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Intermodal Non-Motorized Transportation Mode Choice; Case Study: Qazvin City

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Abstract

Achieving the sustainable development of the urban transport network requires systematic and efficient planning and precise implementation. In this regard, consideration of non-motorized transport (walking and cycling) as a successful way to reduce the economic and environmental costs of urban transportation is debatable. For this reason, the present research studies the characteristics and factors affecting riding, pedestrians, and bicycles. The case study data is derived from a sample origin-destination questionnaire from residents of Qazvin, including personal and family characteristics, socioeconomic characteristics, environmental characteristics, and transport network characteristics. Therefore, to investigate the behavior of individuals in mode choice model, the modeling was carried out in three modes, namely: motor and non-motor transport (32053 views), second mode: walking and cycling (8203 views), and third mode: motor transport, walking and cycling (32053 views) is presented using discrete selection models. Depending on the models, it is observed. The results of the review of the choice of motorist non-motorized travel method, the same final model resulting from considering different modes of non-motorized transport (pedestrians and bicycles) as an option. If the intermediate model (selection mode between walking and biking) replaces the option to choose a motor transport option. According to the results, in older people than young people, men than women, people with less education than people with more education, shopping and entertainment trips than medical and work trips and short trips than a long trip, the tendency to choose non-motor mode is more.

***Keywords*:** Sustainable Development, Motorist Transport, Non-Motorized Transport, Discrete Selection Model.

1. **Introduction**

Living in cities requires an efficient and sustainable transportation system, but high dependence on private vehicles and increasing travel demand in the city has changed the travel pattern and distanced itself from the sustainable urban transportation system [1, 2]. Therefore, the development and expansion of non-motorized transportation systems, along with other transportation systems, is one of the effective policies in the world in reducing the irregular consumption of gasoline and air pollution, etc. To this end, in the context of the sustainable development of the transportation network, the question arises whether pedestrians, bicycles, and riders today have the same rights in the use of urban roads and systems. Hence, it is necessary for intercity travel planners and communication network designers to study the features and factors affecting riding, walking, and cycling. The use of non-motorized vehicles can have a significant impact on reducing emissions, improving the quality of transportation, and thus achieving sustainable development goals [3-5]. Consequently, it is necessary to understand the factors that affect people's motivation to

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Numerous studies have been conducted to determine the various factors affecting the choice of non-motorized travel methods. Thus, it is necessary to review the importance of the subject and the proposed solutions of each researcher by reviewing the studies.

Ortuzar [6] and Parkin [7] in their studies found a negative relationship between increasing personal vehicle ownership and the choice of cycling style. Wardman et al. [8] found the effects of age on cycling in the UK to be negative, while Plaut [9] found the effects of age on walking and cycling in the United States to be positive. Noland and Kunreuther [10] found a positive relationship between walking and cycling use in men, while Agrawal and Schimek [11] found a negative relationship in walking use for men. Also, with increasing cycling travel time, it has been determined to reduce the likelihood of choosing to use it [12]. Buys and Miller [13] suggested that the perceived comfort of transportation is balanced by the destination and purpose of the trip, along with the consequent effects on the choice of travel method. In confirmation of this point, Ortuzar [6] achieved the goal of the school as a positive effect on the way he cycled. Other factors influencing the choice of non-motorized travel are mentioned in studies, population density, and land use. Habibian and Kermanshah (2012), concluded that a specific policy cannot always be the most effective policy in changing the means of travel From personal

riding to other modes of transportation he considered a city; Therefore, in most cases, using a combination of different policies can be more effective. However, in this study, it has been shown that absorption policies often affect public transportation methods and repulsion policies affect public transportation methods [14, 15]. Manaf and Al-Junidi (2013) Using the clustering technique, travelers were initially classified into six distinct groups based on personal motivations. Findings showed that people who pay more attention to environmental issues and physical activity show more interest in choosing to walk [16]. Rahola and Wormb (2013) studied the effects of various factors influencing the choice of non-motorized travel. The results showed that when the travel time is more than 20 minutes, the probability of wanting to use walking and cycling is reduced by about 68% and 79%, respectively. There is also a decrease in the tendency to use non-motorized transport with age. According to the results, women are more interested in walking than men, but in the case of cycling, the opposite is true [17].

Juremalani and Chauhan assessed that if characteristics of the trips especially shopping are analyzed then effective promotion policies can be framed to increase the use of non-motorized vehicles. An attempt is made in this paper to analyze shopping trips characteristics in Vadodara City like trip distance, travel time, mode choice behavior along socio-economic characteristics of the commuters so that land use can be planned and designed accordingly to promote non-motorized vehicles use. Benefits of NMT are multifold like reduction in air and noise pollution, saving in fossil fuel, increase in the health of citizens, reducing congestion on the roads [18].

Hatamzadeh et al. (2014) found that the decrease in the tendency to walk was accompanied by an increase in travel distance in all educational levels. Studying trips at noon compared to the morning shift increases the tendency of elementary and middle school students to walk, but has no significant effect among high school students. The population density in the area of residence, in the travels of middle and high school students, does not have a significant effect on the choice of walking method to school, but among elementary students has a negative effect on the likelihood of choosing a walk [19]. Qorbani and Asadi (2014) examined the factors affecting the reduction of the tendency to use bicycles in urban travel in Zanjan. The results of their work showed that the use of bicycles in urban transportation are very low, so that according to the results of studies, only 8% of the statistical population of the research, significantly use bicycles for urban activities. This is due to factors such as lack of culture in the use of bicycles and the incompatibility of women's cycling with public culture (91%), poor advertising in the media (86%), lack of special cycling routes (91%), lack of use of community leaders (78%), the impact of climate (85%), impact of topography (66%), lack of awareness of the benefits of cycling (85%), lack of safety on urban routes for cyclists (94%) and lack of special and accessible parking for bicycles (80%) is affected [20]. Scheiner et al. reported that the models include a large variety of variables that capture the child and household sociodemographics, parents' mode use, trip distance, parental concerns, attitudes and perceptions, and the built and transport environment. Some of our results confirm previous studies (e.g. on the role of age, gender, and trip distance), while others differ. For instance, we found no effects of household socioeconomic status or the social environment on mode choice. Concerning the role of the transport environment, we want to highlight two findings. Firstly, narrow pavements along the route increase the odds of being driven rather than walking [21].

Pike and Lubell (2018) in a study developed a series of complementary statistical models find the strength of social influence is lower for those with longer commute distances where biking is more costly than driving or taking the bus and is also lowering at a distance where walking has higher utility than biking. Social influence is most important when the external commute characteristics entail relatively equal travel costs for different modes. As the social influence and other social processes are evaluated as potential policy instruments, these and other heterogeneous effects should be taken into account [22]. Ahmadi and Habib (2008), considering the principles of sustainable development, examined the traffic situation in Asian cities by emphasizing the role of pedestrianization in the city and in other words, pedestrian traffic and provided solutions to improve the condition of urban sidewalks. The analytical research method is used and to achieve the goals of sustainable development by expanding the sidewalk to solutions such as observing pedestrian health, observing pedestrian safety [23], observing the human scale of the pedestrian crossing, considering the sidewalk capacity in proportion to the number of pedestrians. Removal of pedestrian barriers and arrangement of street equipment has been mentioned and practical measures have been proposed for each case. The main point in this study is the significant effect of pedestrian promotion on the achievement of sustainable development goals [24]. Hatami Nejad and Ashrafi (2008) conducted a study to show the importance of bicycles in urban transport in Bonab and to investigate the causes of citizens' inclination to this sustainable vehicle. According to the results and findings of this study, more than 71% of respondents use bicycles for various purposes. Students are the most popular users of bicycles, while the shortness of the path is the most important factor in the use of bicycles [25].

Habibian et al. (2012) have studied the combined policies of transportation management and their impact on people who have used private cars to go to work in the city center. By analyzing the obtained results, the behavioral model of passenger vehicle selection is presented in the form of a multiple logit model [26]. Panter et al. (2013), in a study entitled "Using walking or cycling on commuting trips to and from work: the role of individuals, the workplace, and environmental conditions," using logistic regression to analyzed variables. Thus, these two variables can be considered as two factors affecting the use of non-motorized vehicles by Cambridge University

staff in daily trips to work [27]. In 2018 with the data collected from over 500 students in six universities in Danang, Vietnam, a conditional logit regression model was developed to explore individual and alternative specific variables influencing the mode choice for trips to school. Key findings show that characteristics of students such as age, gender, and income have a significant impact on their mode choice decision. Travel time from home to school is found to have a strongly negative effect on the choice of walking as a means of traveling to school. It is also found that students who are using motorcycles to schools are willing to switch to public transport if an efficient and reliable public transport system is available [28].

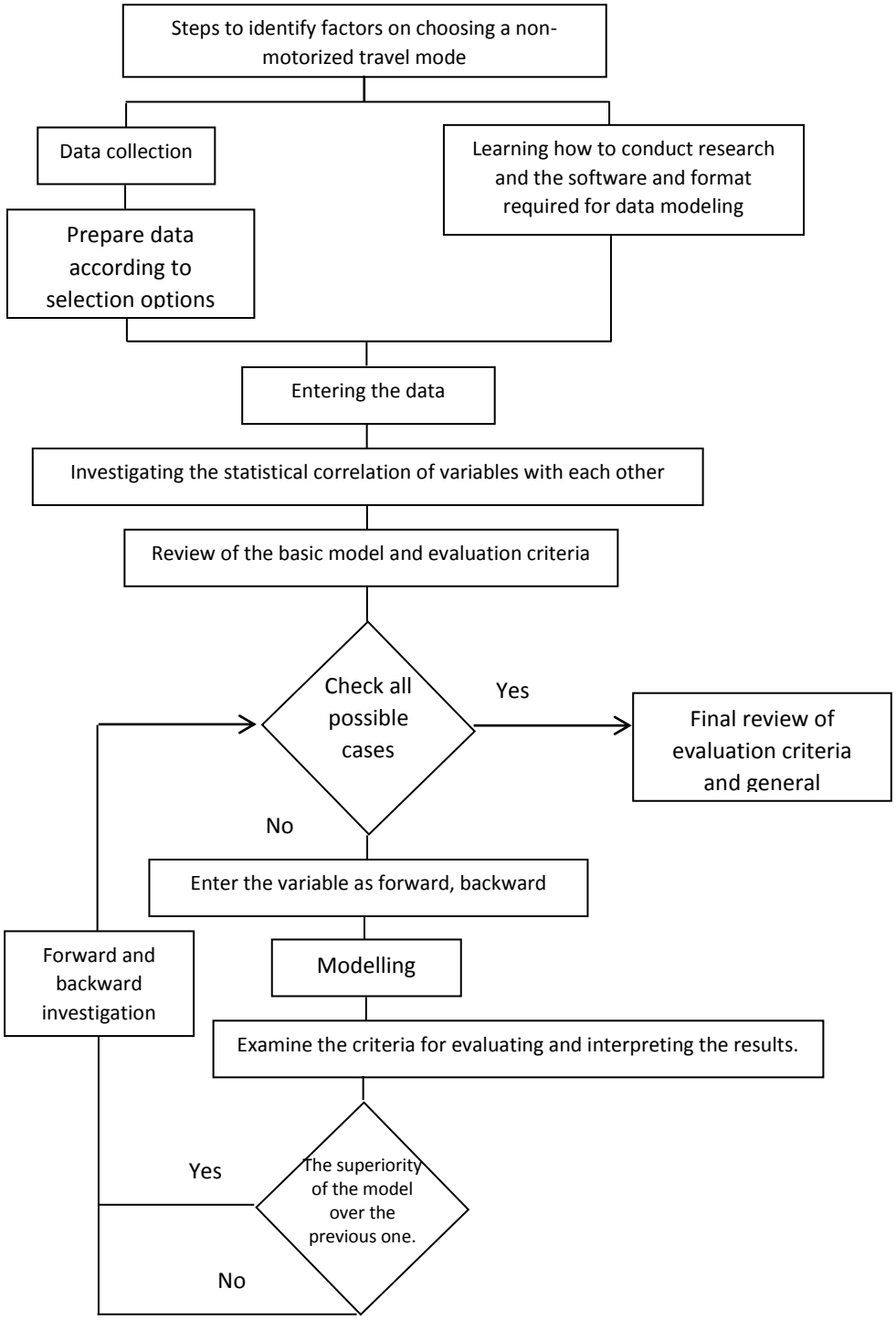

Fig. 1. Flowchart of Methodology

2. Methodology

After collecting the data and preparing it for entering the software, while examining the correlation of the variables

with each other, the basic model is also examined. Then, using the forward and backward methods, the variables enter the model and leave the model if the model does not improve compared to the base model, or is replaced by a variable in terms of high correlation with it. By examining the evaluation criteria of the models, the improvement in the modeling conditions and also the interpretation of the results is done, and finally, by examining all possible cases, the final model is selected and the main interpretation is done on the variables (Figure 1). Recently, the officials of Qazvin Municipality Transportation and Traffic Organization have paid special attention to bicycle and pedestrian modes. Also, various expenses have been incurred in this regard. Therefore, trying to enter these two modes for the first time in different scenarios (proposed in the research method) specific to the city of Qazvin. In previous studies, bicycle and pedestrian modes were not usually distinguished. The goal is to give a better direction to these efforts and achieve the desired result.

3. Case Study

The data obtained from the questionnaire of a sample of origin-destination from the residents of Qazvin [29] were collected using a questionnaire using the revealed preference method and examined the actual choice of travelers in real conditions [30]. People have expressed their opinions based on real choices. Accordingly, to collect the origin-destination statistics from the residents, 9938 households were interviewed and 35418 trips were recorded in the database (2010). It is worth noting that each person's travels are related to his or her travels over 24 hours.

3.1. Qazvin data feature

The information obtained from the survey in Qazvin consists of two main parts. One part includes information about people, travel goals, principles, and destinations, travel methods, start and end times of the trip, and the other part includes the characteristics of the areas, the spatial and temporal distances of each area, each of which is described below. Also in the comprehensive study of transportation and traffic, Qazvin city is divided into 113 traffic zones (14 traffic areas). Figure (2) and Figure (3) show the traffic areas of Qazvin, respectively.

Fig. 2. Traffic areas of Qazvin [26]

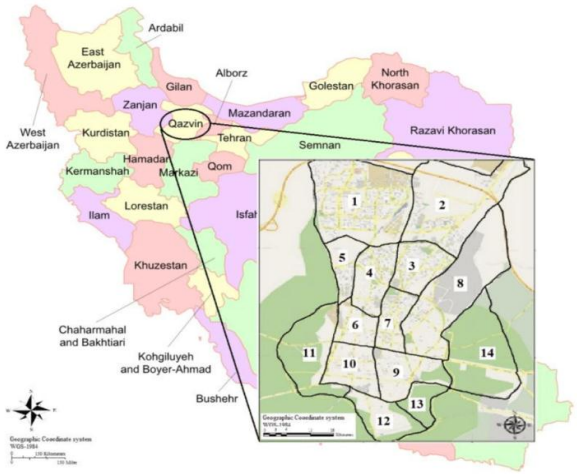

Fig. 3. The 14 traffic areas of Qazvin [26]

3.1.1. Information of people

The data obtained from this section include gender, age of the individual, household size, vehicle ownership, certification, residence area, employment status in 14 categories (1 employee, 2 masters, 3 businessmen, 4 teachers, 5 drivers, 6 school students, 7 housewives, 8 university students, 9 weak for work, 10 military, 11 workers, 12 retirees, 13 farmers, 14 unemployed), educational status in 10 categories (1 illiterate, 2 elementary, 3 middle schools, 4 third class of middle school, 5 high school, 6 diplomas, 7 post-diploma, 8 bachelors, 9 masters, 10 doctorates).

3.1.2. Travel objectives

According to the answers of the people in the questionnaire, 10 goals of the trip (1 job, 2 studies, 3 shops, 4 visits to offices, 5 visits to relatives, 6 entertainment, 7 companionship, 8 return home, 9 medical cases, 10 others) are defined. These goals have been determined according to the questionnaire and can be combined with both mandatory and optional goals.

3.1.3. Principles and destinations of travel

The origins and destinations of the trip include the interior and exterior areas of Qazvin. Due to the availability of information from 113 domestic areas, in this study, travel information of these areas has been used and other information that is considered as incomplete information has been removed from the data used.

3.1.4. Travel methods

According to the questionnaire, the methods are divided into 9 categories (1 pedestrian, 2 taxis and passengers, 3 personal rides, 4 agencies, 5 vans, 6 single buses, 7 motorcycles, 8 bicycles, 9 non-unit buses).

3.1.5. Travel time

According to the response of people to the time of travel can be divided into two periods of peak (including a peak in the morning and evening) and non-peak.

3.1.6. Characteristics of areas

The 113 areas used in the data include the properties that are presented separately in the existing data. These characteristics include area, population, employment rate, education rate, sponsorship rate, vehicle ownership rate, household size, and commercial area, administrative, educational, and medical areas.

3.1.7. Spatial and temporal distances of areas

In another part of the data, information about air and ground distances between areas, average travel time between areas by private vehicle and public transportation is provided.

3.2. Information on the use of different travel methods

After reviewing all the data and removing incomplete data, finally, 32053 trips out of the total trips were used for modeling. According to the purpose of the study (study of the choice of travel methods of individuals), the share of each travel method is reported in Table (1).

Table 1
Frequency of mode choice of Qazvin citizens (2010)

Trip Mode	Absolute Frequency	Relative Frequency (percentage)
Pedestrian	7568	0.236
Taxi	7092	0.221
Private Vehicle	7994	0.249
Taxi Agency	885	0.028
pickup	363	0.011
Bus	4616	0.144
Motorcycle	906	0.028
Bicycle	635	0.020
Minibus	1994	0.062
Total	32053	1

3.3. Case sample information collected

In this study, we tried to use all the important information of questioning for analysis and modeling. A summary of the collected information, including demographic, socio-economic, land use, and travel characteristics statistically, is presented in Table (2) and can be seen.

Table 2
Summary of statistical results of collected information (2010)

	Variable	Explanation	Unit	Min	Max	Average	Standard Error
Personal characteristics	Age	Age range	Year	5	90	31.15	15.77
	Gender*	Female	-	0	1	0.41	0.49
	Job*	Employee	-	0	1	0.12	0.32
		Teacher	-	0	1	0.04	0.2
		School student	-	0	1	0.29	0.45
		University student	-	0	1	0.07	0.26
		Housewife	-	0	1	0.2	0.4
		Worker	-	0	1	0.08	0.26
		Other	-	0	1	0.2	0.39
	Driving license*	+	-	0	1	0.44	0.49
	Education*	Illiterate	-	0	1	0.03	0.17
		Elementary	-	0	1	0.18	0.39
		Middle school	-	0	1	0.12	0.33
		The third class of middle school	-	0	1	0.16	0.36
		High school	-	0	1	0.05	0.23
		Diploma	-	0	1	0.24	0.43
		Post diploma	-	0	1	0.07	0.25
		Bachelor	-	0	1	0.13	0.33
		Master	-	0	1	0.02	0.13
		PhD	-	0	1	0.00	0.05
Socio-economic characteristics	Family size	Number of household members	Person	1	11	4.02	1.09
	Car Ownership	Motor vehicle	Number	0	5	0.97	0.71
	Bicycle Ownership	Bicycle	Number	0	5	0.59	0.69
	Area sponsorship rate	Population / Number of employees	Share	0	8.09	3.28	0.57

*Dummy variable: 1 per dose given in the next column and 0 otherwise
Views: 32053 Travel

Table 2
Summary of statistical results of collected information (continued)

	Variable	Explanation	Unit	Min	Max	Average	Standard Error
Land use Characteristics	Commercial destination travel rates	Commercial area / zone area	Share	0	0.27	0.04	0.05
	Zone Area	Area	Hectares	6.02	439.87	38.26	24.86
Trip Characteristics	Travel Time	Average travel time from origin to (destination (ride	Minute	0	31	7.2	5.4
		Average travel time from origin to destination (public (transport	Minute	0	206.4	24	19.5
	Number of public transport lane changing	The average number of lane changes from origin to destination	Number	0	6.4	1.9	1.2
	Trip distance	Average air distance	Kilometer	0	25.37	2.91	3.3
		Average ground distance	Kilometer	0	29.23	3.89	3.9
	Time-of-day travel	Peak period	-	0	1	0.33	0.47
	Travel chain	Number of consecutive trips	-	1	10	2.13	0.54
	Trip Purpose*	Job	-	0	1	0.14	0.35
		Education	-	0	1	0.15	0.36
		Shopping	-	0	1	0.07	0.26
		Visit the offices	-	0	1	0.02	0.13
		Meet relatives	-	0	1	0.04	0.2
		Recreation	-	0	1	0.03	0.17
		Accompanying	-	0	1	0.02	0.13
		Return home	-	0	1	0.5	0.5
		Medical	-	0	1	0.01	0.01
		Other	-	0	1	0.01	0.07

*Dummy variable: 1 per dose given in the next column and 0 otherwise
Views: 32053 Travel

4. Results

The process of modeling people's travel behavior in choosing a travel method is done in 3 parts and finally compared with each other. Firstly, modeling engine against non-motorized travel mode and then in the second stage, the selection of non-motorized modes (bicycle and pedestrian) will be provided. Finally, the model includes options for motorized transport, and walking and cycling are two ways to evaluate the overall model provided in detailed models. It is noteworthy that in each stage, by paying more than 100 multiple logit models, the best

model was selected. In addition to modeling, software N-logit [31] and the multiple logit models of the maximum likelihood method are used.

4.1. Variables used in modeling

The dependent variable in modeling in this section, mode choice, and the options of choice also include the first mode: motorized and non-motorized transport, the second mode: walking and cycling, and the third mode: motorized transport, walking, and cycling. Table (3) shows the frequency of each option over 24 hours. The independent variables used in modeling are divided into four general categories of personal characteristics, socioeconomic characteristics, travel environmental characteristics, and travel characteristics in different models for modeling, in Tables (4) to (6). It should be noted that in addition to these variables, other variables were used in modeling and finally the best model was paid in each section.

Table 3
Frequency of travel behavior options in choosing a travel method in different modeling modes

Model	Mode choice option	Absolute Frequency	Relative Frequency (percentage)
Motorized and non-motorized transport	Non-motorized transport	8203	25.59
	Motorized transport	23850	74.41
	Total	32053	100
Pedestrians and bicycles	Walking	7568	92.26
	Riding	635	7.74
	Total	8203	100
General model	Walking	7568	23.61
	Riding	635	1.98
	Motorized transport	23850	74.41
	Total	32053	100

Table 4
Modeling variables of pedestrian versus cycling mode choice

	Variable	Variable description	Average
Personal characteristics	Low_Age	If the age is less than 18 years = 1, otherwise zero	0.474
	Fem_Midage	If it is a woman and the age is more than 35 and less than 51 years = 1, otherwise zero	0.156
	Male	If it is male = 1, otherwise zero	0.578
	UnEducated	If illiterate = 1, otherwise zero	0.034
Socio-economic characteristics	HH	Family size	4.118
	Cyc_Owner	Bicycle ownership	0.621
Environmental characteristics	Area_D	Destination zone area (hectares)	36.103
Travel characteristics	Work_Aim	If the purpose of the trip is work = 1, otherwise zero	0.065
	Education_Aim	If the purpose of the trip is to study = 1, otherwise zero	0.212
	Recreation_Aim	If the purpose of the trip is recreation = 1, otherwise zero	0.045
	Net_len	Ground distance from the origin to destination (km)	1.481

Table 5
Modeling variables of travel of motorized versus non-motorized transport mode choice

	Variable	Variable description	Average
Personal characteristics	Low_Age	If the age is less than 18 years = 1, otherwise zero	0.286
	Old	If the age is more than 50 years = 1, otherwise zero	0.105
	Midage	If the age is more than 35 and less than 51 years = 1, otherwise zero	0.283
	HouseKeeper	If it is a housewife = 1, otherwise zero	0.2
	DL	If it has a license = 1, otherwise zero	0.443
	High_Edu	If the education is higher than the post-diploma = 1, otherwise zero	0.147
	Uni	If it is a university student = 1, otherwise zero	0.07
	Stu	If it is a school student = 1, otherwise zero	0.289
	Employ	If the person is an employee = 1, otherwise zero	0.116
Socio-economic characteristics	HH	Family size	4.021
	Cyc_Owner	Bicycle ownership	0.588
	Car_Ownr	Car ownership	0.973
Environmental characteristics	Com_D	Destination commercial rates between 0 and 1	0.042
Travel characteristics	Num	Number of trips on the tour	2.135
	Work_Aim	If the purpose of the trip is work = 1, otherwise zero	0.14
	Shop_Aim	If the purpose of the trip is shopping = 1, otherwise zero	0.072
	Medical_Aim	If the purpose of the trip is medical = 1, otherwise zero	0.009
	Recreation_Aim	If the purpose of the trip is recreation = 1, otherwise zero	0.029
	Net_len	Ground distance from the origin to destination (km)	3.892

Table 6
Modeling variables of motor transport travel, walking, and cycling mode choice

	Variable	Variable description	Average
Personal characteristics	Low_Age	If the age is less than 18 years = 1, otherwise zero	0.286
	Midage	If the age is more than 35 and less than 51 years = 1, otherwise zero	0.283
	Male	If it is male = 1, otherwise zero	0.595
	HouseKeeper	If it is a housewife = 1, otherwise zero	0.2
	DL	If it has a license = 1, otherwise zero	0.443
	UnEducated	If illiterate = 1, otherwise zero	0.029
	Employ	If the person is an employee = 1, otherwise zero	0.116
Socio-economic characteristics	HH	Family size	4.022
	Cyc_Owner	Bicycle ownership	0.588
	Car_Ownr	Car ownership	0.973
Environmental characteristics	Com_D	Destination commercial rates between 0 and 1	0.042
Travel characteristics	Num	Number of trips on the tour	2.135
	Peak	If the trip is in the peak period = 1, otherwise zero	0.333
	Work_Aim	If the purpose of the trip is work = 1, otherwise zero	0.14

	Shop_Aim	If the purpose of the trip is shopping = 1, otherwise zero	0.072
	Medical_Aim	If the purpose of the trip is medical = 1, otherwise zero	0.009
	Recreation_Aim	If the purpose of the trip is recreation = 1, otherwise zero	0.029
	Net_len	Ground distance from the origin to destination (km)	3.892

4.2. Choosing motorized versus non-motorized transport

In this section, the results of the model developing for the travel behavior model of individuals in terms of choosing the mode of the motorized trip versus non-motorized trips with multiple logistics structures for one full day are presented. At this stage, by paying more than 200 models of multiple logits in the forward and backward methods, the effect of various variables (continuous and dual) and their logical combination were investigated. The results of the model are presented in Table (7). As can be seen, the coefficients defined for the variables are assumed to be specific to the options and are observed:

1- The fictitious variable of being a housewife is quite significant in the desirability of the non-motorized transportation option and its coefficient has a positive sign (0.604). Therefore, it is understood that such people are more likely to travel by foot and bicycle. This can happen because housewives are not affected by employment and job-related fatigue, or in other words, they have more free time. Also, the interest of these people to have more mobility can be considered as one of the factors that make this result logical.

2- The age status of individuals is also one of the factors influencing the choice of travel methods. The variables of individuals with an age range of fewer than 18 years and also middle-aged individuals have a significant and positive coefficient (0.490 and 0.540, respectively) in the desirability of the option of non-motorized transportation. Also, this coefficient for the elderly in the desirability of choosing the option of motorized transportation is significant and has a negative value (-0.151). In other words, the use of motor transport for the elderly is undesirable. Therefore, according to the results, the tendency to use non-motorized transportation is less seen only in the young age group.

Table 7
Model developing results of multiple logit mode choices of motorized versus non-motorized travel mode

Mode choice option	**Variable**	**Coefficients**	
		Amounts	The significance level
Unmortised transport	Constant	0.656	0.000
	Low_Age	0.490	0.000
	Midage	0.540	0.000
	HouseKeeper	0.604	0.000
	HH	0.072	0.000
	Cyc_Owner	0.100	0.000
	Com_D	1.510	0.000
	Shop_Aim	0.391	0.000
	Medical_Aim	-0.522	0.002
	Recreation_Aim	0.609	0.000
Mortised transport	Old	-0.151	0.021
	DL	0.467	0.000
	High_Edu	0.277	0.000
	Uni	-0.239	0.010
	Stu	-0.642	0.000
	Employ	0.500	0.000
	Car_Ownr	0.314	0.000
	Num	0.241	0.000
	Work_Aim	0.230	0.000
	Net_len	0.727	0.000
LL(β)= -12290.11		LL(C)= -18230.01	LL(0)=-22217.45
ρ2C= 0.326		ρ20= 0.447	
$\chi^2_{20}(\mathbf{0.01\ d.f}) = \mathbf{37.57}$		$-2[LL(0) - LL(\beta)] = 19854.67$	
$\chi^2_{20}(\mathbf{0.01\ d.f}) = \mathbf{37.57}$		$-2[LL(C) - LL(\beta)] = 11879.80$	
	Number of observations=32053	**umber of model coefficients = 20**	**Number of independent variables = 19**

3- As expected, having a license (coefficient 0.467 and significant) is one of the effective factors in choosing to use motorized transportation in inner-city trips.
4- Also, ownership of motor and non-motor vehicles has a direct effect on the choice of homogeneous travel methods. In other words, bicycle ownership (significant coefficient of 0.100) is effective on the choice of non-motorized transport and motor vehicle ownership (significant coefficient of 0.314 and significant) is effective on the choice of motorized transport.
5- The household size also has a significant and positive coefficient (0.072) in the desirability of the non-motorized transportation option. In other words, with the increase of the family size, the needs of the family and consequently the travel of the family increase. So short trips, such as daily shopping, increase, with people preferring to travel on foot rather than using motorized transportation.
6- One of the most important variables affecting the way of traveling is the purpose of the trip. As can be seen in Table (7), the goals of medical travel, shopping, and leisure are significant in the desirability of non-motorized transport options and have coefficients of -0.522, 0.391, and 0.609, respectively. In other words, when the purpose of travel is compulsory, such as medical cases, the convenience of the normal use of non-motorized travel methods becomes undesirable, and when the purpose of travel is optional, such as shopping and entertainment, one can use non-motorized transportation with more open hands. This is also reflected in the desirability of using the option of using motorized transportation. Because the use of motorized travel methods for compulsory purposes such as work is desirable (work goal has a significant and positive coefficient of 0.230).
7- As can be seen from the results, people with a bachelor's degree or higher have positive desirability (0.277) in choosing the option of motor transportation. This result is one of the contradictory results of individual thought. Because of a scientific point of view, with the increase of literacy, the culture of using non-motorized transportation on motorcycles should increase, while the result is quite the opposite. In justifying this phenomenon, it can be said that in small cities such as Qazvin, according to the existing observations and also to show the superiority of the welfare index, more literate people instead of showing a higher culture using non-motorized transportation, to show the level of welfare They mostly use motorized transportation [32].
8- The destination trade rate variable, which is one of the environmental characteristics of the travel destination area, has a significant and positive coefficient (1.510) in the desirability of the non-motorized transportation option. Thus, increasing this rate, like the purpose of the shopping trip discussed earlier, increases the use of non-motorized transportation. In other words, it can be said that by increasing the business space and more options in the destination area of the trip, the use of non-motorized transportation to achieve the purpose of the trip can be useful.
9- According to the developed model, university students and school students have significant and negative coefficients (-0.239 and -0.642, respectively) in the desirability of the option of using motorized transportation. This group of people is among the groups that naturally lead to the use of non-motorized transportation due to having more time, more daily needs for shorter trips such as buying the equipment they need, and also eager to travel with their friends of the same age. Also, due to the requirement to be present at a fixed time to start and have a fixed time to finish work and possibly due to having a service or vehicle ownership, employees often tend to use motorized transportation (0.500).
10- The variable of the number of trips in the tour has a significant positive coefficient (0.241) in the desirability of the option of using motorized transportation. Therefore, by making more trips in the travel chain, people are more inclined to use motorized transportation.
11- Another important factor influencing the choice of motor travel is travel distance. As the results show (significant coefficient 0.727), with increasing travel distance, the tendency to use motor transportation increases, and this is obvious. This is because the use of non-motorized transport also has a threshold at best, and if the distance exceeds this limit, a transition between modes of travel will occur.

4.3. Choosing the method of walking against cycling

In this section, as in the previous section, the results of the developed model of the travel behavior of individuals in terms of choosing a pedestrian-cycling travel method with multiple logistics structures for a full day period are presented. At this stage, by developing more than 200 models of multiple logits in the forward and backward methods, the effect of various variables (continuous and dual) and their logical combination were investigated. The best model was selected. The results of the model are presented in Table (8) and can be seen:
1- The coefficients of 4 variables (age variables, household size, and bicycle ownership) in terms of the sign, like the multiple logit model for choosing the travel mode of motorized versus non-motorized transport, are present in the desirability of the options and according to the serious selection options (Motorized transport) are only slightly different and will have the same interpretations as before.
2- The variable of the area of the destination area has a negative coefficient in the desirability of the walking option. In other words, increasing the area of the travel destination reduces the likelihood of using the walking method. Therefore, since the average distance between areas increases with the area of the zones, with the increase of this variable, the person has to travel more distances on average to travel, and this increases the time spent by the person.
3- The purpose of the trip is influential in mode choice. In other words, the purpose of the business trip is to choose the method of walking with undesirable (-0.446). Also, the use of cycling for recreation (0.544) and walking for

education (0.581) are other results obtained from the model.

4 - Another important factor influencing the choice of walking mode like the previous model, is travel distance. As the results show (significant and negative coefficient -0.133), with increasing travel distance, the tendency to walking decreases, and this is obvious. This is because the use of non-motorized transport has a threshold at best, and if the distance exceeds this limit, a transition between modes of travel will occur.

5. Another factor that affects the choice of cycling travel is gender. As can be seen from the model, the choice of cycling for men is desirable (2.756) and this can be due to the less freedom of action of women in small towns and the unwillingness of this group to use this vehicle.

6- According to the results of the model, one of the variables that create unfavorable conditions for using bicycles as a way of traveling is education and illiteracy (-0.237).

7- The relatively high constant value of the model (5-147) indicates the quantitative difference between the options and the absence of useful variables to identify the behavioral mechanism of cycling selection or the unknowns of the model. Perhaps in the presence of more appropriate variables in the data, the obtained model could have significantly improved.

Table 8
Multiple Logit developed model results for choosing a pedestrian-cycling travel method

Mode choice option	**Variable**	**Coefficients**	
		Amounts	The significance level
Walking	Low_Age	0.295	0.006
	Fem_Midage	1.501	0.007
	HH	0.161	0.000
	Area_D	-0.003	0.087
	Work_Aim	-0.446	0.003
	Education_Aim	0.581	0.000
	Net_len	-0.133	0.000
Riding	Constant	-5.147	0.000
	Male	2.756	0.000
	UnEducated	-2.037	0.005
	Cyc_Owner	1.157	0.000
	Recreation_Aim	0.544	0.006
LL(β)= -1683.652		LL(C)= -2234.492	LL(0)= -5685.886
ρ^2_C= 0.247		ρ^2_0= 0.704	
$\chi^2_{12}(0.01\ \mathbf{d.f}) = 26.22$		$-2[LL(0) - LL(\beta)] = 8004.469$	
$\chi^2_{12}(0.01\ \mathbf{d.f}) = 26.22$		$-2[LL(C) - LL(\beta)] = 1101.681$	
	Number of observations = 8203	**Number of model coefficients = 22**	**Number of independent variables = 11**

4.4. choosing a travel mode for motor transport, walking, and cycling

In this section, as in the previous sections, the results of the developed model of people's travel behavior in terms of choosing the method of motor travel, walking, and cycling with multiple logistics structures for one full day are presented. In this stage, by developing more than 200 multiple logit models by forward and backward methods, the effect of various variables (continuous and dual) and their logical combination were investigated. The best model was selected. The results of the model are presented in Table (9) and can be seen:

Table 9
Results of multiple logits developed mode choice model of motor, pedestrian, and bicycle

Mode choice option	**Variable**	**Coefficients**	
		Amounts	The significance level
Walking	Low_Age	1.097	0.000
	Midage	0.462	0.000
	HouseKeeper	0.803	0.000
	HH	0.153	0.000
	Com_D	0.982	0.001
	Shop_Aim	0.349	0.000
	Medical_Aim	-0.512	0.003
	Recreation_Aim	0.561	0.000
Riding	Constant	-4.705	0.000

	Male	2.930	0.000
	UnEducated	-2.495	0.000
	Cyc_Owner	1.028	0.000
	Recreation_Aim	1.072	0.000
	Net_len	0.238	0.000
Mortised transport	DL	0.529	0.000
	Employ	0.598	0.000
	Car_Ownr	0.310	0.000
	Num	0.095	0.000
	Peak	-0.065	0.053
	Work_Aim	0.247	0.000
	Net_len	0.736	0.000
LL(β)= -14005.85	LL(C)= -20465.502	-35213.820 LL(0)=	
ρ^2_C= 0.316	ρ^2_0= 0.602		
$\chi^2_{21}(0.01\ d.f) = 38.93$	$-2[LL(0) - LL(\beta)] = 42415.939$		
$\chi^2_{21}(0.01\ d.f) = 38.93$	$-2[LL(C) - LL(\beta)] = 12917.305$		
	Number of observations = 32053	**Number of model coefficients = 21**	**Number of independent variables = 18**

Since the present model is the same as the first mode model, or in other words, the choice of motorized versus non-motorized travel mode by considering different non-motorized modes or the same as the second mode model, it is expected that the model variables are approximately the same as the previous two-mode models. It has also happened. All variables in the model have signs and interpretations similar to the previous two models. The only variable added in this mode is the time-of-day travel variable. According to the model, traveling during the peak period of the day to use the method of motor transportation creates disadvantages. Obviously, during the peak period of the day, due to the high density of vehicles and also the fatigue and nervous consequences of staying in the density, people are less inclined to use motor vehicles.

4.5. Evaluation of mode choice models

As mentioned in the previous sections, different criteria are used to evaluate discrete selection models, the results of some of these criteria used in this study are presented below.

4.5.1. coefficients of models

One of the most basic validation tests of developed models is to check the amount and sign of the calculated coefficients. As mentioned in the previous sections, all the coefficients of the models have the expected sign and relative values.

4.5.2. Probability value

The probability value is used to determine the significance level of each of the explanatory variables of the model with a specific confidence level. According to the results presented in Tables (7) to (9), almost most of the explanatory variables of the multiple logit model are significant at the confidence level of more than 0.95.

4.5.3. Fit Test

This statistic indicates the improvement or non-improvement of the developed models compared to each other and its range is between 0 and 1 so that the closer ρ^2_0 and ρ^2_C are to 1. It indicates that the obtained model is better than the reference model. In this study, the fit (ρ^2_c) for the models presented in Tables (7) to (9) is 0.326, 0.247 and 0.316, respectively.

4.5.4. Percentage estimate index

After developing the models, the probability of selecting each option for all observations is calculated and the option that has the highest probability is considered as the model option for this observation. The percentage of prediction conformity with the observations is the percentage of correct estimation. Tables (10) to (12), respectively, the value of this index for the constructed models. First mode: motorized and non-motorized transport, second mode: walking and cycling, and mode Third: show motorized transportation, walking, and cycling.

Table 10
Prediction of multiple logit model mode choices of motorized versus non-motorized

Observation - Estimate	Unmortised transport	Mortised transport	Total
Unmortised transport	4285	3918	8203
Mortised transport	3918	19932	23850
Total	8203	23850	32053
Correct estimate = 75.55%			

Table 11
Prediction of multiple logit model mode choice of walking versus cycling

Observation - Estimate	Walking	Riding	Total
Walking	7076	492	7568
Riding	492	143	635
Total	7568	635	8203
Correct estimate = 88.00%			

Table 12
Prediction of multiple logit model mode choices of motorized, walking, and cycling

Observation - Estimate	Walking	Riding	Mortised transport	Total
Walking	3766	210	3592	7568
Riding	219	51	365	635
Mortised transport	3525	375	19951	23850
Total	7510	635	23908	32053
Correct estimate = 74.15%				

4.5.5. Likelihood ratio test

This test is performed to validate the whole model (comparing the estimated model with the base model) and shows whether the difference between LL (β) and LL (0) is significant for the model. In this study, the likelihood ratio for the constructed models is the first mode: motorized and non-motorized transport, second mode: walking and cycling, and third mode: motorized transport, walking, and cycling, relative to the equal share of 1985/67 against the critical value of 37.57 respectively, 8004.469 against the critical value of 26.22, and 42415.939 against the critical value of 38.93. Also, these values are equal to 11879.80 against the critical value of 37.57 and 1101.589 against the critical value of 26.22, and 12917.305 against the critical value of 38.93, respectively, this means that the explanation of the multiple logit model is significant for the mentioned models with a confidence level of more than 99%.

5. Conclusion

In this study, first, the data obtained from questioning the origin-destination sample of Qazvin residents were reviewed to implement the proposed concepts, review and evaluate the results. Then, to study the travel behavior of people in mode choice, modeling is presented in three modes, including the first mode: motor and non-motor transport, the second mode: walking and cycling, and the third mode: motor transport, walking, and cycling, using discrete choice models. Some of these results are:

1- The age status of individuals is one of the important factors influencing the mode choice, as people in different age groups than young people are more inclined to use non-motorized transportation.

2- Gender is one of the individual factors that affect the use of bicycles. Basically, in Iran and small urban communities, the use of bicycles by women is less common.

According to the results, education as another individual factor can be a barrier to the use of non-motorized transportation. As mentioned earlier, in addition to the small size of the city, these people have shown a greater tendency to use motorized transportation to demonstrate the superiority of the cultural and welfare index.

4. Having a license and ownership of a personal car, as expected, have a positive effect on the use of motor transport. Bicycle ownership also has a similar effect on the use of non-motorized transportation, and especially the use of cycling.

5 - One of the most important variables affecting the way of travel is the purpose of travel. According to the results, people tend to use motorized transportation for compulsory travel such as medical and work, and non-motorized transportation for voluntary travel such as shopping and entertainment. In other words, when the purpose of travel is compulsory, such as medical cases, the usefulness of normal non-motorized travel methods becomes undesirable, and when the purpose of travel is optional, such as shopping and leisure, one can use non-motorized transportation to buy more freely. Have more free time.

6- Another important factor influencing the choice of motor travel is travel distance, which is one of the characteristics of the network. As the travel distance increases, so does the tendency to use motorized

transportation, and this is a matter of course. This is because the use of non-motorized transport has a threshold at best, and if the distance exceeds this limit, a transition between modes of travel will occur.

7- Variables related to land use, such as the destination trade rate variable, which is one of the environmental characteristics of the travel destination area, are among the factors affecting the use of non-motorized transportation. In other words, it can be said that by increasing the business space and more options in the destination area of the trip, the use of non-motorized transportation to achieve the purpose of the trip can be useful.

8- Job-status is also one of the variables related to personal characteristics that can affect the mode choice.

9- The density of the peak period leads to a decrease in the desirability of using motorized transportation when traveling during this period of the day.

10. More trips in the travel chain make people more inclined to use motorized transportation.

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