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Developing a Model to Predict the Gasoline Motorcycle Commuters' Willingness to Buy the Electric Motorcycles

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ABSTRACT: Nowadays, in most of the megalopolises such as Tehran, the lack of Transportation Demand Management (TDM) policies on Gasoline-fueled Motorcycles (GMs), in comparison to policies implemented on private cars such as odd-even scheme, have been considered effective in increasing GM usage and its undesirable consequences such as Air and Noise pollution. To cope with these issues, Electric Motorcycles (EMs) have been widely implemented and used in most developed and developing countries. The goal of this study is to identify effective factors on motorcyclists' willingness to purchase EMs in the case of a GM ban. A paper-based questionnaire has been used for data collection through a face-to-face survey with those motorcyclists whose work-places are located in the Central Business District (CBD) of Tehran which resulted in 503 samples. A binary logit model has been developed to examine the role of motorcycles' characteristics, socioeconomic characteristics, and motorcyclists' attitudes toward GM usage. The results revealed that those motorcyclists who have purchased their GM because of its cheaper price, those who drive their GM longer, and those who have older motorcycles are less willing to purchase EMs.

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INTRODUCTION

Nowadays, the motorcycle due to its unique characteristics such as maneuverability in narrow and congested streets and hence, shorter travel time, is one of the most popular modes of transportation in several developing countries, especially in Asian countries. As these countries are facing serious traffic congestion on one hand, and on the other hand the transportation demand growth is higher than provided facilities, the GMs usage has been tremendously increased [1,2] and this increase has created serious environmental problems such as Air pollution, noise pollution, and traffic accidents. [1,2]. Based on recent studies conducted in Tehran, each GM emits an average of six times more pollution than a standard Euro II vehicle and 45% of the whole noise pollution of the city is produced by GMs [3,4].

One of the solutions, which has been significantly implemented in most of the developed and developing countries, is using Electric Motorcycles (EMs). As these type of motorcycles produce no emission, provide the promising potential to mitigate the severe environmental problems caused by the existing gasoline-fueled motorcycles. [5].

The goal of this paper is to identify the GM users' willingness to buy EMs in the case of the GM ban in the central business district of Tehran.

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DATA COLLECTION

This study was carried out based on 503 interviews with motorcyclists whose work-place are located in the CBD of Tehran.

The data of this paper has been collected in December 2015 and a group of students in Amirkabir University of Technology carried out the interviews with motorcyclists who were commuting to the central part of Tehran based on a random sampling plan [6].

The questionnaire of this study included five parts: trip-related characteristics, motorcycles' characteristics, socioeconomic characteristics, motorcyclists' attitudes toward GM usage, and their response to policies that restrict GM usage in the CBD of Tehran.

Promoting EMs as a studied policy, led to assess the commuters' willingness to pay for EMs in the case of GM ban in the CBD of Tehran. According to the market, the price of these motorcycles is estimated to be 2900$ the half of which is funded by government subsidies.

METHODOLOGY

The binary logit model has been used to identify factors affecting motorcyclists' willingness to purchase EMs. Eq. (1) shows the utility function of the logit model [7].

$$U_n = \beta_n X_n + \varepsilon_n \quad (1)$$

Where U_n is the utility function of using EM, X_n is the vector of related variables, β_n is the vector of coefficients, and ε_n is the unobserved part of utility.

Eq. (2) shows the probability of choosing alternative "*n*" by a binary logit model [7].

$$P_n = \frac{\exp(U_n)}{\exp(U_n) + \exp(U_m)} \quad (2)$$

Where P_n is the probability of choosing EM and U_m is the utility of not choosing EM. The model uses the maximum log-likelihood function to estimate the coefficients of the utility function. The log-likelihood function of the BL model is shown as Eq. (3) [7].

$$LL = \sum_{i=1}^{n} \sum_{n=1}^{c_i} Y_{in} \ln P_i(n) \quad (3)$$

It is worth noting that if the person *i* chooses alternative *n*, Y_{in} will be equal to 1, otherwise it is set to 0. If all of the coefficients be 0, Eq. (3) will be shown by L_0. Furthermore, if all of the coefficients except constant term be 0, the value of Eq. (3) will be shown by L_c and L_β is the likelihood logarithm of the best model.

Validation of a model can be calculated by the Chi-square test according to Eq. (4) [7].

$$-2\left(L_0 - L_\beta\right) > \chi^2_{N.1-\alpha} \quad (4)$$

Where *N* is the number of observations and α is the significance level. During the modeling process, various variables were assessed using a systematic process; the variables without enough statistically significant values were eliminated from the model (remaining variables were significant at 10% level).

To assess the model goodness of fit, Mc Fadden goodness of fit measure has been suggested according to Eq. (5) [7].

$$\rho^2_{Mc.Fadden} = 1 - \frac{L_\beta}{L_c} \quad (5)$$

RESULTS

In this study, the binary logit model has been developed for estimating motorcyclists' willingness to purchase EM using NLOGIT5.0 software. Table 1 shows the result of the model and significant variables.

The percent correct index has been used for model validation. This index expresses the number of correctly predicted cases divided by the number of total cases. In this paper, the percent correct index is derived 65.6% that is acceptable according to previous studies [8].

Table 1. The final model.

Level	Variable name	Description	Coefficient
Trip characteristics	U_Lcost	Using GM because of its low price (1=Yes,0=No)	-0.487
GM characteristics	Engine Size	The engine size of GM (CC)	0.010
	M_Age	GM age (year)	-0.083
	Oil1	Motorcycle's oil changes monthly (1=Yes,0=No)	-0.468
Socio-economic characteristics	Age40_49	Motorcyclist is 40-49 years old (1=Yes,0=No)	0.444
	HHsize7_18	Number of people between 7 and 18 in motorcyclist's household	0.302
Motorcyclists' attitudes	Q63_1_3	Motorcyclist believes "I can better ride my motorcycle than others" (1=Yes,0=No)	-0.389
	Q65_3_3	Motorcyclist believes "Driving motorcycle gives me confidence" (1=Yes,0=No)	-0.397
	Q68_1_3	Motorcyclist believes that" The cost of cordon pricing is high" (1=Yes,0=No)	-0.586
	Q70_1_3	Motorcyclist believes that "Motorcycles are easily recognizable by drives of other vehicles" (1=Yes,0=No)	-0.337
	Q71_3_3	Motorcyclist believes that" Other motorcyclists ride" safe (1=Yes,0=No)	-0.740
L_0 = -348.65	L_β = -318.52		L_c = -347.92
$\rho^2_{Mc.Fadden}$= 0.085	χ^2 = 60.26		N= 503

CONCLUSIONS

The result revealed that those motorcyclists who have a lower level of economic status, are not willing to purchase an EM with the offered subsidiary. According to the results, the authors concluded that economic status is the most influential factor in choosing an EM by motorcyclists.

This model can apply to find a market for EMs. Based on the model results, those who are predicted to buy an EM can be treated as a good target for the EMs market. It should be accentuated that as using EMs seems necessary in polluted cities such as Tehran, those respondents who are not willing to buy an EM, need higher economical support and encouraging schemes to purchase EMs in the case of GM ban. Also, it is necessary to increase the social awareness of people about the negative consequences of GM usage to promote EM usage by them.

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