection bias may affect the

sample's representativeness and, consequently, the generalizability of the results. Therefore, future researchers should consider whether e-jeepneys provide a gender-equitable mode of transport. Future research should examine gender-specific needs and challenges like safety, accessibility, affordability, and convenience. Understanding these factors can help us design transport systems that cater to the needs of all users, thereby promoting inclusivity and equity.

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