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Willingness to Pay for the Public Electric Bus in Nepal: A Contingent Valuation Method Approach

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Abstract: The rapid increase in conventional diesel and gasoline vehicles in developing countries draws attention to clean energy vehicles, including electric buses. From socioeconomic and environmental perspectives, the benefits of electric buses are well described; however, there is a lack of studies to analyze the willingness to pay (WTP). This study aims to estimate 500 residents' WTP in Pokhara Metropolitan City in Nepal, based on a contingent valuation method (CVM). The survey results show that 78% of respondents are willing to pay a special monthly tax for introducing electric buses in the city primarily due to the fact that electric buses are likely to be helpful to the environment (82.3%). Using the logistic regression analysis, it is estimated that the mean WTP is 758.6 NPR per person, with the most influencing factors of 'willingness to ride electric buses for free' and 'the average usage of the main transportation per week'. The variables that show a positive relationship with the WTP are 'the average usage of the main transportation per week', 'willingness to ride electric buses for free', and 'age'. The variable that negatively correlates with the WTP is 'age'. The study's findings provide references for developing funding options and budgeting plans for local policymakers.

Keywords: willingness to pay; contingent valuation method; electric bus; clean energy vehicle; climate change



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1. Introduction

Nepal has emerged with the problem of habitual designation and environmental pollution due to the rapid population increase over the past five years. Reducing greenhouse gases by improving the transportation environment is one of Nepal's top priorities [1,2]. The country established related plans, such as sustainable transportation strategies, electric vehicle plans, and sustainable development goals [3–5].

Nepal is geographically located in South Asia and borders northern India and southwestern China. The total land area is 147,181 km², and the northern mountainous area has eight mountain peaks with a height of more than 8000 m, including Mount Everest (8848 m). The population is about 29.13 million, and more than 160,000 people migrate to cities every year [6]. The country is the least developed country, with 33.43 billion USD of GDP (GDP per capita is 1147.5 USD), and the average monthly income ranges from the lowest income of 20,400 NPR (approx. 168.5 USD) to 360,000 NPR (approx. 2973.2 USD) [6].

More than 90% of passengers and goods are carried by road transport in Nepal [7]. Nepal has shown a rapid growth in registered vehicles, and this trend will continue because of rapid urbanization, improved roads, and a rise in income [2]. Especially from 1980 to 2018, the annual growth rate of two-wheeler vehicles (17%) is higher than that of the vehicle as a whole (14%). In Nepal's second Nationally Determined Contribution [3], it is stated that electric vehicles account for approximately 1% currently, and one of the mitigation targets is increasing the sales of electric vehicles by 25% of all private passenger vehicle sales in 2025 and by 90% in 2030. A large number of vehicles with conventional fuels have been a culprit in emitting greenhouse gas and particulate matter in Nepal, and with traffic congestion, the pollution has worsened [8].

To tackle the issues caused by conventional diesel- and gas-fueled vehicles, introducing clean energy vehicles, including electric vehicles, has been raised as a solution [9,10]. Previous studies were conducted to evaluate electric vehicles' benefits and challenges. For example, health, environmental, economic, and societal benefits [11–13], greenhouse gas emissions [14–16], and technical challenges [17,18] of electric vehicles were investigated. Additionally, challenges of electric vehicles in the Nepalese market were studied, including high cost, policy and finance, power availability, and charging stations [19]. Examples of the challenges for a middle-income family were unaffordable prices and maintenance costs to own electric vehicles, high tariffs on electric vehicle charging and unstable electrical power at charging stations.

Some papers focused on analyzing electric buses since public transportation can bring greater impacts by reducing the number of cars on the roads. According to Grijalva and Martínez (2019), “a standard full urban bus could remove more than 40 cars from the city”, which results in less traffic congestion and lower emissions [20]. Lajunen and Lipman (2016) assessed the lifecycle costs (purchase, operation, maintenance, and carbon emission costs) of various types of city buses, deriving that the carbon dioxide emissions of electric buses can be reduced by up to 75% [21]. Zhou et al. (2016) show that electric buses can be a suitable alternative to downtown Megacity by showing higher fuel-saving potential than diesel buses under challenging conditions such as traffic congestion, AC operation, and overall passenger load [22].

Direct benefits from replacing diesel or CNG buses with electric buses may include reduced vehicle operating costs and increased ‘comfort of use’ due to reduced noise and fuel odor in the vehicle [23–25]. The fuel cost, reduced by using electricity instead of conventional fuel, can be directly calculated [8,26]; however, it is difficult to measure the value of an increase in ‘comfort of use’, which depends on the subjective satisfaction of each individual.

As shown in Table 1, indirect benefits arising from the introduction of electric buses include ‘environmental cost reduction’ benefits, ‘economic effects on related industries’, and ‘urban quality enhancement effects’ [27–29].

Table 1. Direct and indirect benefits of electric bus.

Direct Benefit	Indirect Benefit
Reduced fuel cost The comfort of use (less noise and vibration, cleanness, spaciousness) ¹	Environmental cost reduction benefit (air pollutant and noise ¹ reduction) Economic effects of related industries ¹ Urban quality enhancement effects

¹ Difficult to quantify.

In the case of ‘environmental cost reduction’, the reduction cost of air pollutants by exhaust fumes—such as carbon monoxide (CO), hydrocarbon (HC), dust (PM), nitrogen oxide (NO_x), and carbon dioxide (CO₂)—can be directly calculated [30]. Still, significant ‘noise reduction’ is difficult to quantify as well as ‘economic effect on related industries’ and ‘urban quality enhancement effects’.

Recognizing the importance of examining direct and indirect benefits to investigate the effects of introducing electric buses [31,32], this study aims to analyze non-market values of the benefits that are difficult to quantify related to electric buses by estimating the residents’ willingness to pay (WTP) in Pokhara Metropolitan City in Nepal. Pokhara City is one of the most popular tourist cities, located 200 km west of the capital city. The population of the city in 2021 was 518,452, and about one million tourists visit the city annually [33]. Residents in the city were asked about their willingness to pay for electric buses based on contingent valuation measurement (CVM), which is a method of measuring the value of non-market goods by establishing a hypothetical situation as if there is an actual market and examining the amount consumers are willing to pay for it [34,35]. The estimation of non-market goods by contingent valuation surveys has been a great support

for policymakers [36]. The CVM is widely used to measure the value of environmental goods and non-market goods because it has the advantage that it can measure not only use-value, but also non-use value [37,38].

The secondary purpose of the study was to help decision-makers better understand the influencing factors of the WTP, which can be considered in developing funding programs and budgeting plans for introducing electric buses in the city.

2. Literature Review

Previous studies on the WTP for clean-energy vehicles and further on new technology vehicles, automated vehicles, have identified influential factors as listed in Table 2.

Table 2. Influential factors on willingness to pay for clean energy vehicles and automated vehicles in previous studies.

Source	Technology/ Study Country	Respondents (n)/ Willing to Pay (%)	Influential Factors *
O’Garra et al. (2007) [39]	Hydrogen bus/Germany	344/80.5	Age (−), Income (+), Frequency of bus use (−), Gender ¹ (−)
	England	282/89.4	Age (−), Income (+), Frequency of bus use (−), Attitude toward solving environmental problems (+)
	Luxembourg	300/72.7	Age (−)
	Australia	146/82.9	Education (+), Attitude toward solving environmental problems (+)
Hackbarth and Madlener (2015) [40]	Alternative fuel bus/Germany	711/-	Age (−), Environmental awareness (+), Education (−), Daily mileage (+), Technical interest (+)
Bansal et al. (2016) [41]	Automated vehicle/United States	347/20	Income (+), Urban residency (+), Technology–savvy male (+), Experience in crashes (+)
Lin and Tan (2017) [42]	New energy bus/China	950/78.9	Age (−), Income (+), Attitude toward air quality improvement (+)
Kim et al. (2018) [31]	Electric bus/Korea	560/56.2	No significant factor was found.
Ramos-Real et al. (2018) [43]	Electric vehicle/Spain	250/63.2	Age (+), Income (+), Education (+), Gender ¹ (−), Average distance traveled per week (+), Level of use of information and communication technologies (+), Level of environmental awareness (+)
Nazari et al. (2019) [44]	Electric vehicle/United States	1249/-	Education (+), Driving frequency (−), Carsharing frequency (−), Ridesharing frequency (+), Residential energy (+),
Cunningham et al. (2019) [45]	Automated vehicle/Australia and New Zealand	6133/-	Age (−), Gender (−)
Chee et al. (2020) [46]	Automated vehicle/Sweden	584/66	Income (+), Riding experience (+)
Carteni (2020) [47]	Automated vehicle/Italy	3140/	Gender (+), Experience (+)
Yan and Zhao (2022) [48]	Heavy-duty hydrogen fuel cell truck/China	396/13.9	Income (−), Education (+), Environmental awareness (+)
Weigl et al. (2022) [49]	Automated vehicle/Germany	725/59–67	Age (−)

¹ 1 = male/0 = female; * Significant level at 0.1.

O'Garra et al. (2007) compared the WTP for hydrogen fuel cell buses in Berlin in Germany, London in England, Luxembourg in Luxembourg, and Perth in Australia. According to this study, the influential factors were age, income, education, frequency of bus use, attitude toward solving environmental problems, and gender [39]. Hackbarth and Madlener (2015) examined the consumer preference for alternative fuel vehicles in Germany and found age, environmental awareness, education, daily mileage, and technical interest to be the influential factors [40].

Lin and Tan (2017) studied the WTP for new energy buses in four cities in China where age, income, and attitude towards air-quality improvement were the influential factors [42]. Kim et al. (2018) estimated the WTP for medium-sized low-floor electric buses, and there were no statistically influential factors. However, gender, age, transportation vulnerability, and income were factors to be reflected in the WTP [31].

Ramos-Real et al. (2018) analyzed the WTP for an electric vehicle in Tenerife, Spain, and age, income, education, gender, the average distance traveled per week, level of use of information and communication technologies, and level of environmental awareness were the influential factors for their willingness [43].

Nazari et al. (2019) used the 2016 California Vehicle Survey results in the United States to identify influential factors in battery electric-vehicle adoption. They found that the WTP was positively related to education, ridesharing frequency, and residential energy status but negatively related to driving frequency and carsharing frequency [44]. Yan and Zhao (2022) studied the WTP of hydrogen fuel cell heavy-duty vehicles in China, and the most influential variables were income, education, and environmental awareness [48].

Similar factors were examined for disruptive technology in automated vehicles, where gender, age, residency, knowledge of self-driving vehicles, and previous experience influenced the WTP [41,45–47,49].

In a broader scope, Herbes et al. (2015), and Streimikiene et al. (2019) reviewed existing literature on WTP in the energy sector and listed socio-demographic factors, such as age, gender, income, and education, as well as psychographic variables, such as environmental awareness and information on renewables, were influential factors to the WTP of respondents [50,51].

As for this study, the repetitive significant variables from previous studies were adopted, such as gender, age, education, income, average usage of transportation per week, and boarding experience. A variable, 'willingness to ride electric buses for free,' was included as a new variable to study if people who are not willing to pay a special monthly tax for introducing electric buses are willing to ride electric buses if the service is provided for free.

3. Survey Design and Methods

According to Venkatachalam (2004) [52], the idea of CVM was suggested by Ciriacy-Wantrup (1947) [53]. Since then, there have been a lot of studies using CVM on diverse topics such as green electricity [41,54–56], waste management [57–60], and health risks [61–63]. The question types of CVM are divided into a method of asking for willingness to accept compensation (WTA) from the loss of relevant goods and a method of asking about the amount of WTP to prevent loss. Although this question type is used in the same CVM study, WTA has a relatively higher value than WTP because it is based on opposite behaviors of payment and reward from the respondents' point of view [42,64]. Therefore, in general, the value calculated through WTP is preferred [65,66].

Applying WTP, a survey was developed to ask respondents' opinions on introducing an electric bus service. It was structured as the double-bounded dichotomous choice format, the preferred method by the NOAA panel [65] to minimize the non-response rate and outliers generated by the open-ended format [38,67].

The survey was designed for local residents aged over 20 yrs in Pokhara Metropolitan City. In order to evaluate the difficult-to-quantify, non-market values of electric buses, the relevant benefits—the comfort of use, noise reduction, economic effects of related industries,

and urban quality enhancement effects—were identified through a literature review along with experts' reviews, as mentioned above.

With the provision of information on those benefits, a total of 14 questionnaires was developed and reviewed twice by five experts in the relative fields, including energy policy, economics, environment, and transport. The structured questionnaires included four sections. The first section was designed to fill out respondents' basic information, including residency, sex, age, household, and income. The second section was designed to understand transportation usage, including personal vehicle ownership, main transportation, the purpose of travel, average use per week, the average payment per week, and experience of electric buses. The third section was designed to estimate willingness to pay for electric buses. The fourth section is for statistical analysis of marriage status, occupation, education, and household income.

A face-to-face survey was conducted for a month, from December 2020 to January 2021, targeting 500 residents of Pokhara Metropolitan City. With visual information, a total of 14 questions were asked by trained surveyors. Prior to the survey, a pilot test was conducted, targeting 25 respondents. The main purpose of the pilot study was to ensure the questionnaires were clearly designed and to have the respondents directly answer the open-ended question about the monthly amount of WTP for five years as a special tax for introducing electric buses in the area, so the range of WTP is to be decided. The average WTP was 1472 NPR (approx. 12.13 USD) per month on the pilot test, ranging from 300 to 3000 NPR per month.

The initial suggested willingness to pay in the questionnaire, n , was set as 1500 NPR, the rounded average WTP value from the pilot test. The survey was structured according to the following logic in Figure 1.

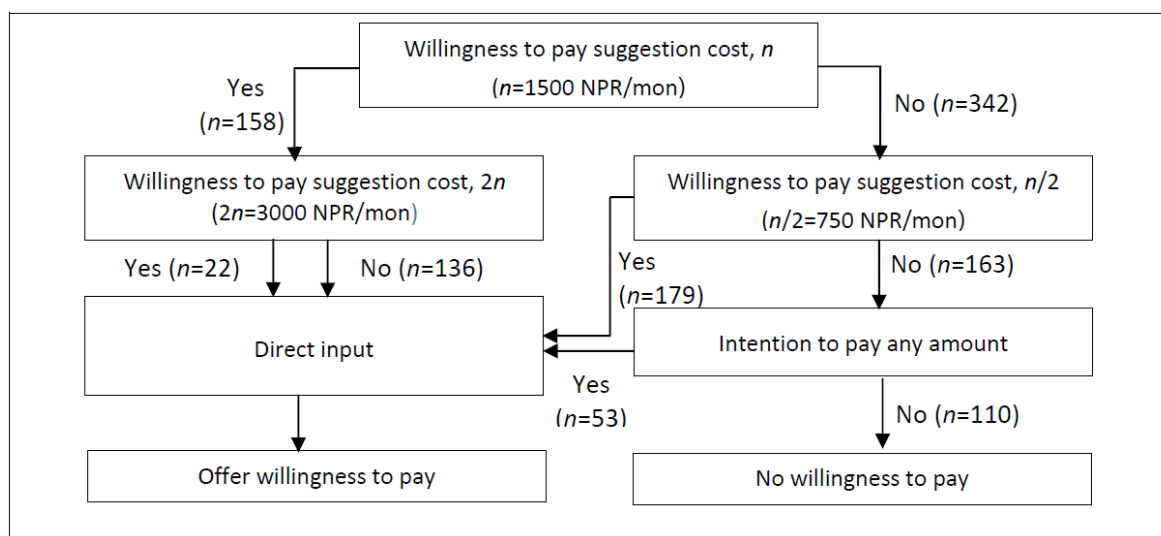


Figure 1. Schemes follow the same formatting.

4. Results and Discussion

4.1. Basic Characteristics

The survey respondents of the pilot test were in their high 20s (44%), and males (84%). Still, the main test was sampled relatively evenly with no significant differences in the ratio of men and women and age groups such as those in their 20 s, 30 s, 40 s, and 50 s as the quota sampling was carried out, as shown in Table 3.

Table 3. Basic characteristics of survey respondents of the pilot and main tests.

Category		Pilot Test (<i>n</i> = 25)		Main Test (<i>n</i> = 500)	
		Number	Percentage (%)	Number	Percentage (%)
Age	The 20 s	11	44	131	26.2
	The 30 s	7	28	143	28.6
	The 40s	4	16	125	25
	≥the 50 s	3	12	101	20.2
Gender	Male	21	84	276	55.2
	Female	4	16	224	44.8
Household	Member	13	52	170	34
	Head	12	48	330	66
Main transportation	Private car			21	4.2
	Motorcycle	19	76	247	49.4
	Bus	6	24	222	44.4
	Taxi			3	0.6
	Foot			5	1
Marriage status	Not married	8	68	12	2.4
	Married Formally/Informally	17	52	455	91
	Separated/Divorced			19	3.8
	Unknown			14	2.8
Work	Student			3	0.6
	White-collar	13	52	314	62.8
	Blue-collar	9	36	127	25.4
	Self-employed	1	4	5	1
	Farmer	1	4	14	2.8
	Housewife			25	5
	Not employed	1	4	12	2.4
Education	Non—Primary	1	4	24	10.4
	Secondary	4	16	187	37.4
	Higher Secondary—Diploma	9	36	206	41.2
	BA—MA	8	32	55	11
	Not answered	3	12		
Monthly income	<30,000	10	40	288	57.6
(NPR)	≥30,000, <50,000	11	44	144	28.8
	≥50,000	4	16	68	13.6

Motorcycles accounted for the highest on the main test at 49.4%, and buses accounted for the second-highest at 44.4% as the main means of transportation. In terms of educa-

tional background, 'Higher secondary' and 'Diploma' showed the highest at 41.2%, and 'Secondary' showed the second highest at 37.4%. Income of less than 30,000 NPR (approx. 247.3 USD) was high at 57.6%, 30,000 to 50,000 NPR was 28.8%, and 50,000 NPR (approx. 412.2 USD) above was found to be 13.6%.

Among 500 respondents, 93.8% of them use 'motorcycle (49.4%)' and 'bus (44.4%)' as their main transportation, while 57.8% of the respondents own 'motorcycle (50%)' or 'car (2.6%)' or 'both (5.2%)'. The most abundant reasons for using the main transportation appeared as 'accessibility to destinations (87.2%)', followed by 'comfort (52.8%)', 'punctuality (easy to plan time) (38.0%)' and 'low cost (28.4%)'. The main purpose for transportation was 'commuting to work (61.8%)', 'shopping (32.2%)', 'socialization (3.8%)', and 'leisure (2.2%)'.

More than half of 500 respondents answered that they use public transportation 'more than 7 times a week (53.0%)' on average. The highest monthly average usage fee (maintenance cost) of the main transportation was 'private car (1776.2 NPR)' and 'taxi (1133.3 NPR)' followed by 'motorcycle (853.1 NPR)' and 'bus (343.2 NPR)'. The respondents who had experience in riding an electric bus were 10.6%, and their experience was 'comfortable riding (47.2%)' and 'eco-friendly (34.0%)'.

As shown in Figure 1 above, 31.6% ($n = 158$) of 500 respondents answered that they are willing to pay 1500 NPR per month, the round value of the average WTP from the pilot test, as a special-purpose tax for introducing electric buses, and 68.4% ($n = 342$) of them answered that they are not.

Among the 158 respondents, who are willing to pay 1500 NPR per month, 13.9% ($n = 22$) of them responded that they are also willing to pay even if the tax is raised to 3000 NPR. Among the 342 respondents who are unwilling to pay 1500 NPR, 52.3% ($n = 179$) of them answered that they are willing to pay if the tax is lowered to 750 NPR. Except for the 110 respondents who have no intention to pay, a total of 189 respondents directly asserted their willingness to pay, which resulted in the average value of willingness to pay of the respondents ($n = 390$) who had intentions to pay to be 1249.1 NPR ranging from 100 to 5000 NPR.

The most abundant reasons for not being willing to pay the tax were: 'not a personal priority (66.4%)', 'electric buses do not seem worth much (14.5%)', and 'my family cannot afford to pay (14.5%)'. However, the reasons for willing to pay the tax were 'electric buses are likely to be helpful to the environment (82.3%)', 'changes expected with the introduction of electric buses are considered to be quite important (45.9%)', and 'changes expected with the introduction of electric buses are attractive (38.7%)'. In the analysis by respondent characteristics, the response of 'electric buses are likely to be helpful to the environment' was the highest at 95.0% of the most educated group.

4.2. Regression Analysis and Willingness to Pay

To analyze the willingness to pay a monthly special-purpose tax to introduce electric buses in the Pokhara Metropolitan City of Nepal, the Binary Logit Model, one of the logistic regression models capable of analyzing 0 and 1 for the responses of 'Yes ($I = 1$)' and 'No ($I = 0$)' for the presented amount (response variable), was used. Fisher's scoring method was applied as a convergence method with a valid sample size of 500.

$$\log \ddot{y}[\pi] = \log\left(\frac{\pi}{1-\pi}\right) = \alpha + \beta_1\chi_1 + \dots + \beta_i\chi_i, \quad n = 1, 2, 3, \dots, i \quad (1)$$

The parameter β_i is the effect of χ_i on log-odds that will be $y = 1$ when other predictor variables are given. According to each predicted value, the final response to the response is predicted through the sign of the above parameter. The hypothesis was set to 'H0: $\beta = 0$ ' versus 'H1: $\beta \neq 0$ ' to test the significance of the effect of χ in the above model. Test statistics for testing this null hypothesis are presented as follows:

$$z = \frac{\bar{\beta}}{\text{ASE}} \quad (2)$$

The test statistic distribution is approximate to the standard normal distribution if $\beta = 0$ for the large sample. If the above test statistic is squared, the Wald statistic can be estimated with a chi-square distribution with a degree of freedom of 1 and a Log-Likelihood Ratio. The likelihood ratio test is presented as $-2 (L0 = L1)$ under the assumption that the maximum likelihood is $L0$ when $H0: \beta = 0$, and the maximum likelihood is $L1$ under the unlimited assumption for β . The chi-square approximation distribution is used with a degree of freedom of 1 of $H0$ if the sample size is large.

The validity of the CVM analysis can be determined by examining whether the coefficients of these variables have expected signs or are statistically significant, influenced by variables that economic theory or other studies and literature suggest that the willingness to pay is important [68].

As a result of analyzing variables in the survey with a scatterplot correlation matrix, a total of three significant variables ($p < 0.1$) appeared as ‘age (p4)’, ‘average usages of the main transportation per week (q5)’, and ‘willingness to ride electric buses for free (q9_7)’. Detailed descriptions of the variables are given in Table 4.

Table 4. The variables and descriptive statistics.

Variable	Description	Mean	Standard Deviation
p3	Gender of the respondent male = 1; female = 2	1.45	0.49
p4	Age of the respondent	38.22	11.63
q5	The average usage of the main transportation per week [1, 3]; [3, 4]; [5, 6]; [7, 8]	5.60	2.30
q7	Boarding experience of electric buses yes = 1; no = 2; uncertain = 3	2.45	0.68
q9_7	Willingness to ride electric buses for free Scale from 1 to 7	5.30	1.58
q13	Educational background of the respondent non = 1; primary = 2; lower secondary = 3; secondary = 4; higher secondary = 5; undergraduate = 6; bachelor = 7; post graduate and above = 8	4.52	1.59
q14	The average monthly gross income of a household in NPR $\leq 10,000 = 1$; [10,000, 20,000] = 2; [20,000, 30,000] = 3; [30,000, 40,000] = 4; [40,000, 50,000] = 5; [50,000, 100,000] = 6; >100,000 = 7	3.48	1.53

The mean value of gender (p3) was 1.45 with a standard deviation of 0.49, with a similar proportion of respondents between women and men. It was also noted that the distribution of age (p4) groups (in their 20 s, 30 s, 40 s, and 50 s and older) was evenly distributed. The respondents’ average usage of the main transportation per week (q5) was 5.6 days, and 55.2% of the respondents said they had no experience using electric buses (q7). The respondents showed a relatively higher willingness to use electric buses for free (q9_7) of 5.3, scaled from 1 to 7. As for the level of education (q13) of respondents, higher secondary (41.2%) was the most common after higher secondary (37.4%). More than half of the respondents (57.6%) were in the low-income group, with less than 30,000 NPR of a household’s average monthly gross income.

The following WTP model was calculated by applying the coefficients for each variable estimated in Table 4. The goodness-of-fit of the multi-logistic regression model follows the Wald Chi-Square value. The Chi-square value of the statistic was 84.3 with a degree of freedom of 7, and the p -value means that the model assumed to be <0.0001 appeared as appropriate, as shown in Table 5.

Table 5. Evaluation of the regression model ($H_0: \beta = 0$).

Test	Chi-Square	Degree of Freedom	Pr > ChiSq
Likelihood Ratio	121.96	7	<0.0001
Wald	84.3	7	<0.0001

The estimated value and the alpha's standard error (ASE) of the models are summarized in Table 6. As a result of estimating the p -value value, the most influencing variables were 'willingness to ride electric buses for free, q9_7 ($\beta_5 = 0.7694$, ASE = 0.0899)', followed by the higher value of 'the average usage of the main transportation per week, q5 ($\beta_3 = 0.1503$, ASE = 0.0583)', the lower value of 'age, p4 ($\beta_2 = -0.0280$, ASE = 0.0120)', and the lower value of 'educational background, q13 ($\beta_6 = -0.1176$, ASE = 0.0868)'.

Table 6. Analysis of maximum likelihood estimates.

Parameter	Estimate Value	Standard Error (ASE)	Wald Chi-Square	Sign	p -Value
Intercept	−2.3883	1.2105	3.8926	−	0.0485
p3	0.3277	0.2804	1.3658	+	0.2425
p4	−0.0280	0.0120	5.4444	−	0.0193
q5	0.1503	0.0583	6.6463	+	0.0099
q7	0.2464	0.1876	1.7251	+	0.1890
q9_7	0.7694	0.0899	73.246	+	<0.0001
q13	−0.1176	0.0868	1.8355	−	0.1754
q14	−0.0924	0.0860	1.1543	−	0.2825
LR Chi-Square	121.96				
LR p -value	<0.0001				
Wald Chi-Square	84.3				
Wald p -value	<0.0001				
Degree of Freedom	7				

As a result of estimating the p -value value with a 5% significance level, the lower the age (p4), the higher the average usage of the main transportation per week (q5), and the willingness to ride electric buses for free (q9_7) appeared as most influencing variables by dismissing $H_0: \beta = 0$.

A positive sign of the estimated value of the maximum likelihood analysis means that a variable has a positive relationship with the willingness to pay. In contrast, a negative sign means a negative relationship with the willingness to pay. The higher values of variables, such as the average usage of the main transportation per week (q5), and willingness to ride electric buses for free (q9_7), showed a positive relationship with the willingness to pay. Conversely, the variable, age (p4), showed a negative relationship with the willingness to pay.

Although the unwilling group showed a lower intention to use the electric bus for free at 20%, the variable, 'willingness to ride electric buses for free', showed a significantly positive relationship with WTP. It can be interpreted that the willingness group has a strong intention to use electric buses, whether provided for free or with a fee. According to the estimation result of the payment intention function, the probability of the WTP can be obtained only by substituting the value of each explanatory variable in the regression equation for a sample size of 500 in the following equation:

$$\log \hat{y}[\pi] = -2.3883 + 0.3277\chi_1 - 0.0280\chi_2 + 0.1503\chi_3 + 0.2464\chi_4 + 0.7694\chi_5 - 0.1176\chi_6 - 0.0924\chi_7 \quad (3)$$

In this case, considering that it is logit, the actual probability of the WTP can be estimated according to the explanatory variable derived by solving the equation about y in the following equation:

$$\log \frac{y}{1-y} = \log \left(\frac{\pi}{1-\pi} \right) \left(\frac{\pi}{1-\pi} \right) = -2.3883 + 0.3277\chi_1 - 0.0280\chi_2 + 0.1503\chi_3 + 0.2464\chi_4 + 0.7694\chi_5 - 0.1176\chi_6 - 0.0924\chi_7 \quad (4)$$

The amount of the WTP was estimated by multiplying each sample by the final available amount to pay, and the average amount of the WTP for the entire sample group was estimated accordingly. As a result, the mean value of monthly WTP was estimated to be 758.6 NPR (approx. 6 USD) per person.

5. Summary and Conclusions

Shifting from conventional diesel- and gasoline-fueled vehicles to electric buses is an attractive solution to reduce carbon emissions and traffic congestion [8–10]. In order to consider funding options and develop budgeting plans for a program, conducting a benefit analysis is necessary [11,13,14,16,31,32]. Non-market values of direct and indirect benefits are difficult to quantify and directly calculate. The CVM has been developed for environmental valuation for the past 30 years and is the most commonly used method in recent value applications. In addition, guidelines have been established in the UK and the United States for policy implications [69–72]. The CVM is widely used to evaluate non-market values of environmental goods and services as well as public opinions by estimating the WTP based on a survey questionnaire [34,35,37,42].

Many studies have shown that person-to-person interview methods increase participation, reduce misunderstanding, and enable immediate response [73]. This paper investigates the WTP of 500 residents in the Pokhara Metropolitan City of Nepal as a part of a benefit analysis and to understand potential users' value behaviors and attitudes. Based on the literature and the experts' reviews, 14 survey questions were developed considering difficult-to-quantify, non-market values, such as the comfort of use, environmental benefits including noise reduction, economic effects of related industries, and urban quality enhancement effects. In this study, the benefits arising from the electric bus were quantified from the residents' perspective by setting the virtual situation of introducing electric buses and explaining to people the various environmental, social, and economic benefits that electric buses could bring, as identified above.

The study found the preference of respondents that about 78% of the respondents are willing to pay for electric buses because 'electric buses are likely to be helpful to the environment (82.3%)'. The other 22% of the respondents do not want to pay because introducing electric buses in the city is 'not a personal priority (66.4%)', and 'electric buses do not seem worth much (14.5%)'.

Among 500 respondents, 4.4% indicate their willingness to pay 3000 NPR per month, 31.6% are willing to pay 1500 NPR per month, and 63% are willing to pay 750 NPR per month. Half of the respondents (50%) have motorcycles, which are the primary transportation for 49.4% of the respondents. The second main transportation is a bus (44.4%), and 95.3% of the respondents who do not have a personal vehicle (42.2%) use it as their main transportation. The reasons for using primary transportation are accessibility (87.2%), comfort (52.8%), and punctuality (38%).

This study presented a comprehensive analysis using the Binary Logit Model to estimate the WTP, and the analysis shows a mean WTP value of 758.6 NPR (approx. 6.12 USD). The results indicate that the mean WTP is between the monthly average usage fees (maintenance cost) of 'motorcycle (85.1 NPR)' and 'bus (343.2 NPR)' among the current main transportation of the respondents, and it is 2.21 times higher than the average monthly fees for using the conventional bus. The results imply that the respondents value the non-market values that the electric buses could provide, as described above.

From the previous studies, it was recognized that the significant factors on the WTP toward clean-energy vehicle use, including hydrogen and electric bus/vehicle, are age

(positive [43] and negative [39,40,42]), income (positive [39,42,43] and negative [48]), attitude/awareness of environmental problems (positive [39,40,42,43]), and travel/riding frequency (positive [40,43] and negative [39,44]). The current study shows that the WTP is greatly influenced by 'willingness to ride electric buses for free (positive)', 'average use of the main transportation per week (positive)' and 'age (negative)'. The respondents, who are younger, travel more and are willing to ride electric buses for free, and tend to pay a higher amount of special monthly tax for electric buses.

It was noted that 'age' showed an inverse relationship with the WTP in other similar studies on clean-energy public transportation [39,40,42]. However, the sign of correlation of 'average use of the main transportation', in other words, frequency, with the WTP differed by studies. It might be due to the different socioeconomic and behavioral characteristics of respondents of the study locations, implying that it is important to study the influencing factors of the WTP for introducing new technologies in the target area.

Policymakers should consider the benefits of technology to make decisions about introducing new technologies. The benefits that should be taken into account are not only economic benefits but also environmental and social benefits. In addition, the direct and indirect benefits that technology will bring must be considered comprehensively. For decision-making by policymakers, it is important to find the preference and intentions of potential users for these benefits. Consequently, understanding the residents' perception and demand behavior is essential to designing environmental and public goods and services [74]. To adopt electric buses in a target region, multiple steps are needed with a long-term plan. According to Li et al. (2019) [28], five steps are necessary at the initial stage of developing a plan: (i) consideration of the existing policies, (ii) analyzing an initial cost-benefit analysis including stakeholders and barriers, (iii) planning pilot project, (iv) updating the initial cost-benefit analysis with collected data, (v) setting targets for a long-term plan.

Through the results of this study, a favorable preference for introducing electric buses was found, and the intention to pay 758.6 NPR as a special purpose tax for the benefits of electric buses was estimated. This finding offers a reference as a cost for indirect benefits at the initial cost-benefit analysis stage of the project planning. Policymakers can also refer to this in setting the national budget for introducing electric buses in the future.

Furthermore, given the in-depth discussion of the influencing factors above, the study provides useful implications to understand the resident's perceptions of adopting electric buses. This could contribute to developing an effective policy with provisions of proper information and campaigns for target groups to enhance their awareness and participation.

For example, in order to replace motorcycles, the primary means of transportation of the largest number of respondents (49.4%), as described above, it is necessary to refer to the route selection so that the 'accessibility to destinations (87.2%)', which was selected as the advantage of the primary means of transportation, can be applied to electric buses. For the smooth introduction of electric buses in this area, efforts should be added to improve awareness of environmental values for people over 50 who are less willing to pay as well as people who do not usually use buses as their primary means of transportation. In addition, as most groups who said they would not use electric buses even if they were provided free of charge take taxis or have low bus usage rates, additional investigations are needed to improve the usage of public transportation.

A limitation of this study is that most respondents (89.4%) did not have actual experience with electric buses. Therefore, the responses rely on hypothetical experiences provided by the image cards and written descriptions during the survey, which can generate uncertainty in the CVM analysis [68]. Moreover, the individual's preference and perspective on a specific technology and environmental values could lead to a bias in response.

Future studies are encouraged with different analysis methods and/or in other locations to validate further and compare with the findings of this study. Additionally, studies for developing a criteria of benefits, including indirect benefits that electric buses can provide, are highly recommended.

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