Role of built-environment, lifestyle, attitude and behavioral factors on mode choice-case of grocery shopping in Tehran

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Abstract

Understanding the effective variables on mode choice of grocery shopping trips is very important, considering the high frequency of these trips. Although previous studies show that attitudes (personal preference) play an essential role in mode choice, few studies investigate the effect of heterogeneity of these factors in mode choice of grocery shopping. This research investigates the role of socioeconomic, built-environment, lifestyle, attitude, and behavioral variables on taste variation of individuals in mode choice of grocery shopping trips.

398 individuals are surveyed in chain grocery stores of Tehran in May 2016 and factor analysis is used to identify latent variable such as safety, pedestrian-oriented, mode flexibility. Furthermore, a mixed logit (MXL) model is employed to test heterogeneity among individuals. Results of MXL model show that several socioeconomic, mode attributes and attitude variables have significant effects on mode choice for grocery shopping activities. Besides, male variable in bus mode and travel time in walking mode is heterogeneous variables among parameters with random normal distribution coefficient for grocery shopping destinations. Moreover, the results of the random coefficient analysis show that the existence of a shopping center in the CBD without parking spaces for bus mode and household car ownership (two or more) for walking mode are the primary sources of heterogeneity of grocery shopping trips. Findings suggest that considering policies like parking management, especially in CBD and development of public transit stations, based consistent with the development of pedestrian facilities, increase the likelihood of using transit. Also, policies like optimal grocery shopping malls sitting in all areas of the city increase the likelihood of using walking mode.

Keywords: Attitude, lifestyle, built- environment, Mode Choice, grocery shopping

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1. Introduction

Finding the important variables in Mode and destination choice models are among the primary concerns for policymakers. Also, the negative consequences of car use, along with deficiencies for investment in environmentally friendly modes, have driven authorities to incentivize shift to other modes [Ehteshamrad et al., 2019]. Today, in addition to socioeconomic and mode-related variables, latent variables like attitude (personal preferences), lifestyle, and behavior factors provide the more realistic representation of the choice process [Ben-Akiva et al., 2002; Walker and Ben-Akiva, 2002]. Johnson's study showed that, in addition to cost and travel time, environmental and comfort variables also influence the mode choice [Johansson and Heldt, 2006]. Scheiner and Holz-Rau studied the relationship between socioeconomic, mode attributes, lifestyle, and residential location choice with travel behavior of the individuals [Scheiner and Holz-Rau, 2007)]. Based on their results, lifestyle influences mode choice. In another study conducted by Van Acker et al., results indicated how residential and travel attitudes affect the decisions regarding residential location choice and travel behavior [Van Acker et al., 2014].

Besides, neglecting the possible heterogeneity of the data during modeling might cause significant biases in the estimations [Hosoda, 1999]. For example, some people might inherently be time-centric, while others may not. Therefore, ignoring the effect of taste variation can be contemplative [Chamberlain, 1984].

On the other hand, the mode choice depends on the trip purpose. Because of the possibility of destination change in non-mandatory trips such as shopping trips, these trips are more dependent on the behavior of travelers. So, mode choice models are more complicated for these trips than the mandatory activities such as working and education trips [Miller, Roorda, and Carrasco, 2005].

Shimazaki et al. reported that shopping is the second most frequent type of trip in major cities of Asia country [Shimazaki et al., 1994]. Based on the Department of transport, Local Government, and the Region, shopping trips have a share of 20% of car travels in the United Kingdom (UK). According to the United States National Household Travel Survey in 2009, the share of shopping trips is about 19.6% of all the trips. Also, based on Tehran transportation comprehensive study in 2016, shopping trips have the highest share of non-mandatory trips in Tehran, which is 16% of all trips.

The work presented here addresses two objectives. First, it will be probe the effect factors in the mode choice of grocery destinations using the Multinomial (MNL) model with a focus on latent factors such as flexibility and safety as a baseline. Second, it will be determined the effect of taste variations of individuals in mode choice models. Therefore, an MXL model will be used to identify variables with random effects. Also, the source of heterogeneity will be determined by the coefficient analysis method.

The remainder of this paper is organized as follows: The next section includes a literature review of the effect of attitude on mode choice and also identifying effective variables in mode choice of shopping trips. The research methodology and data collection are stated in the third section. The statistical analysis of the data are presented in the fourth section. The results and discussion on heterogeneity and affective variables in mode choice of the shopping trips are described in the fifth section. Finally, the paper is concluded in section six.

2. Literature Review

Identifying effective factors on mode choice is

one of the main concerns of urban policymakers. There are many studies on mode choice in Iran. For instance, Haghshenas, Talebi, and Noori studied mode choice in the presence of congestion pricing and improving public transportation policies in Isfahan. The results show that congestion pricing has the most impact on mode choice for both of the nan-mandatory and mandatory trips [Haghshenas, Talebi, and Noori, 2019]. Samimi, Rahmati, and Sadeghi investigated the effects of HOT lane on mode choice. Through a stated preference survey, respondents are given three alternatives and asked to choose their preferred travel mode. The alternatives are: 1) SOV users pay the toll and use HOT lanes, 2) HOV users use HOT lanes for free, and 3) SOV users use general-purpose lanes for free. Results indicate that users are more sensitive toward changes in variables in their "Go" trips, and "toll amount" is the most effective variable on users' mode choice decisions [Samimi, Rahmati, and Sadeghi, 2016]. Hanifi, Shahangian, and Mamdoohi investigated the effects of attitude variables on mode choice in Tehran. The results show that attitude variables only affect taxi mode. Also, congestion pricing and parking pricing were two main policies to reduce private car utility, while travel time impact on public mode choice [Hanifi, Shahangian, and Mamdoohi, 2017].

There are many studies about effective variables on mode choice of occasional shopping trips (e.g. personal shopping), but there are a limited number of studies on mode choice of grocery shopping trips. Mode choice for general shopping varies depending on multiple factors such as gender, household types, income level, presence of children, and children's age group, and car ownership [Handy, 2000]. A study conducted by Bhat found that unemployed individuals are more likely to use public transportation for general

shopping trips than employed individuals [Bhat, 1998)]. Guo et al. showed that household size, being a female, and age (older than age 65 years) increases the likelihood of using a private car. While household's income level, the number of vehicles in the household, and employment status decrease the likelihood of using Non-motorized mode for grocery shopping. Generally speaking, gender, employment status, income, car ownership are essential socio-demographic factors in mode choice of shopping trips [Guo, Bhat, and Copperman, 2007].

Factors relevant to the built environment have significant effects on the mode choice for shopping trips. For instance, Scheiner and Holz-Rau studies showed that increasing the distance to the closest grocery story by more than 325 meters will increase the probability of using a private car for the trip [Scheiner and Holz-Rau, 2007]. Also, another study showed that the car is the primary transportation mode for grocery shoppings at a distance more than 670 meters [Scheiner, 2007]. Frank and Pivo found that employment density, population density, and land use mix have increase the probability of using public transportation [Frank and Pivo, 1994)]. Overall, the distance between activities, development density, land use mix, and street network connectivity are some of the built environmental factors which impact the mode choice for the shopping trips [Steiner, 1998; Cervero, 2002; Moudon et al. 2006, McCormack, Giles-Corti and Bulsara, 2008; Scheiner, 2007].

Traditional models in the literature employed socioeconomic variables and alternative attributes to explain the mode choice behavior. However, these are not the only variables that explain heterogeneity in the mode preferences. It has been well accepted that attitudes and perceptions play essential roles in the decision-making process [McFadden, 1986].

Values make individual attitude and attitudes influence individual behaviors. So, values can provide predictive and explanatory power in the analysis of attitudes. Moreover, values can reflect the significant social change in societies and across nations [Schwartz, 1992]. Studies on abstract variables such as values, lifestyle, and attitudes might influence travel mode choice [Choo and Mokhtarian, 2004; Collins and Chambers, 2005]. So, using latent variables with observed variables provide more explanatory power [Walker and Ben-Akiva 2002]. The effect of attitude, lifestyle, behavior, and psychology factors on travel behavior have also been investigated. For example, in a review, Scheiner and Holz-Rau studied the connection between socioeconomic attributes, life situation, and lifestyle, choice of residential location, and travel behavior of the individuals. They employed data from a survey in Cologne, Germany, to develop Structural Equations to identify effective variables on mode choice. Based on their results, lifestyle can influence the mode choice, even when life situation such as income is controlled [Scheiner and Holz-Rau, 2007]. Outwater et al. use structural equation modeling to identify the attitudes of traveler behaviors and the causal relationships between the traveler's socioeconomic profile and traveler attitudes [Outwater et al., 2003)]. Hosoda (1999) worked on the mode choice models for shopping trips employing both latent variables and latent classes. Results showed that there would be a significant bias in the parameter when there is not any proper model of heterogeneity in the sample. Besides, it suggested that attitudinal variables are included through appropriate hybrid choice models [Hosoda, 1999]. Morikawa and Sasaki and Morikawa et al. considered modal comfort and convenience in their analyses of mode choice [Morikawa and Sasaki, 1998 and Morikawa et al., 2002]. Mahpour et al. conducted a study on

destination choice of shopping trips by the ICLV model in Tehran. Two types of shopping were selected: shopping for clothing and grocery shopping. The results show that that personal attitude towards shopping malls and lifestyle indeed impacts destination choice [Mahpour et al, 2018]. Furthermore, Golob used different models to explain how mode choice and attitudes regarding tolled high-occupancy vehicle lanes in San Diego differed over the population [Golob, 2001]. Study on the effects of attitude and lifestyle on vehicle type choice showed that attitudes, personality, and lifestyle are essential to mode choice, in ways that are relevant to transportation planners and policymakers as well as vehicle manufacturers [Choo and Mokhtarian, 2004]. In a study, Johansson et al. analyze the effect of the behavioral and attitude variables on mode choice of Swedish commuters. They reported that both attitudes towards flexibility and comfort, as well as being pro-environmentally inclined, have an essential role in mode choice and enable policymakers to improve transportation systems concerning the behavior of travelers [Johansson and Heldt, 2006]. Walker and Li study lifestyle preferences with data from Portland, Oregon. They identify different latent classes of individuals that have different residential location choices, resulting from their lifestyle preferences that affected mode choice [Walker and Li, 2007]. Atasoy et al. were employed to integrate latent attitudes of the individuals into a transport mode choice model through latent variable and Latent class models (LCM). First, they presented an integrated choice and latent variable (ICLV) models that consider attitude toward public transportation. Then, they gave an integrated choice and LCM, which identified two classes of individuals having different sensitivities to the attributes of the alternatives, resulting from their characteristics. The results showed the importance of attitudinal

variables in the characterization of heterogeneity of mode preferences within the population [Atasoy, Glerum and Bierlaire, 2013)]. Domarchi et al. investigated the effect of attitude on university workers. Results showed that these factors, in addition to the impacts on mode choice, improve the goodness of fit index [Domarchi, Tudela and González, 2008)]. Galdames et al. studied the role of psychological factors in mode choice for work trips. They used Triandis's theory of interpersonal behavior to identify the effects of an individual's attitude in mode choice. They reported that attitude variables such safety, convenience and so on has an essential role in improving fitness index [Galdames, Tudela, and Carrasco, 2011]. In a study by Sarkar and Mallikarjuna on effects of perception and attitudinal variables on mode choice in Agartala of India, mode of comfort and flexibility factors identified as effective variables on mode choice. Also, the outcome of the ICLV model showed that perception and attitude have an essential role in an individual's mode choice [Sarkar and Mallikarjuna, 2018]. So, according to the studies mentioned above, attention to the attitude and behavior of travelers and the relationship between these two factors are crucial in studying the travel behavior, especially mode choice. According to literature review, there is no comprehensive study on integrated effect of value, attitudes, and behavioral factors on mode choice of grocery shopping trips. So this study focuses on determining effective behavioral variables on mode choice of grocery shopping trips. Besides, the MXL model are employed due to its ability to identifying taste variation and heterogeneity.

3. Study Area

3.1. Study Design and Sampling

The setting of this research is Tehran, the capital of Iran (more than 13000000 populations in the 2016's census). In recent years, the development of malls has proliferated. In Tehran, private car, taxi, mass transit, bus, biking, motorcycle, and walking are the dominant modes of transportation in Tehran. The level of public transportation network coverage and active mode facilities affect mode choice for grocery shopping. The objetcitves of this study are identifying effective factors in mode choice models for grocery shopping activities. Before conducting the primary survey, a pilot study was conducted to assess the correct functioning of study procedures and instruments. A total of 210 questionnaires were distributed among the costumers of different shopping centers in Tehran. Data validation was undertaken by comparing the sample data with the Tehran comprehensive transportation studies. The pilot survey resulted in a minor revision of the questionnaire.

In the next step, a final questionnaire was designed and distributed among 398 costumers (between 15 -75 age) at four grocery shopping malls in Tehran city. To ensure that the sample is random, one customer was surveyed per every ten customer exiting the shopping center. We emphasized on customers leaving the centers because the shopping time and the amount of money spent were known at the time of departing the store. Geographic situation of Tehran and the location of the selected shopping destinations are presented in figure 1 and Table 2, respectively.

Krejcie and Morgan used the following formula to determine sampling size [Galdames, Camila, Krejcie and Morgan, 2016]:

$$S = \frac{\chi^2 NP(1-p)}{d^2(N-1)} + \chi^2 p(1-p) \qquad (1)$$

S = required sample size

χ^2 = the table value of chi-square for one degree of freedom at the desired confidence level

N = the population size

P = the population proportion (assumed to be 0.5since this would provide the maximum sample size)

d = the degree of accuracy expressed as a proportion.

Table 1. Some previous studies related to mode choice for grocery shopping trips

Study authors	Research design	Statistical analysis method	Explanatory variables	Main finding	Most critical variable for mode choice
Haghshenas et al.	Cross sectional, in Isfahan (2019)	MNL model	Socio-demographic, congestion and parking price	Increasing congestion pricing have the most effect on mode choice	Congestion pricing
Hanifi et al.	Cross sectional, in Tehran (2016)	MNL model	Socio-demographic, congestion pricing and attitude variable	Attitude variables impact on taxi mode choice, while congestion pricing reduce to use of private car	Congestion pricing, travel Time, attitude variable
Handy	Cross sectional, in USA (2000)	MNL model	Socio-demographic,	Income, presence children, and children age have more effect on mode choice, car ownership plays a vital role in mode choice for shopping trips,	Income, presence children, carownership
Scheiner and Holz-Rau,	Cross sectional, in Germany (2007)	SEM model	Socio demographic, built environment, life style and life situation.	increasing distance to the closest grocery story more than 325m, it will increase using private car lifestyle influence mode choice, even when life situation is controlled	Distance to grocery shopping
Mahpour et al.	Cross sectional, in Tehran (2018)	ICLV model	Socio demographic, built environment, life style , attitude and shopping-orientation	personal attitude toward clothing shopping center and lifestyle indeed impact destination choice	Lifestyle and distance to clothing shopping center
Johansson and Heldt	Cross sectional, in Switzerland (2006)	ICLV model	Socio demographic, built environment, attitude.	attitudes towards flexibility and comfort, as well as being pro-environmentally inclined, have an essential role in mode choice	Attitude and built environment variabls.

| Study authors	Research design	Statistical analysis method	Explanatory variables	Main finding	Most critical variable for mode choice
Atasoy et al.	Cross sectional, in Switzerland (2006)	LCM & ICLV model	Socio demographic, built environment, attitude.	results showed the importance of attitudinal variables in the characterization of heterogeneity of mode preferences within the population	Attitude and attributes of the alternatives
Sarkar and Mallikarjuna	Cross sectional, in India (2018)	ICLV model	Socio demographic, built environment, attitude	Comfortable and flexibility factors identified as effective variables on mode choice.	Attitude variables

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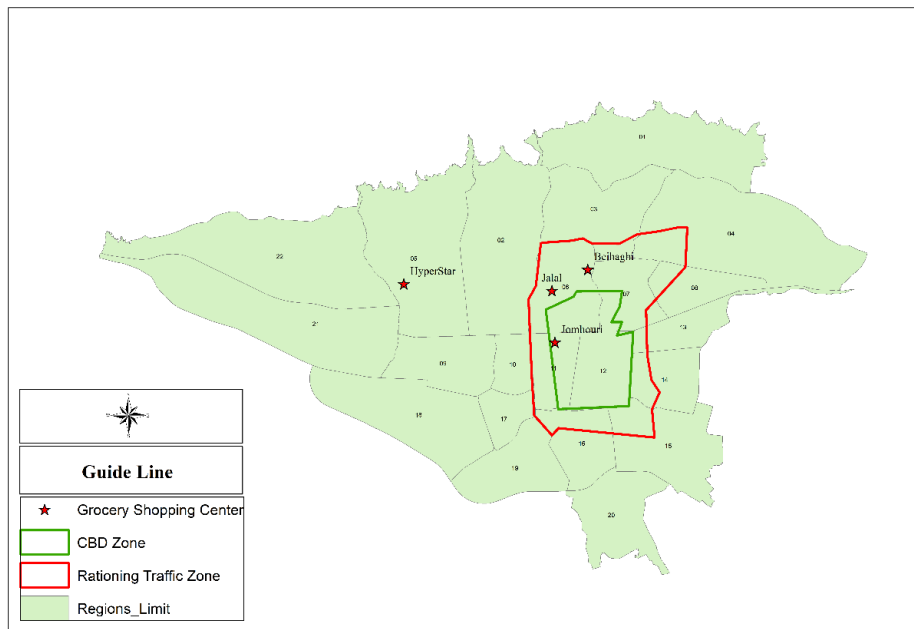
Figure 1. Geographic situation of Tehran and location of the selected shopping destinations

Table 2. Several characteristics of the selected shopping malls (Mamdoohi et al. 2016)

Category	Shopping mall	District	CBD	Private parking?
Grocery	Beihaqhi	6	☒	☒
	Jalal	6	☒	☒
	Hyper Star	5	☒	☑
	Jomhouri	11	☑	☒

According to the formula (1), the minimum sample size for 8.9 million population of Tehran city would be 385. In order to ensure the adequacy of the number of correct questionnaires, 398 questionnaires were collected

3.2. Results

According to Tehran Municipality Transport and Traffic Statistics, private car, Taxi, bus, subway have 40%, 22%, 20%, 18% share of mode choice in Tehran, respectively. Data analysis on mode choice showed that motorcycle and bicycle have lower shares (less of 5 percent). Also, 15% of travelers use the walking mode. Thus, cycling for grocery shopping trips not considered. Based on the data analysis, mode choice for grocery shopping trips classified into five groups (private car, taxi, bus, subway, and walking). Descriptive statistics of socio-economic variables showed

that the average age of respondents is 38.75. Regarding gender, 42.71 percent of grocery customers are male, and the rest are female. A total of 78.64 percent of customers have a driving license (Table 3). Further, households owned no car have a minimum share (1.5 percent), while households with two-car ownership have the maximum share. Moreover, only 5.53 percent were retired, while the rest of the customers have a part-time or full-time job. Also, 65.73 percent of responders have high level of education (BS and higher). Analysis data showed that 7.03 percent of grocery customers have less than 1 million tomans monthly income, respectively, while most of the customers have income between 2 to 3 million. Also, results showed that individuals with income of over 2 million tomans tend to use private car.

Table 3. Frequency analysis of socio-economic characteristics of the research sample

Characteristics	Categories	Grocery trips
gender	Male	170 (42.71)
driving license status	Has	313 (78.64)
occupational status	Retired	22 (5.53)
Educational status	High school diploma	175 (43.97)
	B.S	186 (46.73)
	M.S & higher	37 (9.3)
Number of private cars owned	0	6 (1.51)
	1	68 (17.08)
	2	262 (65.83)
	3 or more	62 (15.58)
households' monthly Income	Less than 1 milion tomans	28 (7.03)
	1 to 2 milion tomans	129 (32.41)
	2 to 3 milion tomans	169 (42.46)
	More than 3 milion tomans	72 (15.07)
HouseHold Size	1	4 (1.02)
	2	62 (15.86)
	3	145 (37.08)
	4 or more	187 (47.83)

*Numbers in parentheses are relative frequency (percent)
**Us dollar was 3800 toman (01/04/2016)

Table 4. Frequency analysis of the travel mode for grocery shopping trips

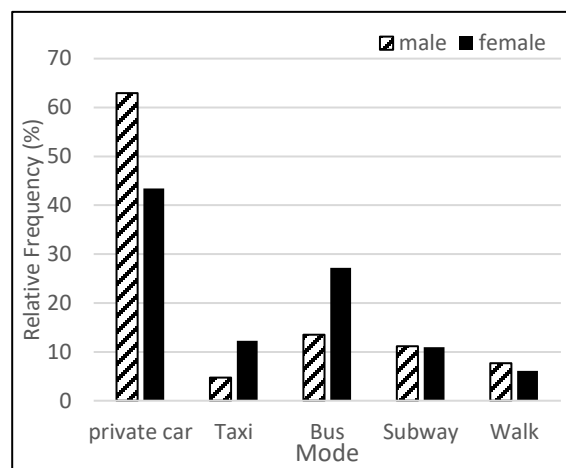| Mode	Grocery shopping trips Frequency	
	Absolute	Relative (Percent)
Private Car	139	34.92
Taxi	57	14.32
Bus	85	21.36
Subway	59	14.82
Walking	58	14.57
Sum	398	100

Figure 2. Relative frequency of mode choice grocery shopping regarding gender

As mentioned, the mode choice for grocery shopping was categorized into five groups. 34.9% of responders tend to use private car mode. In contrast, only 36.2% use public transportation (Bus and Subway) for grocery shopping destinations (Table4).

Regarding gender, men tend to use a private car for shopping purposes, while females tend to use public transportation (Figure 2).

The MNL model is used to determine effective factors on mode choice of shopping purposes. Also, the effect of taste variation on mode choice is investigated by the MXL model. The independent explanatory variables were: socio-economic factors, built environmental and attitude, and behavioral variables (see Table 5 for more detailed descriptions of used variables in models).

4. Methodology

4.1. Measurement Instruments and Modeling Approach

The questionnaire had 6 major sections. The first section questioned shopping orientation (real or recreation shopping orientation) through six questions. 27 questions of section two were supposed to determine lifestyle of people. The third section contained 14 questions about attitude of respondents to the shopping center. The last three sections composing of 40 questions focused on the respondents, their families, and travels details.

Also, lifestyle, attitude, and shopping oriented questions were scored on a Likert scale ranging from 1 to 5 (Table 8-10 in Appendix). Type of shopping-oriented individuals was also assessed

on the Likert scale (1 indicating not at all agree to5 immensely agree). The lifestyle of individuals was determined on the same Likert scale (1 indicating not at all important to 5 extremely important). Also, according to a study by Johnson, two different methods were used for constructing the attitude and behavior variables [Johnson,2006)]. Attitudinal indicator variables erected comfort, convenience, and flexibility, and behavioral indicator variables were used for constructing safety and environmental preference variables. The behavioral questions, which are included using seat belts, bike helmets, and recycling habits, have directly related to safety and environmental preferences. This matter led to that these variables are exogenous to the individual mode choice. Also, these questions were scored on a Likert scale ranging from 1, indicating never to 5 indicating always. Unlike behavioral indicators, attitude indicators could be affected by the chosen mode. So, attitude variables may be endogenous to the selected mode. Attitude indicators also were scored on the Likert scale from 1, indicating not crucial to 5 indicating very important. All three cases the lifestyle, attitude, and shopping orientation instruments have been tested in previous work [Johansson and Heldt, 2006; Schiffman and Kanuk, 2007; Blackwell, Miniard and Engel,2006; Shim and Bickle, 1994, Moye and Giddings, 2002].

Principal components of attitude and behavioral variables along with socio-economic, built environmental and alternative attributes were used as explanatory variables in the discrete choice modeling shopping of trip modes like a private car, public transportation, and walking modes, (Figure 3).

The factor analysis method focuses on reducing dimensions and finding relationships between variables. In other words, it creates underlying dimensions between measured variables and latent constructs [Thompson 2004]. Factor analysis includes two main categories: Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA). The EFA is used when there is no particular theory, and there is little information about the subject, while the CFA is based on previous theories. In this study, Latent variables attained using the EFA method based on collected data of questions of the first to the third part of the questionnaire (measured indicators) [Thompson 2004].

Internal consistency was assessed using Cronbach's alpha coefficients and Average Inter-item correlation (AIC). In Table 9, both of them estimated. The acceptable range for the Cronbach's alpha coefficient and AIC index is above 0.5 and between 0.2 and 0.6, respectively [Lima, Barreto and Assunção, 2012].

The Kaiser-Meyer-Olkin (KMO) test was performed to analyze the feasibility of factor analysis. This measure may vary between 0 and 1; high values of sphericity mean that the variables are correlated, and the analysis is feasible. In this study, KMO was 0.64. Bartlett's test of sphericity was also performed. In the Bartlett test, P-value was less than 0.05, so there is a significant relationship between the variables, and new components can be defined between variables.

Table 5. Variables description and symbol by category for grocery shopping purpose

Category name	Symbol	Type of variable	response category
Personal /household information	withspo	Binary	1: a trip with spouse; 0: otherwise
	fulltijo	Binary	1: if individuals have full-time job ; 0: otherwise
	liemp	Binary	1: if individuals employee who have a driving license; 0: otherwise
	male	Binary	1: male, 0: otherwise
	fmwfr	Binary	1: females with friends, 0: otherwise
	hhc1	Binary	1:households costs <1million tomans, 0:otherwise
	fhfm	Binary	1: females who come from home ; 0: otherwise
	age2	Binary	1: individuals with age<=25, 0: otherwise
	fwfm	Binary	1: females who come from work ; 0: otherwise
	mlice	Binary	1: a male who have a driving license, 0: otherwise
	nv5	Binary	1: number of household carownership>=3, 0: otherwise
	nv1	Binary	1: number of household carownership=1, 0: otherwise
Built environmental	tveh	continues	Travel time (minute)
	cnp	Binary	1: if the shopping center is CBD but do not have parking, 0: otherwise
	dtp	continues	Distance to the public station (km)
	parking	Binary	1: shopping center has parking, 0: otherwise
Shopping-Oriented	Reaorie	ordinal	real-oriented costumer (5 point- Likert scale, 1 indicating not at all agree to5 immensely agree)
	Recorie	ordinal	recreation-oriented costumer (5 point- Likert scale, 1 indicating not at all agree to5 immensely agree)
Lifestyle	mfambase	ordinal	Male with family-base lifestyle (5 point- Likert scale, 1 indicating not at all important to 5 extremely important)
Attitude	flex	ordinal	Flexibility of the vehicle for performing different activity (5 point- Likert scale, 1 indicating not at all important to 5 extremely important)
	conv	ordinal	Convenience in inside of vehicle (5 point- Likert scale, 1 indicating not at all important to 5 extremely important)

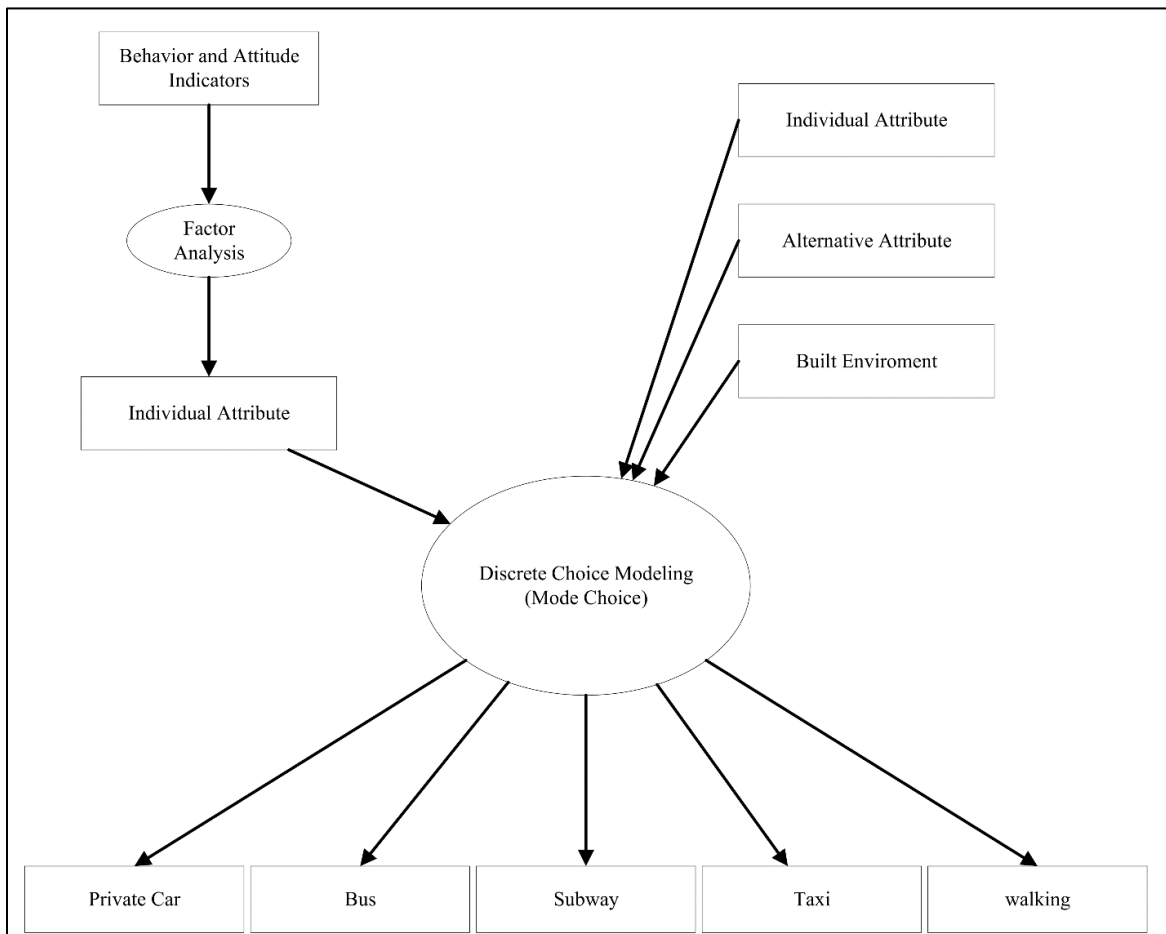| Category name	Symbol	Type of variable	response category
	comf	ordinal	Comfort in accessibility and mobility of travel mode (5 point- Likert scale, 1 indicating not at all important to 5 extremely important)
	saf	ordinal	Individuals attitude toward to safety in vehicle (5 point- Likert scale, 1 indicating not at all important to 5 extremely important)

Figure 3. Proposed Conceptual Framework of current research

4.2. Discrete Choice Models (MNL, MXL)

4.2.1. MNL model

Based on the theory of every individual is a rational decision-maker, maximizing utility relative to his or her choices. The individual's derived utility consists of a deterministic and a random component. The general form of the utility functions assigned to alternative j by individual n is as follow:

$$U\,n_j = \theta\,jn + \beta n\,X\,jn + \varepsilon\,jn \qquad (2),$$

where U_{nj} is the utility of alternative mode j for person n, θ_{jn} is estimable alternative-specific constants, β_n is parameters of observed variables, and ε_{jn} is random error.

The MNL model is a dominant and simple model

in most of the studies to analyze trip behavior. The underlying assumption in this model is Independence from Irrelevant Alternatives (IIA), and this feature is based on simplified assumptions of Independent and Identically Distributed (IID) error term. The assumption of homogeneity in unobservable components is derived from the property of IIA. The probability function for MNL models is [Taherdoost et al.2014]:

$$P_{nj} = \frac{\exp(\theta_j + \beta X_{jn})}{\sum_{j'=1}^{J} \exp(\theta_{j'} + \beta X_{j'n})} \quad (3)$$

MNL model is simple; however, it has disadvantages. One of the disadvantages is ignoring non-systematics taste variations of individuals. The MXL model is a highly flexible model that can approximate different models with random utility and allows model parameters to vary over individuals. In the following, the MXL model is briefly explained.

4.2.2.MXL model

MXL model or random parameters logit is one of the popular approaches to investigate the variation in tastes across individuals. McFadden and Train showed that the MXL model could approximate different models with random utility [Taherdoost, 2014]. In MXL model, some parameters are estimated as random values with distinctive distribution. The general form of MXL Model is as follows [Train, 1980]:

$P_{nj} = \int L_{nj}(\beta) \, f(\beta) \, d(\beta)$ (4),

where P_{ni} is the probability that an individual n chooses alternative i, L_{ni} is probability that an individual n chooses alternative i in MNL model that is a function of β parameter and f(β) is density function. Therefore:

$$L_{ni} = \frac{\exp(\theta_j + \beta X_{jn})}{\sum_{j=1}^{J} \exp(\theta_{j'} + \beta X_{j'n})} \quad (5),$$

where $\theta_j + \beta X_{jn}$ is a utility function.

5. Results and Estimations

5.1. The Baseline (MNL) Model

As mentioned, the first stage of this research aimed to examine the role of socio-economic, lifestyle, built environmental and psychological factors in the mode choice for grocery shopping. Five hundred different models were calibrated in the final model (MNL model).

The results show that car ownership has a positive effect on private car choice, which is consistent with Bocker et al. study. Having a driving license (lice; +1.15) increases the probability of choosing a private car over other modes. Investigating effective factors showed that household car ownership also is a significant factor in mode choice of grocery shopping trips, which is consistent with Bocker et al. Besides, as expected, Travel time has a negative effect on mode choice. Also, the coefficient of travel time shows that individuals are more sensitive to travel time for taxi mode choice of the grocery shopping center. The coefficient of individuals, along with their spouse (withspo: +0.94) shows that couples tend to use a private car. Having parking in shopping centers increases the probability of using private car mode (parking; +1.31). Also, if the shopping center is located in CBD and there is no parking, it will increase the probability of using the bus. The coefficient of distance to public transportation stop in bus mode showed that increasing distance to public transportation (Bus) reduces the likelihood of using these modes. The coefficient of an individual with real shop-oriented (realshop; +0.27) is more likely to use private car mode. Also, the result shows that the attitude of individuals toward to flexibility of vehicle increases the probability of using the private car (flex; +0.42). Also, the results show that females who come from work tend to use taxi mode

(fwfm; +1.75) while females who come from home tend to use subway mode (fhfm;-0.87). On the other hand, females traveling with their friends are more likely to use a taxi mode (fmwfr; + 1.06). Also, the results show that male participants are less likely to use bus mode (male; -1.23) and when they have a driving license, they are less likely to use the subway (Mlice; -1.36).

According to the age of the individuals, individuals under the age of 25 years old are more likely to use subway mode while individual over the 60 years old tends to use walking mode (age2; +1.01 and Age6; +1.31) about the income of individuals. The result shows that people who earn less than one million tomans are more likely to use the subway (Table 6).

Table 6. MNL model result for mode choice of the grocery shopping trips

Variable	Private car		Taxi		Bus		Subway		Walking	
	coeff	t-stat.	coeff	t-stat.	coeff	t-stat.	coeff	t-stat.	coeff	t-stat.
Constant							-.86*	-1.83	.82*	1.75
nv5	1.99***	4.81								
tveh	-.047***	-3.12	-.077***	-4.47	-.021***	-2.70			-.019***	-4.51
withspo	.94***	3.18								
parking	1.31***	4.55								
reaorie	0.27**	2.02								
flex	0.42***	3.09								
fwfm			1.75***	3.76						
fmwfr			1.06**	1.99						
nv1					.98***	2.63				
male					-1.23***	-3.56				
cnp					1.20***	3.93				
dtp					-1.45***	-2.87				
age2							1.01***	2.56		
fhfm							-.87*	-1.94		
hhc1							2.06**	3.66		
mlice							-1.36***	-3.09		
age6									1.31*	1.89

Number of observations=398

LL(0)=-548.40   LL(β)=-378.40   LL(C)=--522.94

$\rho^2 = 0.31$ $\rho_c^2 = -0.28$

-2[LL(0)-LL(β)]=340

-2[LL(C)-LL(β)]=289.08

Note: *** Significant at 1% level; ** Significant at 5% level; * Significant at 10% level

5.2. Individual Taste Variation of Mode Choice for Grocery Shopping Trips

As mentioned, the MXL model is a popular method for performing heterogeneous

analysis. In this study, the MXL model was used to identify the possible sources of any heterogeneity that may exist. In the MXL model, four different distributions were employed to test all coefficients as random coefficients. The

results show that Male variable in bus utility function and travel time in walking utility function have a random normal distribution (see Table 7). The results also showed that other variables were similar to MNL in the case of signs but the magnitude was different.

The random coefficient analysis showed that some parts of random taste variation of the male were explicable by shopping centers without parking. So, not having parking space in shopping centers in CBD is a primary heterogeneous resource of males. In other words, due to having or not having parking in a shopping center in CBD, male have different tendency towards the public transportation. Also, results showed that the individual's sensitivity to walking time for grocery shopping center increase when the number of owned cars by household is two or higher.

Table 7. Result of MXL model for mode choice of the grocery shopping trips

Variable	Distribution of parameter	car		Taxi		Bus		Subway		walking	
		coeff	t-stat	coeff	t-stat.	coeff	t-stat.	coeff	t-stat	coeff	t-stat
Random parameters in utility functions											
male	Normal					-1.70***	-3.56				
tveh	Normal									-0.33***	-2.87
Nonrandom parameters in utility functions											
Constant								-0.93	-1.92	1.47	2.38
nv5		2.10***	4.81								
tveh		-0.05***	-3.30	-.082***	-4.60	-0.024	-2.96				
withspo		0.92***	3.02								
parking		1.29***	4.32								
reaorie		0.28***	2.03								
flex		0.45***	3.17								
fwfm				1.78***	3.79						
fmwfr				1.11***	2.06						
nv1						1.07***	2.57				
cnp						1.39***	4.05				
Dtp						-1.96***	-2.03				
age2								1.03***	2.55		
fhfm								-0.90**	-1.97		
hhc1								2.17***	3.77		
mlice								-1.46***	-3.20		
age6										1.58*	1.87
Standard deviation of random parameters											
NS- male		1.49	1.93								
Ns-tveh		0.11	1.96								
Random coefficient analysis											
Mode alternative	Variable	Source (heterogeneity in mean)		P[|Z| [z]							
Bus	CNP	-1.65***		0.00							
Walking	NV2	-0.17		0.00							

Variable	Distribution of parameter	car		Taxi		Bus		Subway		walking	
		coeff	t-stat	coeff	t-stat.	coeff	t-stat.	coeff	t-stat	coeff	t-stat
Number of observation= 398											
LL(0)=-640.56				LL(β)=-376.38			LL(C)=--622.94				
$\rho^2 = 0.41$				$\rho_c^2 = -0.39$							
-2[LL(0)-LL(β)]=528.36											
-2[LL(C)-LL(β)]=493.12											

6. Discussion and Policy Implication

One of the main concerns of policymaking is to understand the travel behavior of individuals and applying proper policies to reduce the demand for private car ridership. Recent studies have shown that lifestyles, attitudes, and behavior of people play an important role in travel behavior besides the socioeconomic and alternative attribute factors. Shopping trips are mostly influenced by factors such as attitudes, behaviors, and lifestyles of the individuals. Also, studies have shown that the travel behavior of individuals depends on the trip destination and the activity type of the individuals [Ronse, Boussauw, and Lauwers, 2015] Therefore, this research aimed to investigate the role of socioeconomic, built-environment, lifestyle and psychological factors in mode choice for grocery shopping activities. The MXl model was used to test heterogeneity and to identify possible sources of this heterogeneity. Analysis on mode choice of the shopping centers showed that walking mode is essential for grocery shopping trips. This issue is probably because of a short distance from the origin to the grocery shopping destination. According to Ibrahim (2003) and Michel and Schiener (2016), the walking mode is only selected for shopping centers at short distances [Ibrahim, 2003 and Michel and Schiener, 2016]. Also, The MNL model findings showed that attitude, behavioral, lifestyle, real of recreation shopping –oriented and built environment variables play an essential role in mode choice for the grocery shopping besides the socioeconomic variables.

Regarding attitude factors, the results showed that preferences for mode flexibility increase the likelihood of choosing car private over other modes. The lifestyle of individuals affects people's choices, such as the shopping destination or mode choice [Suwanvijit and Promsa 2009]. Shopping-orientation defined as a shopping lifestyle that reflects consumer view about shopping and is related to social class, economic aspect, and so on. Shopping-orientation, as one of the lifestyle indicators, affects the individuals' choice. In this study, the results show that individuals with real shopping-orientation prefer using a private car, and it is less likely to choose a subway as a travel mode. This issue is probably due to the individuals with real-orientation shoppig feels more power and more success in using a private car, and it comes from a lifestyle and values that one has grown up. In a study by Shim and Kotsiopulos, it was also mentioned that the lifestyle and family life cycle are significant factors in predicting shopping orientation [Shim and Kotsiopulos, 1992]. Destination accessibility and distance to transit are one of the built environment variables. Findings show that reducing accessibility by transit system for shopping destincation, reduces the likelihood of using public transport. Moreover, the result showed that not having parking in downtown shopping malls increase the likelihood of using the bus. Access to parking in grocery shopping centers increase the likelihood of using private car. This result is in line with previous works focused on the effect of the built environment on mode choice [Papaioannou and Martinez, 2015; Popovich and Handy, 2015].

Regarding socioeconomic variables, the findings showed that men prefer using the private car over modes. Also, the results showed that increasing car ownership reduces the likelihood of using public transportation mode. Having a driver's license, Spouse's accompaniment, and having a fulltime job has a positive effect on private car choice. This result is in line with previous work. MXL model finding showed that travel time in

walking mode and male (demographic variable) in bus mode for grocery shopping destinations had a random normal distribution. Moreover, Random coefficient analysis showed that household car ownership is a source of heterogeneity for travel time of walking to grocery shopping destinations. In other words, increasing distance between the origins to grocery shopping destination may expand the role of car ownership (two or more) in mode choice. Also, the random coefficient analysis showed that the location of shopping centers in CBD without parking is a source of heterogeneity on bus mode choice for the male. In other words, the factor that makes the sensitivity of males to choosing a bus trip different is the location of shopping malls in the CBD without parking.

Connected to the findings, policies like parking management, especially in CBD and development of public transit stations based on TOD (Transit Oriented Development), increase the likelihood of using public transportation. Encouraging families to travel by public transport and creating incentives for families will increase the willingness to use public transportation for shopping trips. On the other hand, policies like optimal allocation of grocery shopping centers across the city increases the likelihood of walking. Because of studies' lack of self-propelled cars, identifying effective factors on self-propelled cars as the trip mode is suggested for further research. This research could also be extended to a hybrid choice model to examine the simultaneous effect of observed and latent variables in mode choice for the shopping centers.

7.   Acknowledgment

8. References

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9. Appendix

Table 8. **Construct of Attitude and Behavior factors in exploratory factor analysis in mode choice for grocery shopping destination**

Measure of Attitude and behavior individuals in mode choice for grocery shopping destination	Factor loading	Cronbach's α	Aiic
Component 1. 'Environmental'		0.619	0.44
The sound pollution and the air around your place are very important	0.643		
I feel responsible for recycling materials like paper, bottle, etc	0.724		
Component 2. 'Safety'		0.798	0.52
Wearing a bike helmet when riding a bike is important to me.	0.784		
I habit of adhering to prevailing speed limit when driving.	0.689		
Safety belts in cars (Also in the rear seats). Is important for me	0.877		
Component 3. 'comfortable'		0.713	0.51
Traveling in a calm, non-noisy environment is important to me	0.854		
Being able to rest or read while traveling is important to me	0.841		
being able to work while traveling is important to me	0.688		
Component 4. 'convenience'		0.754	0.49
not having to wait for another travel mode while traveling is important to me	0.668		
It's important to know the length of time traveling	0.741		
avoiding queues and congestion while traveling is important to me	0.697		
having little or no variation in her daily travel time is important to me	0.834		
Component 5. 'Flexibility'		0.711	0.48
The respondent's appreciation of being able to shop or run errands while traveling to/from work.	0.698		
The respondent's appreciation of being able to leave/collect children at school or similar while traveling to/from work.	0.754		
Explained variance	48.80%		

Aiic average corrected inter-item correlations

Table 9. **Construct of lifestyle factors in exploratory factor analysis in mode choice for grocery shopping purpose**

Measure of lifestyle individuals of mode choice in grocery shopping destination	Factor loading	Cronbach's α	Aiic
Component 1. 'Fashion-based'		0.691	0.57
I am an active member of more than one service organization	0.735		
I like parties where there is lots of music and talk	0.647		
I usually have one or more outfits that are of the very latest style	0.640		
I often seek out the advice of my friends regarding which brand to buy	0.626		
When I must choose between the two, I usually dress for fashion, not for comfort	0.564		
Component 2. 'Economy-based'		0.698	0.50

Measure of lifestyle individuals of mode choice in grocery shopping destination	Factor loading	Cronbach's α	Aiic
I usually watch the advertisements for announcements of sales	0.798		
I find myself checking the prices in the grocery store even for small items	0.719		
A person can save a lot of money by shopping around for bargains	0.684		
Component 3. 'Home-based'		0.603	0.47
I would rather spend a quiet evening at home than go out to a party	0.773		
I am a homebody	0.745		
My children are the most important things in my life	0.510		
Component 4. 'Family-based'		0.490	0.54
I usually keep my house very neat and clean	0.766		
I am uncomfortable when my house is not completely clean	0.750		
Component 5. 'Optimist'		0.601	0.53
I like parties where there is lots of music and talk	0.807		
I am an active member of more than one service organization	0.711		
Component 6. 'Independent'		0.604	0.65
I am more independent than most people	0.703		
I think I have more self-confidence than most people	0.642		
I like to be considered a leader	0.630		
People come to me more often than I go to them for information about brands	0.565		
Component 7. 'Health-oriented'		0.376	0.41
I have used diet foods at least one meal a day	0.789		
I participate in sports activities regularly	0.689		
Explained variance	53.51%		

Aiic average corrected inter-item correlations

Table 10. **Construct of shopping-orientation factors in exploratory factor analysis in mode choice for grocery shopping purpose**

A measure of Shopping orientation individuals in mode choice for grocery shopping destination	Factor loading	Cronbach's α	Aiic
Component 1. 'Real-orientation' shopping		0.764	0.57
I am expert in shopping because I could find what I need for the first time	0.854		
I think almost all of my shopping trip was successful	0.830		
I like to feel smart about my shopping trip	0.748		
Component 2. 'recreation-oriented' shopping		0.762	0.61
Shopping made me happy	0.871		
When I go shopping, have good feeling	0.831		
Shopping makes me feel like I am in my universe	0.734		
Explained variance	61.93%		

Aiic average corrected inter-item correlations