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The Assessment of the Change in the Share of Public Transportation by Applying Transportation Demand Management Policies

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ABSTRACT: The growing car ownership has caused a lot of problems, such as increased travel time and environmental pollution. In recent years, different policies have been proposed for travel demand management. Among these plans conducted in Tehran, the Odd-Even day plan starting from the door of each house or the extension of the traffic congestion zone to the Odd-Even plan zone can be mentioned. In the present study, to determine the change in the behavior of the people traveling in the Odd-Even plan in Tehran in return for the payment of a various toll and exploring their pro-environmental beliefs and attitudes which supports the Value-Belief-Norm (VBN) theory, a stated preference questionnaire has been designed, and 500 of it were distributed among the individuals in this area and then were collected. The results showed that 51% of people have used their private cars to travel within the area. 24% of people have used semipublic transportation, and 25% of them have used public transportation (bus and subway) for their traveling. Based on the tolling design scenario, which was with an increase of 15 to 18% of the base traffic congestion zone prices of 2016, the relative frequency of using four types of non-public transportation (which is the sum of private vehicles and semipublic transportation) decreased 20 and 21% for different types of tolls throughout the day.

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1- Introduction

In recent decades, all countries around the world have been experiencing a rapidly increasing problem of traffic congestion, particularly in the form of its associated environmental knock-on effects, urban livability problems, and caused economic loss.

Generally, low traveling costs can partly explain the high car use [Lindsey, 2003; Cipriani et al. 2018]. Car users, for instance, only pay for the direct costs of their travel (e.g., purchase of the car, fuel, insurance), but do not pay the costs they cause to third parties. These indirect costs, such as congestion or air and noise pollution, are paid by all taxpayers and not only by those people who create them (especially car users). Embracing different kinds of pricing policies can help societies that are suffering from traffic anomalies to address these congestion-related problems [De Vos, 2016].

Traffic congestion pricing, as a method of traffic demand management, can compensate for the negative effects of traffic congestion, road accidents, and air and noise pollution. This pricing method operates on the basis that encourages travelers to choose low-impact road itinerates (route diversion) by applying a surcharge on the demands for short-term selection, which can help to create a sustainable structure of the transportation system. In other words, congestion pricing has to be considered as a policy tool that can be useful in managing limited resources in modifying the road user's behaviors in terms of route choice and mode choice [Cipriani et al. 2018]. In this regard, urban road pricing schemes have been designed to reduce externalities generated by traffic. Main impacts regard time loss due to congestion, local pollution, noise, and contribution to climate change caused by emissions of GHGs, pavement costs, and road damages, increase in accident risks, extra-fuel consumption, and decrease in quality of life. Moreover, road pricing schemes generate public revenues.

The amount of the toll paid by the road users can depend on various factors such as the route, travel time, the type of vehicle (depending on the number of vehicle axles, weight, and type of fuel), and the corresponding traffic class. The pricing policy as one of the subsets of the traffic restriction policy can be applied in different ways [Lindsey, 2003]: 1) area pricing, within a defined area, 2) cordon pricing, for access to a defined area, 3) facility pricing, imposed on individual freeways, and 4) network pricing, for a freeway system with potential differentiation of tolls on each freeway.

Singapore is one of the leading cities in the world that has effectively implemented the road pricing system to restrict car inflows into the city. Singapore's government has levied congestion taxes for designated areas in the Central Business

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District (CBD), demarcated as the “Restricted Zone (RZ)” since 1975 [Agarwal et al., 2004]. The prices were considered to be above the optimal rate, since the initial 45% reduction in traffic during the peak hours in the RZ far exceeded the original target of a 25 to 30% reduction, leading to underutilized roads [Phang and Toh, 2015]. Stockholm (in operations since 2007, after a period of trial in 2006), London (in operations since 2003), and Milan (in operations since 2008, with a shift from pollution to congestion charge in 2012) are three main experiences of urban road pricing in Europe.

Stockholm adopted a “pay as you drive” tariff (modeled after Singapore) to be paid at every single crossing of the area, differentiated for the time. In contrast, London and Milan set daily entrance charges, allowing for unlimited entrances, exits, and travels during the time of charge application. Milan considered entrance crossings; however, in Stockholm entrance, and exit crossings are considered. In London, all trips (even inside the cordon) are considered. In all pricing systems, a flat daily rate is imposed: £11,50 in London (€ 14,50), SEK 20 in Stockholm (€ 2) and € 5 in Milan. At first, Milan imposed differentiated charges (€ 0, 2, 5, and 10) based on PM10 emission factors. In all cases, a robust increase in the inclination toward public transportation systems was announced. Moreover, the revenues obtained from these pricing policies are invested in sustainable mobility and developing different types of public transportation systems (in Stockholm indirectly through an agreement with national governments) [Croci, 2016].

Even though the economic benefit resulting from the applications of congestion pricing approaches is undeniable, this policy is usually rejected by public opinion because it is considered as an additional tax. The cases of Edinburgh and Manchester can be accurate examples of this issue, where cordon tolling schemes were rejected by public referenda in 2005 and 2008, respectively. The same happened in New York City in April 2008 and Copenhagen in 2012.

To increase the acceptability of congestion pricing, factors as the evidence of improvements of traffic congestion, public transport, environmental improvements, and road networks are fundamental [Walker, 2011], [Glavic et al., 2017], together with the vision of the policy as a part of an overall traffic plan with alternative modes and improvements in public transport, all funded by the road pricing revenue. Environmental improvements depend on individuals’ sustainable behavior that is developed by an environmentally responsible lifestyle [Gkargkavouzi et al., 2019], and the behaviors like the improvement of using green transportation modes and car use reduction policies are driven by moral or normative considerations. The behaviors that are perceived as pro-environmental behaviors are categorized into four groups in VBN theory, and it indicates the correlation between values, beliefs, norms, and behaviors in a causal chain [Stern, 2000].

The current study aims to investigate whether values, as a part of the VBN theory, causal chain, pro-environmental behaviors, and the effects of independent variables on dependent variables besides the other independent variables or not.

2- Literature Review

To influence people’s travel behavior, road pricing among demand management strategies can be employed. By implementing charges to private mode users at different times and locations, urban congestion can be relieved, and people’s traveling mode choices can be spread to other modes. In research, three road pricing schemes: fixed pricing, credit-based pricing, and differential pricing (peak and off-peak), proposed or implemented in different countries, were investigated [Jou et al., 2007]. In the mentioned research, a computer-based survey was conducted in specific locations in Taiwan to acquire information about individuals’ traveling characteristics, their attitudes on different road pricing schemes, and their tendencies towards incentive alternatives. Finally, the collected data were used to consider the most important attributes influencing car/motorcycle travelers’ behavior and the adoption of different road pricing schemes. The results of that study have provided valuable insights into road pricing strategies to be regulated and implemented in the future. The acceptance of road pricing and the commuters’ choice behavior under three road pricing schemes for private passengers, including both car and motorcycle, were investigated. Two types of models were established: ordered probit (OP) and logit models, including multinomial logit (MNL) and nested logit (NL). The result indicated that the likelihood of non-acceptance (including very unlikely and unlikely to accept) was higher than that of acceptance (including very likely and likely to accept), which probably is due to the fact that road pricing has not been implemented yet in Taiwan and consequently, people were more reserved about this policy.

In the conclusion of the research, around 52-60% of car commuters choose to drive on the road pricing routes, and 27-35% want to drive on the alternate free routes, while the proportions for motorcycle commuters are 46-50% and 42-47%, respectively. However, switching to public transport is rare for both. Mainly car commuters were found to be less likely to change their commuting modes. This is most probably due to the more significant influence of road pricing on motorcycle commuters [Jou et al., 2007].

Dynamic congestion pricing, as a road pricing scheme, is capable of controlling the traffic flow in which the amounts of tolls are adjusted concerning the real-time traffic condition. However, since now, most of the developed models have been based on deterministic network equilibrium rather than stochastic choices of travelers. Thus, only a few case studies have been done on complex networks, and, as a result, the use of existing models has been limited. In research, a dynamic congestion pricing model was developed based on a discrete choice framework to capture users’ personal choices. Several solution algorithms were examined and tested in a synthetic network for solving this model. In the structure of the model, the departure time was considered together with route choice, where a combination of one departure time and one route was considered as one alternative. An MNL model was applied to determine the right departure time and route. In this process, some weighting was applied in each time interval to capture the passengers' willingness to change departure time, as well as the penalty for early and late arrivals. Weighting parameters were determined by calibration. Among these algorithms, SPSA (Simultaneous Perturbation Stochastic Approximation) was considered as the best model which is successfully exploited in a real case study in Lower Westchester County, New York State. The results showed that dynamic congestion pricing had the potential to improve network performance [Xu, 2009].

In another study, the research aimed to estimate travel behaviors by dividing individual travelers into several groups based on their features. The case study was based on trips to the CBD in the Nanjing City of China. Two travel mode choices, the transit (bus and metro) and car, were investigated using the cluster analysis with the aid of the statistical analysis system (SAS) software. Travelers' personal information, as well as travel information, were collected through both revealed preference (RP) and stated preference (SP) approaches. The travel information consists of the mode choice, walking time, waiting time, in-vehicle time, fare, and comfort, while personal information contains gender, occupation, income, and car ownership. A total of 524 individuals were questioned and then categorized into three groups based on their personal information using cluster analysis. The results showed that each group shows very different characteristics, confirming the capabilities of cluster analysis. Moreover, each respondent was asked to choose their travel mode choice. Afterward, using a discrete choice model, the travel mode choices consisting of public transit (bus and subway) and car were approximated, and the results were compared with the mode choices which were included in the travel information part of the RP/SP survey for each category.

The results showed that the accuracy of estimating mode choice using individual grouping was remarkably higher than that without grouping, confirming that the individual grouping enhanced the accuracy of travel behavior estimation. The cluster analysis was conducted for the individual grouping of the travelers based on their attributes, which are gender, occupation, income, and car ownership. The MNL models were applied to predict the travel mode choice of the three groups from the cluster analysis. The results showed that the cluster analysis method is a useful mathematical method to divide individuals into groups. Secondly, by using an approach where individuals are grouped using cluster analysis, individuals' travel behavior estimation can be visibly improved. The advantage of the model with grouping compared to that without grouping is that it takes full account of the travelers' characteristics. This is important in analyzing travelers' behavior using a discrete choice model. The proposed model can also be potentially adopted by the managers to analyze residents' travel behavior and to make necessary strategies. In future studies, the authors will take into account more travel mode choices, personal attributes, and other contributing factors in the model [Ding and Zhang, 2016].

Road pricing can improve air quality by reducing traffic flows [Coria and Zhang, 2017] - [Wangsness, 2018]. The main purpose of a conducted research in the year 2016, was to develop a bi-level pricing model to minimize the CO_2 emissions and the total travel time in a small road network. For the higher level of the model, different road toll strategies were applied to minimize the CO_2 emissions. In the lower level of the model, it was assumed that users of the road network find a dynamic user equilibrium that minimizes the total costs of those in the system. The results showed that the produced CO_2 emissions could be significantly influenced by the number of servers and the type of used toll strategy. The model was also capable of finding the best toll strategy when there is a constraint on the revenue. The results also showed the effects on traffic flows, revenues, total time, and CO_2 emissions concerning the numbers of servers collecting tolls and different pricing strategies over a morning peak traffic period. Moreover, the traffic flows were distributed to different periods by using the logit model. In the logit model, the road user only considers the travel cost. The logit model was used to simulate the users' choices of the route and departure time. The logit model depends on the total cost of the users for the journey. The result of the logit model is a percentage representing the proportion of users from a user group that selects a particular route, and the sum of all the results for different periods is equal to 1. Further runs compare strategies to minimize the CO_2 emissions with those that minimize total travel time in the road network. Accordingly, minimizing the total travel time and CO_2 emissions leads to the same results [Wen and Eglese, 2016].

In Abidjan, along with the operation of a new commuter rail system, a road pricing policy is currently under evaluation as a transportation control measure. While this scheme may be useful in reducing congestion in CBD, the provision of alternative modes of transportation for the "pushed-out" auto users is of great importance to obtain public acceptance. Hence, it is essential to simulate the road pricing scheme and the commuter rail development at the same time, which may serve as an alternative for assumed pushed-out auto users. Using data obtained from the available opinion survey, this paper investigates how commuter rail and auto ridership are likely to change based on travelers and system attributes. The survey data contained socioeconomic information of over 4,000 respondents as well as details of to-work/school or to other trips to CBD, including the mode, travel cost, time, etc. Respondents were then asked about their tendency to shift from their current mode to commuter rail to make the same travel for different commuter rail fare levels. A mixed logit model was used for policy simulation that captured the key variables that were considered to explain mode choice behavior and presents great potential for practical use in policy simulation in a large metropolitan area of the developing world [Yagi and Shiraishi, 2017].

To explain environmental friendly behaviors, four types of value orientations that are the most influential on pro-environmental behaviors such as egoistic, hedonic, altruistic, and biospheric values were used in the previous researches [Hiratsuka et al., 2018; Jakovcevic and Steg, 2013; Kiatkawsin and Han, 2017; Nordfjærn and Zavareh, 2017; Ünal et al., 2019] and represented in the current study. Individuals who are more concerned about the environment, like pollution and global warming, are introduced as individuals with a high level of biospheric values. Individuals with deep concern about the welfare of other humans are introduced as individuals with a high level of altruistic values. Both of the mentioned values are related positively to pro-environmental behaviors [Cleveland et al., 2005], [Nordlund and Garvill, 2003]. Unlike the biospheric and altruistic values, some values represent a key concern for doing things for fun and reducing effort, and also increasing or securing personal resources [Ünal et al., 2019]. Those mentioned values are introduced as hedonic and egoistic values, and both of them are negatively related to pro-environmental values [Steg et al., 2014].

In the current study, it is expected that the positively related values to pro-environmental behaviors are related to semipublic and public transportation, and negatively related values to pro-environmental behaviors are related to non-public transportation.

3- Methodology

Regarding the policies and restrictions that have not been implemented, the stated preferences methodology is used. In this method, by designing a hypothetical market for a product without price, people are asked about Willingness to Pay (WTP) or Willingness to Accept (WTA) to qualitatively improve or not to improve the product. This method is related to the compensated demand curve known as the Hicksian demand function. Because this method directly uses the mentality of individuals about non-market goods, it is called a direct pricing technique. According to this method, for goods and services that have no prices, a hypothetical market is considered, and based on that, the demand of individuals for such goods and services is measured by their declared demands (extracted from the questionnaires). The most common way to achieve the expressed preferences of applicants is to interview them about their willingness to pay or accept for maintaining or improving the quality of products or services under study [Cipriani et al., 2018].

To conduct a pricing policy in the current research, the 2016 traffic congestion zone policy has been considered. To assess the sensitivity of individuals to different prices and their willingness to participate in the Odd-Even plan, during the implementation of the Traffic congestion zone in the area and the event of a critical amount of pollutant produced, different percentages based on the innovative method has been added to the base amounts and permissions in the Traffic congestion zone of that year to examine their willingness to pay. After reviewing and analyzing the results of distributed questionnaires among people using the expressed preferences, discrete modeling methods are used, the most common of which are Logistic and Probit models. In this research and according to the nature of the research, binary logistic regression models have been used.

In the logit model, assuming that each random value ε_{nj} is independent and has a bounded distribution, the not-observed utility density, and its cumulative distribution is written, respectively, as follows:

$$f(\varepsilon_{nj}) = e^{-\varepsilon_{nj}} e^{-e^{-\varepsilon_{nj}}} \tag{1}$$

$$F(\varepsilon_{nj}) = e^{-e^{-\varepsilon_{nj}}} \tag{2}$$

Which in the above distribution has a non-zero mean and the $\frac{\pi^2}{6}$ variance. The difference between the two bounded variables is distributed logistically. Therefore, if ε_{nj} and ε_{ni} are variables with bounded values, then the equation of $\varepsilon_{nji} = \varepsilon_{nj} - \varepsilon_{ni}$ follows the following logistic distribution:

$$F(\varepsilon^*_{nji}) = \frac{\varepsilon^*_{nji}}{1+\varepsilon^*_{nji}} \tag{3}$$

The above equation is usually used in binary logit models (models in which there are two alternatives). The use of the distribution of bounded values for errors (or logistic distribution for the difference of errors) is similar to assuming errors are independent and normal. According to the above mentioned, pointing out the utilities of the probability logit model would be useful. First, P_{ni} is always between zero and one. The important point is that the P_{ni} probability value can never be zero, and if the modeler believes that the probability of selecting one option is zero, he (she) they must remove that option from his set of options. Also, when the probability of choosing an option is one, only that option is in the selection set.

$$P_{ni} = \frac{e^{V_{ni}}}{\Sigma_j e^{V_{nj}}} \tag{4}$$

It should be noted that the observed utility is usually in the linear parameter. It is noteworthy that the probability ratio of choosing two options depends only on the utility function of these two options and is independent of the utility of other options. When V_{ni} increases, it states that utility of the observed function has enhanced, and in effect causes the P_{ni} probability function approaches one, and the converse is quite true. The second point is that the sum of utility probabilities of all options, according to the following formula, is equal to one:

$$\Sigma_i^j p_{ni} = \Sigma_i \exp(V_{ni}) / \Sigma_j \exp(V_{nj}) = 1 \tag{5}$$

And in fact, the decision-maker must choose one of the alternatives [Cipriani et al., 2018].

As a new approach to discrete choice modeling, it is possible to connect the latent variable model and standard choice modeling [Wen and Eglese, 2016]. The indicators of latent variables which could be Likert scale, binary or categorical, and by application of structural and measurement equations, the probability could be written as follows [Mahpour et al., 2018]:

$$P(y_n|X_n,w_n,\theta,B)=\int_{x_n^*} P(y_n|x_n^*,X_n,\theta)g(x_n^*|B,w_n)dx_n^* \qquad (6)$$

4- Modeling and Collecting Data

In this research and to investigate the sensitivity of Tehran citizens to increase the values of Traffic congestion zone prices in the year 2016 and its implementation in the Odd-Even plan and their decision to use a personal vehicle or other transportation modes, different scenarios were designed in distributed questionnaires. The structure of the distributed questionnaire has the following elements that, according to the obtained results, its database structure was formed:

1. Information about personal characteristics and household properties.

2. Measuring individual Value orientations using a scale consisting of 16 value items reflecting the hedonic, egoistic, altruistic, and biospheric values

3. Information daily trips within the Odd-Even plan.

4. Information about the decisions of individuals to select a vehicle during the implementation of the Traffic congestion zone within the Odd-Even plan with the designed amounts.

The first category of information consists of information such as gender, marital status, age, education, occupation, monthly installments, the status of education, employment of persons with a focus on Odd-Even plan, the presence of a child under the age of 6 and Or the elderly person in the household, having the certificate, the number of personal vehicles, as well as the number of the Odd-Even plate of their vehicles. These options, after examining the degree of correlation and effect, can be evaluated and examined for use in the final utility model as well as the willingness of individuals to pay. The second part is a measurement to evaluate an individual's pro-environmental beliefs using a scale consisting of 16 value items reflecting the hedonic, egoistic, altruistic, and biospheric orientations [Wangsness, 2018]. Using a nine-point scale ranging from -1 (opposed to my values), not important (0), (unlabeled; 1, 2), important (3), (unlabeled; 4, 5), very important (6) and 7 (of supreme importance) the importance of the values as a guiding principle in life were evaluated. The third category, which is related to the daily travel information of the people, include questions about travel objectives, how to travel, having a companion, the origin and final destination of the people, the start and end times of travel, the average cost of people in the event of not using a personal vehicle and the duration of their presence in the desired areas. The fourth category is described in more detail in separate sections .In Tables 1 and 2, statistical analysis of socio-economic variables and daily trips, and in Table 3, the Frequency Distributions for the questions related to the value measure items are represented. In appendix 1, the descriptions of the variable which are used to evaluate the model are included.

Table 2 shows the final percentages added to the base values of the Traffic congestion zone under Scenario 1 of this research. Also, Table 4 presents the Traffic congestion zone prices in the year 2016, and Table 5 presents the Final road prices for choosing people's travel options in this research.

A. The Scenario of road pricing according to the implementation of the Traffic congestion zone within the Odd-Even plan in the year 2016 (Scenario No1 of current research)

In the central area of Tehran, areas known as the Odd-Even range or traffic areas have been introduced. The traffic congestion zone, which is smaller than the Odd-Even plan zone, is within the heart of the Odd-Even plan zone, and normally to be present in this area, Tehran citizens are obliged to pay approved amounts. For the Odd-Even plan zone that includes a wider range than the traffic congestion zone, the only restriction on the citizens, to be present in this zone, is the first digit from the right side of their vehicle plates. Thus, they are required to use cars with even number plates on Saturdays, Mondays, and Wednesdays, and cars with the odd number plate on Sundays, Tuesdays, and Thursdays. To investigate the willingness of Tehran citizens to pay different amounts for attendance in the Odd-Even plan zone during the implementation of the Traffic congestion zone in the mentioned zone and the event of a critical amount of pollutant produced, it was necessary first of all, based on preliminary studies, their willingness to pay the proposed initial amounts to be examined and then, at a later stage, more rational amounts, according to their desire, will be offered for payment. Considering the amounts of Traffic congestion zone prices in the year, 2016, which is shown in Table 1, using an innovative method, 10 to 90 percent were added to mentioned amounts and various types of traffic permits and then, according to the results obtained from pilot distribution, the final table of added percentages to determine the willingness of individuals to pay when implementing the traffic congestion zone within Odd-Even plan zone, as one of the traffic execution constraints in the city of Tehran in recent years and the case of environmental problems, was distributed as a questionnaire.

B. Sample Size

To calculate the sample size, the traffic volume in the Odd-Even plan zone on a specific and busy day was received from traffic control companies from streets of Sohrevardi,

Table 1. Statistical analysis of socio-economic variables in the current study (Sample size=500) (Continude).

Variable	Category	Absolute frequency	Relative abundance
Sex	Women	213	42.6
	Men	287	57.4
Marital status	Single	200	40
	Married	300	60
Age	18-24	80	16
	25-34	157	31.4
	35-44	135	27
	45-54	76	15.2
	55-64	42	8.4
	65-74	10	2
	74>	0	0
Education	Middle school degree	43	8.6
	High school Diploma	111	22.2
	Associate	111	22.2
	Bachelor	168	33.6
	Master	58	11.6
	Doctoral	9	1.8
Occupation	Jobless	122	24.4
	Retired	26	5.2
	Government's employee	36	7.2
	Private sector employee	99	19.8
	Self-employed	194	38.8
	Physicians	5	1
	Engineer	11	2.2
	Faculty member	0	0
	Other	7	1.4
Monthly installments	10 million Rials[1]	15	3
	10-20 million Rials	98	19.6
	20-30 million Rials	141	28.2
	30-40 million Rials	129	25.8
	40-50 million Rials	89	17.8
	50-100 million Rials	22	4.4
	More than 100 million Rials	6	1.2
Number of cars	0	52	10.4
	1	334	66.8
	2	102	20.4
	3	10	2
	4	2	0.4
Address	Outside of the Odd-Even zone	250	50
	inside of the Odd-Even zone	200	40
	Inside of the Traffic congestion zone	50	10

[1] 10 million Rials approximately equals to 88 U.S Dollar

Table 1. Statistical analysis of socio-economic variables in the current study (Sample size=500)

Variable	Category	Absolute frequency	Relative abundance
Number of households	1	46	9.2
	2	107	21.4
	3	176	35.2
	4	137	27.4
	Five and More	34	6.8
Family-owned cars prices	Less than 20 million Rials	97	19.4
	20-50 million Rials	240	48
	50-100 million Rials	83	16.6
	More than 100 million Rials	28	5.6

Table 2. Frequency Distributions for the questions related to the Value measure items in the current study (Sample size=500).

How important each of the following values is as a principle in your life?	-1[2]	0	1	2	3	4	5	6	7
Hedonic Values									
Pleasure	0%	0.6%	0.8%	2.4%	9.2%	2.6%	10.2%	27.8%	46.4%
Enjoying life	0	0.2	0.8	1.4	4.4	3.6	8	30.4	51.2
Self-indulgent	0	0.6	0.8	1.2	5.2	5.2	11.4	31.2	44.4
Egoistic Values									
Social power	0.6	3.2	1.2	2.8	8.2	6.6	18.2	30.4	28.8
Wealth	0	0.6	0.8	1.8	3.6	4.6	11.4	27.8	49.4
Authority	0.2	0.8	2	3.2	6.8	5.2	20	34.2	27.6
Influential	0.4	1.4	3.2	3.4	8.2	8.2	19.6	33.6	22
Ambitious	6.2	7.8	4.8	7	11	13	19.4	17.2	13.6
Altruistic Values									
Equality	0.4	0.8	1	2.6	6.5	8	15.2	31.4	34.4
A world at peace	0	0.6	0.4	1.4	3.6	5.6	14.2	31.6	42.6
Social justice	0	0.6	0.8	1.6	3.4	5	14	36.2	38.4
Helpful	0	0.8	0.8	0.4	4.4	5	16.8	32.2	39.6
Biospheric Values									
Respecting the earth	0	0.8	1	1.8	3.6	8.8	21.6	30.8	31.6
Unity with nature	0	0.4	1	1	5.8	7.8	23.8	30.2	30
Protecting the environment	0	0.4	0.4	1.4	5	6.4	22.2	30.6	33.6
Preventing pollution	0	0.4	0.2	0.8	5.4	6.8	21	30.4	34.8

[2] The nine-point scale ranging from: -1 (opposed to my values) to 7 (of supreme importance)

Table 3. Statistical analysis of daily trips information to the Odd-Even zone (Sample size=500).

Variable	Category	Absolute frequency	Relative abundance
The purpose of the trip	Work	232	46
	Education	43	9
	Shopping	39	8
	Recreation	34	7
	Personal Affairs	139	28
	Other purposes	13	2
Did you travel in your own car?	Yes	244	49
	No	256	51
Number of cars occupants (If you are using you are car)	1	135	27
	2	65	13
	3	30	6
	4	11	2
	5	3	1
Duration time of stay in Odd-Even zone	Less than 1 Hour	23	5
	1-2 Hours	70	14
	2-3 Hours	114	23
	More than 3 Hours	293	59
Travel cost	Less than 20000 Rials	30	12
	20000-50000 Rials	74	29
	50000-100000 Rials	86	34
	More than 100000 Rials	62	24
Traveling using Subway	More than seven times in a week	51	10
	4-7 times in a week	25	5
	1-3 times in a week	40	8
	1-3 times in a month	31	6
	4-8 times in a year	36	7
	Less than four times in a year	69	14
	Other	248	50
Traveling Using Bus	More than seven times in a week	39	8
	4-7 times in a week	27	5
	1-3 times in a week	34	7
	1-3 times in a month	32	6
	4-8 times in a year	20	4
	Less than four times in a year	99	20
	Other	249	50

Table 4. Traffic congestion zone prices in the year 2016.

Different permits to enter the traffic congestion zone	Prices (Rials)
Type1 (Enter from 6:30 AM)	312,000[3]
Type2 (Enter from 10:00 AM)	234,000
Type3 (Enter from 2:00 PM)	150,000
Weekly license (Check-in at all hours)	1,000,000

Table 5. Final road prices for choosing people's travel options.

Type1 (Enter from 6:30 AM)	Prices (Rials)	Variable Symbol
10%	343,200	Price1
20%	374,400	Price2
30%	405,600	Price3
50%	468,000	Price4
Type1 (Enter from 10:00 AM)	Prices (Rials)	
10%	257,400	Price5
25%	292,500	Price6
50%	351,000	Price7
75%	409,500	Price8
Type1 (Enter from 2:00 PM)	Prices (Rials)	
10%	165,000	Price9
25%	187,500	Price10
50%	225,000	Price11
75%	262,500	Price12
100%	300,000	Price13
Weekly license (Check-in at all hours)	Prices (Rials)	
10%	1,100,000	Price14
25%	1,250,000	Price15
50%	1,500,000	Price16

Fig. 1. The selected area as a part of the Odd-Even plan zone in this research.

Table 6. Classifying selected alternatives into Non- public and public transportation

Non-public Transportation	Public Transportation
1-Using personal vehicle with a payment of fees	1-Train
2-Using Personal Vehicle with accepting a fine of 200,000 rials per hour	2-Bus
3-Changing the hours of presence in the zone	
4-Changing the way of presence in the zone	
5-Motorcycle	
6-Call Taxi	
7-Street Taxi	
8- Internet-based ride-hailing	

Beheshti, and Khorramshahr (north of the zone), Shariati, and Bahar Shiraz (east of the zone), Valiasr (west of the zone) and Motahari and Shariati (south of the zone). Fig. 1 shows the mentioned above area as a part of the Odd-Even plan zone of Tehran city that is chosen for this research.

Accordingly, on Tuesday, November 8, 2016, the intake traffic volume during the 24 hours to the mentioned zone was 258,632 cars, which was an average of 10,776 cars per hour. So and using the Cochran formula for a moderate society which is mentioned below, and considering the statistical population and taking into account the error margin of 5%, 95% confidence level and with placing the maximum amount of passing vehicles during 24 hours in the corresponding formula, the sample size is 370.9. The number of questionnaires to increase the reliability of the data will be 384 (according to Eq. (7)). The sample which is used for this study is 500 travelers to the Odd-Even zone in Tehran.

$$n = \frac{NZ^2 pq}{Nd^2 + Z^2 pq} \tag{7}$$

C. Classifying selected Alternatives in the Questionnaire

In this research, to construct a binary logit model in statistical models, all the alternatives contained in the questionnaire, have been divided into two main categories of non-public transportation and public transportation. It should also be noted that after obtaining the results from the distribution of questionnaires, two items of “canceling the travel” and “changing the present day in the zone” due to the low number of responses to them, were removed from the overall selected options.

Table 7. Estimated parameters for people's travel options.

Option	Variable Symbol	Variable Description	Coefficient	Significance level
Private Car	Constant	Constant number	-3.067	0.0000
	Empd	Government's employee=1, otherwise=0	-0.367	0.0007
	Empkh	Private sector employee=1, otherwise=0	0.160	0.0327
	Nowor	Jobless=1, otherwise=0	-0.406	0.0106
	Costf2	HH cost per month 10-20 million Rials=1, otherwise=0	-0.199	0.0199
	Hhs	A ranking variable of HH	-0.079	0.0125
	Hloc2	Family address (Inside of the Odd-Even zone=1, otherwise=0)	0.219	0.0005
	Nveh	A ranking variable of the number of vehicles in Household	0.223	0.0010
	Ipub	A ranking variable of traveling using public transportation 4-8 times in a year or less than four times in a year	1.233	0.0000
	AC	Altruistic value (latent variable)	-0.319	0.0000
	Age	A ranking variable of age (18-24=1, 25-34=2, 35-44=3, 45-54=4, 55-64=5, 65-74=6)	-0.069	0.0181
	Eng	Engineer=1, otherwise=0	0.560	0.0130
	Vehcost3	vehicle cost 50-100 million Rials=1, otherwise=0	0.385	0.0001
	Price2	Payment amount of 374,400 to enter the zone from 6:30=, otherwise=0	-0.0012	0.0798
Public Transportation	Age1	Between 18-24=1, otherwise=0	0.524	0.0000
	Age3	Between 35-44=1, otherwise=0	-0.264	0.0001
	Costf	HH cost (all of the combinations)	-0.085	0.0089
	Hhs5	HH size (more than 5) = 1, otherwise=0	0.290	0.0297
	Vehcost	Vehicle cost (all of the combinations)	-0.216	0.0000
	Zpurp4	Travel purpose (Recreation) =1, otherwise=0	-0.443	0.0003
	Zpurp5	Travel purpose (Back to home) = 1, otherwise=0	0.745	0.0007
	Zsar	A ranking variable of the number of car occupants	-0.109	0.0156
	Zdu	Duration of stay in the zone (all of the combinations)	-0.262	0.0000
	Zttpub	Average travel time of public transportation	-5.425	0.0745
	Zcost	Travel cost (all of the combinations)	-0.432	0.0000
	BV	Biopheric value (latent variable)	0.206	0.0000
	EV	Egoistic value (latent variable)	-0.059	0.0168
Evaluation Criteria	$LL(\beta)$	-4035.05		
	ρ_c^2	0.2020		
	ρ_0^2	0.2562		
	ρ_{adj}^2	0.1993		

D. Software introduction and statistical methods used

In this study, Nlogit software was used to construct the binary logit model. In the current study and to analyze the variance between several dependent variables based on their description in terms of a small number of latent variables, the Factor analysis method is used. In other words, factor analysis seeks to simplify complex data by describing it in terms of fewer variables.

To provide an estimate of the model parameters in the current study, the rules of $LL(\beta)$, ρ_c^2, ρ_0^2 and are ρ_{adj}^2 used.

E. effectiveness of independent variables on dependent variables in scenario No. 1

In this section, the effect of all the independent variables in the questionnaire on the dependent variables, which is a type of selected vehicle as "non-public transportation," and "public transportation" has been evaluated. Considering the numerous pricing scenarios defined in each of the main scenarios of "Implementing the Traffic congestion zone within the Odd-Even plan zone in the event of the air pollution problem, a summary of the results based on the coefficient and significant level for scenario one is shown in Table 7.

5- Conclusion and Reviewing the Results

According to the sign of the parameter, the following results are obtained:

1) The negative sign of the coefficient for those who work as a government employees represents that they are less desired to use a private car to travel in the Odd-Even zone. On the contrary, those who work as an employee in private companies have more interest to use private cars for traveling.

2) Individuals that they use fewer public vehicles (4-8 times in a year or less than four times in a year) are more interested in using private cars.

3) Those who have selected the highest price category for their household cars (50-100 million Rials) are more interested in using private cars.

4) Individuals who don't work are less desired to use private cars to travel in the Odd-Even zone. On the contrary, people who work as an engineer are more interested in using a private car.

5) As it was expected, individuals who had a stronger altruistic value, which means more concerned about the environment, had less interest to use a private car when the emission rates reached their maximum amount. Biospheric values had the same result as altruistic values. Those who had a stronger biospheric value were more interested in using public transportation. On the contrary, Individuals who had stronger egoistic values (such as social power, wealth, a world at peace, Social justice, Helpful) and were less concerned about the environment, were less desired to use public transportation.

6) People who are 18-24 years old are more interested in using public transportation under Scenario 1 of this research. On the other hand, people who are 35-44 years old are less desired to use public transportation.

7) Traveling purposes showed different results. For example, those whose purpose was to return home, had more interest to travel by public transportation, but on the other hand, those whose travel purpose was recreational were more interested in using a private car.

8) Individuals who had more travel time are less interested in using public transportation and more interested in using private cars.

To summarize, the result of this study shows that there is a close relationship between individuals' pro-environmental beliefs and their choices to travel among specific areas in Tehran in a critical condition. Studies like the one reported here provide new insights to improve public transportation conditions. By considering people's behavioral responses and analyzing appropriate pricing policies, the improvement of the urban environment, traffic congestion, and quality of life could be possible.

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