

The effect of transportation and safety attitudes, personality, and lifestyle on vehicle type choice: a case study of Tehran

Ali Mohammadi^{1,*} and Mohammad Kermanshah²

Abstract:

In recent years, researchers have paid specific attention to safety, air pollution, and energy consumption, which are all affected by the vehicle type. The primary objective of this study is to achieve a thorough understanding of the relationships between transportation attitudes, safety attitudes, personality, as well as lifestyle and vehicle type for the first time in Iran, as a developing country. For this purpose, an interview questionnaire was designed, and 740 participants were interviewed in Tehran. Vehicle types are categorized into seven groups: mini, compact, medium, heavy, SUV, pickup, and motorcycle. In the first stage, factor analysis was used to identify the latent variables regarding transportation attitudes, safety attitudes, personality, and lifestyle. In the second step, by using these latent variables, individuals are classified, and a two-level clustering is formed. The correlation analysis performed in the third step shows a significant relationship between each category of people and the type of car. Likewise, the analyses carried out in this study reveal the significant relations between the vehicle type (classified based on fuel economy level, production country, vehicle emission, and vintage) and the attitudes of its owner. This information is beneficial to both vehicle manufacturers and transportation planners.

Keywords: Vehicle type choice, Subjective Variables, Safety attitude, Factor analysis, Cluster analysis, Fuel economy level, Vehicle emission, Case study.

^{1,*} Corresponding Author. Currently a PhD candidate,
Institute for Transportation Studies and Research (ITSR)
Department of Civil Engineering, Sharif University of Technology (SUT), Azadi Ave., Tehran, Iran
PO Box: 11365-11155
Tel.: E-mail address: ali.mohammadi92@student.sharif.edu

² Professor,
Institute for Transportation Studies and Research (ITSR)
Department of Civil Engineering, Sharif University of Technology (SUT), Azadi Ave., Tehran, Iran
PO Box: 11365-11155
Tel.: +98 21 66164187.
E-mail address: mkermanshah@sharif.edu

1. Introduction

Previous studies indicate the factors that have the greatest effects on transportation behavior are objective variables such as household socio-economic status and the built environmental features; therefore, many researchers (e.g., McCarthy and Tay [1], Bhat et al. [2], and Liu et al. [3]) have studied the effects of these variables on vehicle type choice. In propounding new viewpoints in social psychology for analyzing people's transportation behavior in recent years, subjective variables, like attitudes, personality, and lifestyle of individuals, give us a better insight rather than objective variables [4]. Therefore, people with similar socio-economic status may differ in their behavioral paradigms. The main objective of this study is to identify the correlation between transportation attitudes, safety attitudes, personality and lifestyle of individuals and their type of vehicle. In other words, this study is trying to find the answer to the following question: which existing kind of car in the market is chosen by each kind of people (according to subjective variables).

Experts in different fields are interested in realizing the factors that affect vehicle type choice for many reasons. Vehicle manufacturers are interested in having data on the status of their products in the market and the factors that affect them [5]. Also, for more than four decades, transportation experts have been studying the factors that affect an individual's vehicle type choice [6]. Vehicle type is one of the factors that have the greatest effects on safety and accident damages [7], fuel consumption [8], and air pollution [9]. According to statistics derived from Iran Legal Medicine Organization, in 2016, more than 16000 people were killed and approximately 333000 people were injured due to car accidents and motor vehicle collisions [10]; this amounts to two people per hour. In 2016, Iran was ranked as the tenth country in fuel consumption, with the use of about 270 million metric tons of oil equivalent [11]. Tehran, the capital city of Iran, was identified as the twenty-first pollution emitting city in the world [12].

Further, due to better economic conditions and a greater diversity of vehicle types, all these studies were conducted in developed countries, like the United States of America [13], Canada [14], Australia [15], Japan [16], Switzerland [17], etc. In recent years, Iran's development and economic growth have led to better socio-economic status, which has caused an increase in the types of domestic vehicles. Our studies show that there are, currently, more than 500 kinds of cars, with different features, in Iran. With the presence of foreign vehicles in the market, this number is increasing each day; vehicles have tremendous differences in safety, size, load weight and seating capacity, engine volume, fuel economy, pollution emission, and many other features.

Considering the undeniable effect of the type of personal vehicle on environmental, energy, and health issues, the behavioral patterns should be identified across different regions, so that customized and proper policymaking would be realized to reduce pollution, optimize fuel consumption, and decrease the damages resulting from accidents. In this regard, our contributions are as follows: 1) focusing on the relations between vehicle types and subjective variables instead of objective variables. 2) Proposing a two-level clustering for car owners based on their attitudes, personalities, and lifestyles. 3) Classification of vehicles according to different aspects such as size, fuel economy level, and vehicle emission. 4) Recognizing a significant correlation between drivers viewpoints and type of their cars. 5) Conducting the study of vehicle type for the first time in a developing country.

In this study, a questionnaire was designed based on behavioral and cultural characteristics as well as the values of Iranian society. Seven hundred and sixty three vehicle owners in Tehran were interviewed. Among them, 740 questionnaires were filled entirely and used for this study. According to the derived results, vehicles are divided into seven groups: mini, compact, medium, large, sport utility vehicle (SUV), pickup, and motorcycle. It is worth mentioning that according to the proposed classification by Nationwide Personal Transportation Survey (NPTS) [18], the motorcycle is reckoned to be a separate class of vehicle. Moreover, there are other classifications based on fuel economy level, country of manufacture, vehicle emission, vintage, and interviewer accident measurement that have been studied here.

The next section briefly describes previous studies on vehicle type choice. In the third section, the collected data and vehicle type classification are described. The fourth section is a brief review of the methodology of the study. The fifth section presents the results derived from the analyses of transportation and safety attitudes, personality, and lifestyle in addition to the classification of individuals based on these factors; next, the relations between different groups of individuals and their vehicle type are studied. The last section of the study discusses the results and proposals for future studies.

2. Literature review

Type of vehicle has always been a subject of interest for policymakers, since the type of vehicle is directly related to safety, pollution, and fuel consumption. Therefore, the earliest studies on this issue commenced in the 1970s, with the activities of Chamberlain [6], Lerner et al. [19] and Ayres et al. [20]. These studies, which aimed to identify the factors affecting the type of car based on size and function, have been continued by different researchers until now (e.g., in the 1980s,

Manski and Sherman [21], Hocherman et al. [22], and Mannering and Winston [23]; in the 1990s, Golob et al. [24], McCarthy and Tay [1], and Wu et al. [25]; in the 2000s, Mohammadian and Miller [26], Bhat and Sen [27], and Spissu et al. [28]; and in the 2010s, Paleti et al. [29], Vyas et al. [30], and Liu et al. [3]). This historical process shows that over many years, the type of vehicle has always been an interesting subject for researchers.

In order to choose the vehicle type in each of the previous studies, according to the purpose of the research and available data, a group of independent variables was considered and analyzed, including vehicle characteristics, household socio-economic factors, individual characteristics, employment, life cycle, built environment, and public transit characteristic. Because in each study different vehicle classifications were used, it is difficult to compare between significant independent variables. However, considerations show that the characteristics of the vehicle and socio-economic factors of the household are the first and the most noticeable variables in previous studies (e.g., Lave and Train [31], Berkovec [32], and Berkovec and Rust [33]). Over time, with more accurate studies, individual characteristics, life cycle, and built environmental characteristics have been added to this group (e.g., Cao et al. [34], Potoglou [35], and Paleti et al. [36]).

Choo and Mokhtarian [5] identified three logical reasons why others have paid less attention to subjective variables. The first reason is that the data collection period for such variables (attitudes) may last longer. Second, designing and analyzing such questionnaires require specific skills (e.g., familiarity with factor analysis). Third, there is no simple method to foresee these subjective variables. Thus, it's not possible to predict the future demand of the dependent variables. However, the third reason does not contradict the value of this study, because the use of these subjective variables gives a better understanding than the use of only objective variables. Besides, these researchers believe that the concept of predicting attitudes without serious efforts in this regard has been rejected [5].

Many different definitions have been provided for attitude, but they all indicate that attitudes are the answers to the evaluation of some motives that affect the behavior of individuals [37]. Wu et al. [25] conducted one of the first studies in this field to identify the effect of attitudes and personality on vehicle type demand in the future. For this purpose, they used a stated preference dataset and people selected their choices among three alternatives according to what is illustrated to them in the future. The alternatives are as follows: (1) not to buy a car, (2) mini-car, (3) standard car. The results show that both groups of factors (transportation attitudes and personality characteristics of individuals) are significant in choosing vehicle type.

Studies on the effect of lifestyle on travel behavior have been more restricted and are more recent in comparison with studies in psychology. One of the first studies on lifestyle that concentrated on comments and individual tendencies regarding problems related to household, work, and recreation is the study by Salomon and Ben-Akiva [38]. They defined a man's lifestyle with respect to household membership, employment, and orientation of leisure time, considering the existing restrictions. Before that, in line with other studies, lifestyle was described as a private and invisible subject, and there have been attempts to illustrate lifestyle through a combination of socio-economic characteristics and life situation [39]. Choo and Mokhtarian [5] studied the effects of attitudes, personality, and lifestyle of individuals on vehicle type choice and showed how some of these factors affect people's choices. The result of the study shows that a frustrated lifestyle has a negative effect on choosing luxury cars and SUV. Researchers regard these kinds of vehicles as a demonstration of self-reliance, and there is little probability that depressed people will select this vehicle type. Furthermore, the lifestyle of workaholic people has a negative effect on choosing mini cars. Probably, such people possess better incomes and tend to use bigger cars.

Unlike numerous studies that have been conducted on vehicle type choice with the focus on objective variables, the main focus of this study is to explore the correlation between vehicle type and subjective variables, like attitudes, personality, and lifestyle. Moreover, this study is done in Iran and it is the first study on vehicle type in a developing country .

3. Data

3.1. Questionnaire design

The data used in this study, includes a questionnaire, which contains questions regarding transportation attitudes, safety attitudes, personality, lifestyle, car information, accidents, household socio-economic information, personal characteristic, and life cycle. To design the questionnaire many researches have been studied. The designed questionnaire have been inspired from Choo and Mokhtarian [5] and Cao et al. [34] for transportation attitudes, Ulleberg and Rundmo [40] and Chen [41] for safety attitudes, NEO personality inventory [42] and Eysenck's personality Inventory [43] for personality, and Redmond [44] and Mokhtarian et al. [45] for lifestyle question. Besides, there are some other questions mentioned in each case, based on the domestic conditions and cultural features of Iran. It is important to note that the 5-point Likert-type scale (strongly disagree, disagree, neither agree nor disagree, agree, strongly agree), which is one of the most common scales in psychology questionnaires, was used for each of this survey's questions.

3.2. Survey and study area

This study was conducted in the capital of Iran, Tehran. With a population of 8.7 million people distributed over a land area of 730 square kilometers, Tehran is the largest city in Iran [46]. The face to face interview with car owners in Tehran carried out to collect data by using a paper-based questionnaire having six pages. The interviews were conducted in collaboration with a team of postgraduates of transportation planning. The interviews were in public places such as offices, shopping malls, gas stations, and parking lots with employees and visitors. The data were collected in a period of approximately one month in February 2018. 763 individuals were surveyed and among them 740 questionnaires were thoroughly complete and got used for this study.

It should be noted that there is no information available about the number of vehicles for each type and their owners in Tehran. Therefore, it is not possible to compare the collected information with the population of car owners. Table 1 shows some personal information about interviewees. In the collected sample, only 20% of interviewees are female, since there are few Iranian women who own and drive cars.

Table 1. around here.

Because only vehicle owners are needed in the study, interviewees were between the ages of 18-71 years. In this study, with an average age of 35.7 years, the contribution of people between the ages of 18-24 years was less than the share of that age class in the population pyramid of Tehran [47] because of low incomes, not having financial independence and the legal beginning age for vehicle ownership. In the collected databank, the average size of the household of interviewees was 3.71. According to the report of the Statistical Center of Iran in 2016, the average size of the household in Tehran province was 3.1 [47]. Because interviewees are all vehicle owners, the increase in the size of the household in the collected samples of this study seems reasonable, since some previous studies show that with an increase in the size of a household, the probability of vehicle ownership increases [48].

3.3. Car classification

Section 5 of the questionnaire is designed to gather information about the household vehicle, including number, name, type, producing company, purchase date, and the owner. Whereas some households own more than one car, we asked the respondents to answer the question with respect to their most used car. Besides, some other information like fuel economy and vehicle emission were gathered through the official websites of the producing companies. Other than these, more data about the number of car accidents and motor vehicle collisions were sought.

There are numerous car classifications based on size and function. Here, according to the relative frequency of existing vehicles in Iran, the proposed classifications of US Insurance Institute for Highway Safety [49] and Nationwide Personal Transportation Survey [18], vehicles were classified based on their function and weight. Therefore, by using vehicle weight, existing vehicles in Iran were divided into the mini, compact, medium, and large; by using function, vehicles were divided into SUV, Pickup, and motorcycle. Table 2 shows the frequency of each type.

Table 2. around here.

In order to take a closer look at the relationship between transportation attitudes, safety attitudes, personality, and lifestyle with vehicle type, more classifications are also proposed here, which are based on vehicle emission, fuel economy level, vintage, and production country. Likewise, to classify the vehicles by safety viewpoint, we obtained our information from injury and damage accidents, because there are limitations in accessing the safety information of domestic vehicles. These categories and the frequency of each variable are shown in Table 2. In this sample, the order of frequency of foreign cars is as follows: those produced by South Korea, Japan, China, Germany, France, Italy, United Kingdom and America.

4. Methodology

To figure out the relations between a set of subjective variables and car type based on the proposed method by Dashtestaninejad et al. [50]; thus, during the first stage of the study, factor analysis was applied to identify the latent factors in relation to transportation attitudes, safety attitudes, personality, and lifestyle. During the second stage, cluster analysis was applied to cluster individuals with the help of the latent factors that were identified at the first stage. During the last stage, correlation analysis was used to study the correlation between individuals and their car type. SPSS Statistics 24 was used for all data analyses.

4.1. Factor analysis

Exploratory factor analysis is used to simplify complicated data by describing them according to a lower number of latent variables (factors) [51]. This method consists of four main steps: adequacy of sampling, factor extraction, selecting the appropriate number of factors, and factor rotation. Typically, adequacy of sampling is assessed using the Kaiser-Meyer-Olkin (KMO) and Bartlett's test. Also, as a criterion for adequacy of sample size Costello and Osborne [52] introduced an index (number of survey to statements), by studying 303 research in this field. They showed that if this ratio is greater than 20 to 1, better results from exploratory factor analysis will be obtained. For the other steps of exploratory factor analysis, several methods have been proposed. In this

study, a set of these methods have been examined, and no change in the results have been observed. Finally, the results obtained from the principal component analysis for the factor extraction, eigenvalue-greater-than-one rule and scree test for selecting the appropriate number of factors, and direct oblimin rotation for factor rotation are presented. It should be noted that due to the correlation between attitudes, it is suggested that oblique rotation methods are used to improve the data structure [52].

4.2. Cluster analysis

Cluster analysis or clustering is a statistical method for classifying data or similar observations (including individuals, objects, or events) into different classes. In this statistical method, data is classified according to their measure of relation. Therefore, members of a cluster have the most similarity with each other and the least similarity with other clusters [53]. There are two main discussions in clustering: the selection of the number of clusters and the selection of similarity criterion between members. Different methods and algorithms have been suggested for cluster analysis. In this study, elbow method was used to determine the number of clusters, and the k-means algorithm was used to cluster people according to the latent factors of attitudes, personality, and lifestyle (which were obtained from the previous section).

4.3. Correlation analysis

As the first study in Iran on vehicle type selection, the correlation analysis was used to identify the relationships between subjective variables and vehicle type. Correlation analysis is one of the descriptive analysis methods used to study the type (positive/negative) and strength of the relationship (correlation coefficient) between variables, which do not imply the causality of variables. In this study, Spearman's correlation was used to measure the type and strength of association, and Pearson's chi-square test was used to examine the association between each cluster of people (which have been verified in clustering analysis step) and their vehicle type. Figure 1 shows the structure of the proposed algorithm.

Figure 1. around here.

5. Analysis and results

In this section, the results of the study are presented. First, the results of factor analysis are explained, followed by the results of cluster analysis and the explanation of each cluster. At the end, the results of correlation analysis and the correlation between the groups of individuals and vehicle type are presented.

5.1. Factor analysis results

In the designed questionnaire, there are 11 statements for attitude toward transportation, 15 statements for attitude toward safety, 14 statements for personality, and 13 statements for identification of the lifestyle of individuals. Because in all cases the ratio of the number of questionnaires to the number of statements is more than 20 to 1, the size of the collected sample is sufficient. Likewise, KMO value and significance of Bartlett's test were determined in all the cases and are indicated in the last line of Tables 3 to 7. In all cases, the KMO value was bigger than 0.6, and the significance of Bartlett's test was 0.000.

Table 3 presents the factor analysis results of transportation attitudes. According to this table, four latent factors have been identified and are named pro-transit, time-dissatisfied, pro-driving and pro-government. Pro-transit attitude refers to those who tend to use public transit for many reasons, while pro-driving attitude points to those who are interested in driving. The results show that these two attitudes have a negative correlation with each other ($r = -0.243$); in other words, those who are interested in using public transit are less interested in driving. Time-dissatisfied attitude refers to those who are more sensitive and suffer from long travel time. For the first time in this study, a new attitude was identified and named pro-government attitude. This attitude indicates the view of some people toward the government. These people have abdicated their social responsibilities, and they think that government is the only organization that must solve the social problems. According to the correlation part of Table 3, this view has a negative correlation ($r = -0.145$) with those who have pro-transit attitude and a positive correlation ($r = 0.146$) with those who are interested in driving. The negative correlation between pro-government and pro-transit attitudes means that those who are trying to be responsible in solving social problems tend to use public transit more, and, conversely, the positive correlation between pro-government and pro-driving attitudes means that pro-driving people are careless about problems caused by vehicles, such as fuel consumption and air pollution.

Table 3. around here.

Table 4 shows the results of exploratory factor analysis of the attitudes of individuals towards safety. As observed in the table, four attitudes have been identified: pro-risk, pro-negligence, pro-law, and pro-motorcycle. In this study, pro-risk attitude refers to individuals who tend to drive with higher speed and venturesome acts, such as overtaking from the right; likewise, pro-negligence attitude refers to drivers who neglect some safety acts, such as fastening the seatbelt and safe distance control with the front vehicle. As expected, these two views have a positive ($r = 0.325$) and considerable correlation with each other. Pro-law attitude is the third view that was identified in this field. This attitude refers to those who believe in the rigid enforcement of the law for the

achievement of collision reduction and to increase the safety level. As observed in the factor correlation section, the pro-law attitude has a negative correlation with both pro-risk ($r = -0.232$) and pro-negligence ($r = -0.120$) attitudes. The last attitude refers to those who believe that motorcycle is the best mode of transportation. According to Table 4, this attitude has a positive correlation with both pro-risk ($r = 0.170$) and pro-negligence ($r = 0.219$) attitudes.

Table 4. around here.

The personality of interviewees was also studied and analyzed by exploratory factor analysis. According to Table 5, six types of personalities were identified: showy, social, patient, adventurer, procrastinator, and conservative. With respect to the correlation between factors, showy personality has a positive correlation with procrastinator personality ($r = 0.100$) and a negative correlation with conservative personality ($r = -0.099$). In other words, those who are interested in attracting people's attention procrastinate more and talk about their achievements in the public more than others. Another significant correlation in this section is the negative correlation between procrastinator and patient personalities ($r = -0.154$). The negative correlation means that patient and quiet individuals are better in management and are usually more punctual in doing their tasks.

Table 5. around here.

Among thirteen statements for the measurement of lifestyle, five latent factors were identified based on the eigenvalue-greater-than-one rule and scree test (Table 6). In the one hand, there are five factors which satisfied the first rule and have the amount of eigenvalue greater than one. In the other hand, in the chart of scree test, the point of five factors is the breaking point of the plot. These factors are lively, pro-sumptuous, unhealthy, unsociable, and workaholic. Pro-sumptuous means being interested in luxury and high priced goods, and unsociable lifestyle means not having the tendency for participation in the society or even in family and friends gatherings. As shown in Table 6, lively lifestyle has a negative correlation with pro-sumptuous, unhealthy, and unsociable lifestyles, while it only has a positive correlation with workaholic lifestyle; in other words, workaholic people are more lively and satisfied with their lives in comparison to others; also, unsociable people are less interested in sports activities and health ($r = 0.165$).

Table 6. around here.

5.2. Clustering

As mentioned earlier, the relation between latent variables and vehicle type is identified by cluster analysis. For this purpose, by using elbow method, the case study analysis was divided into two main (and almost equal) clusters: risk-oriented and safety-oriented. The clustering results are

shown in Table 7. The numbers in each column of the table indicate the factor scores of each Cluster Center (CC), and in each section of transportation attitudes, safety attitudes, personality, and lifestyle, the main factor in each cluster (which has the biggest absolute value of numbers) is shown in boldface. According to Table 7, it was determined that pro-transit attitude, pro-risk attitude, patient personality, and lively lifestyle are the main factors that resulted in this classification. Among them, pro-risk attitude (with the highest rank) is the factor that caused the highest difference between these two groups (0.638 and -0.585). Therefore, these two clusters were named risk-oriented and safety-oriented.

Table 7. around here.

Considering the fact that the clustering was general and to show the effect of the other factors in the classification, the individuals of each cluster were divided into sub-clusters by the k-means method. In the new clustering, risk-oriented people were divided into four sub-clusters, and safety-oriented people were divided into three sub-clusters. The results of clustering are shown in Table 8.

Table 8. around here.

As shown in table 8, the pro-risk attitude is positive in all the sub-clusters of risk-oriented people and is negative in all the sub-clusters of safety-oriented people. In Table 8, the main feature (the biggest absolute value of numbers) of transportation attitude, safety attitude, personality, and lifestyle is shown in boldface, and the biggest number of each sub-cluster (which demonstrates the main feature of each sub-cluster) was used for naming the clusters. Therefore, risk-oriented people are divided into four sub-clusters: (1) depression-oriented, (2) motorcycle-oriented, (3) danger-oriented, and (4) driving-oriented. Safety-oriented people are divided into three sub-clusters: (1) work-oriented, (2) transit-oriented, and (3) vitality-oriented. These sub-clusters are described as follows.

According to Table 8, depression-oriented people, which are the first sub-cluster of risk-oriented people, have a very low lively lifestyle ($CC = -1.016$), and time-dissatisfied attitude ($CC = 0.523$) and showy personality ($CC = 0.763$) are the main features of this sub-cluster. Having a showy personality means that people of this sub-cluster tend to be seen more in the society. Moreover, depression-oriented people have procrastinator personality ($CC = 0.627$) and are less patient ($CC = -0.552$). Unhealthy ($CC = 0.792$) and unsociable ($CC = 0.632$) lifestyles are the other features of this sub-cluster.

The main features of motorcycle-oriented people are as follows: (1) pro-motorcycle attitude ($CC = 1.183$), (2) procrastinator personality ($CC = 0.774$), (3) not having time-dissatisfied attitude

(CC = -0.885), and (4) not having workaholic lifestyle (CC = -0.651). Moreover, motorcycle-oriented people have high pro-negligence attitude (CC = 1.077).

As mentioned earlier, pro-risk attitude can be seen in every sub-cluster of risk-oriented people. Nevertheless, pro-risk attitude is the main feature (the biggest absolute value of numbers) of the third sub-cluster of pro-risk people, which has been named pro-danger people. Other main features of this sub-cluster are nonexistence of pro-transit attitude (CC = -0.865), patient personality (CC = -0.899), and unsociable lifestyle (CC = -0.720). It is interesting that people of this sub-cluster are not very good in pro-law attitude (CC = -0.858). In other words, pro-danger people do not pay attention to strict laws aimed at decreasing accidents and their damages.

The last sub-cluster of risk-oriented people is driving-oriented people. These people have a pro-driving attitude (CC = 0.843), pro-risk attitude (CC = 0.743), showy personality (CC = 0.709), and pro-sumptuous lifestyle (CC = 0.827). In this sub-cluster, pro-government attitude (CC = 0.801) means that while these people are interested in driving, they count on government as the organization that has to solve the problems which are related to vehicle use.

The first sub-cluster of safety-oriented people is named work-oriented people. It consists of workaholic lifestyle (CC = 0.595) and pro-law attitude (CC = 0.581), but not adventurer personality (CC = -0.518). People of this sub-cluster (who assign most of their time to work) have a time-dissatisfied attitude (CC = 0.409).

The second sub-cluster of safety-oriented people is transit-oriented people. They do not have pro-driving attitudes (CC = -0.716). The main features of this sub-cluster are rather against the features of driving-oriented people (the fourth sub-cluster of risk-oriented people). People of this sub-cluster do not have a pro-risk attitude (CC = -0.523) and showy personality (CC = -0.601). The other main feature of this sub-cluster is unsociable lifestyle. It is worth mentioning that people of this sub-cluster do not have pro-sumptuous lifestyles (CC = -0.581).

The last sub-cluster of safety-oriented people, which is visible in the last column of Table 8, is vitality-oriented people, who have a lively lifestyle (CC = 1.017). The main features of this sub-cluster are pro-transit attitude (CC = 0.562), no pro-risk attitude (CC = -0.673), and no procrastinator personality (CC = -0.826). Furthermore, people of this sub-cluster do not have pro-risk (CC = -0.673), pro-negligence attitude (CC = -0.526), pro-sumptuous lifestyle (CC = -0.759), nor showy personality (CC = -0.608) and are rather patient (CC = 0.570). The final structure of this clustering is shown in Figure 2.

Figure 2. around here.

The comparisons of the relative frequency of socio-demographic characteristics of sub-clusters are shown in Figure 3. This figure is a multidimensional chart that the vertical axes show the sub-clusters and the horizontal axes show the percentage of relative frequency. This figure consists of four-part of gender, marital status, age, and education. According to Figure 3a, the male to female ratio in depression-oriented cluster is more than other clusters. The relative frequency of women in motorcycle-oriented cluster is influenced by the fact that it is illegal for women to ride a motorcycle in Iran. In contrast, there is an increase in the relative frequency of women in danger-oriented cluster than in other clusters. According to Figure 3b, most of the people in danger-oriented and driving-oriented clusters are single, while transit-oriented and vitality-oriented people are often married. It is interesting that the frequency of divorced or widowed people is more among danger-oriented and work-oriented clusters. According to Figure 3c, danger-oriented and driving-oriented people are usually 18-30-year-olds, while transit-oriented and vitality-oriented people are often more than 40 years old. Figure 3d compares the education of individuals. It shows that depression-oriented people have low levels of education (no academic degree and diploma), while vitality-oriented people have higher levels of education (bachelor and further).

Figure 3. around here.

5.3. Correlation analysis

In this section, we studied the results of correlation analysis between vehicle type and each group of individuals specified through clustering. Table 9 shows the result of this analysis for the vehicle type based on weight and function. In this table, the first and the second column respectively show the position of individuals in each cluster and sub-cluster. The category of individuals' car is presented in the first row and only the significant correlations are displayed. As shown in the following table, each of these vehicle types is more attractive to specific groups of individuals. Because people of each sub-cluster have different attitudes, personalities, and lifestyles, numerous results are derived from the combination of Table 8 and 9, and some of them are as follows:

Table 9. around here.

- *Mini*: The mini cars have a positive correlation with motorcycle-oriented ($r = 0.116$) and transit-oriented people ($r = 0.085$). Motorcycle-oriented people, who have a pro-negligence attitude and don't have a workaholic lifestyle, may not be in a proper financial position, and transit-oriented people, who tend to drive less and have an unsociable lifestyle, will probably select smaller cars. However, driving-oriented people hardly drive mini cars ($r = -0.098$).

- *Compact:* Compact car drivers are mostly from danger-oriented and vitality-oriented clusters. Transit-oriented people are less likely to drive these cars. Those who have a danger-oriented approach share many similarities with those who have a vitality-oriented approach. They are both sociable and against individualism, and unlike transit-oriented people, these two groups of people tend to drive bigger cars than mini.
- *Medium:* Those with a vitality-oriented approach, who do not have a showy and pro-sumptuous lifestyle, are the only ones who tend to drive medium cars more than any other type of car. Vitality-oriented people are mostly educated people who procrastinate less. This is similar to the result obtained by Choo and Mokhtarian [5], who stated that organizers tend to drive mid-sized cars. It is important to note that almost the same questions were asked in both surveys to study the personality of organizers and procrastinators, and the difference in nomenclature is due to the difference in other effective questions for exploring the latent variable.
- *Large:* Driving-oriented people, who mainly have a showy and adventurer personality and follow a pro-sumptuous lifestyle, tend to drive large cars that show wealth and power more than other types, and vitality-oriented people, who don't follow a pro-sumptuous lifestyle, are the only ones who are less interested in driving these cars. The preceding result is in agreement with the finding of Choo and Mokhtarian [5], who revealed the direct correlation between status seeking lifestyle and luxury and sports cars.
- *SUV:* SUV car drivers mostly tend to be driving-oriented and work-oriented people. They are showy and have a pro-sumptuous lifestyle. Furthermore, the size and operation of this type of car are suitable for adventurous driving-oriented people and for drivers with a work-oriented approach, who are displeased with travel time. It is also important to note that unlike these two groups, motorcycle-oriented drivers who tend to drive mini vehicles are less interested in driving SUV.
- *Pickup:* Today in Iran, pickups are mostly used for shipment and freight delivery. Pickup driving, which is an example of service sector job, is reckoned to be a low-class job in Iran, and its drivers are mostly transit-oriented and depression-oriented people. Transit-oriented people who do not enjoy driving are frequently married and old people as well as depression-oriented people who have less lively lifestyle.
- *Motorcycle:* Motorcycle drivers are mostly those who have a motorcycle-oriented approach and are pro-risk and pro-negligence. Therefore, vitality oriented people who are less pro-risk and pro-negligence are the only ones who do not tend to drive motorcycles.

To take a closer look at the correlations between vehicle type and transportation attitudes, safety attitudes, personality, and lifestyle, the results of the correlation analysis for clustering the vehicles based on fuel economy level, production country, vehicle emission, and vintage are shown in Table 10. In this table, the results of correlation analysis for one category of dummy variables (in table 2) can be seen, and the results of the other categories are opposite. After this, the results derived from this analysis are interpreted.

Table 10. around here.

- *Low emission:* Low emission cars have a positive correlation with driving-oriented and work-oriented people. It is interesting that both of these groups have healthy lifestyles, whereas depression-oriented people, who live unhealthy lifestyles and have a pro-government approach, are the only ones who have a negative correlation with low emission vehicles.
- *Low consumption:* Motorcycle drivers are the only ones who have a positive correlation with low consumption vehicles. These groups of people, who have a low time-dissatisfied attitude, mostly tend to drive motorcycles and mini cars, which have a low fuel economy level (Table 9). On the contrary, driving-oriented and transit-oriented people mostly choose cars with high fuel consumption rate. As mentioned earlier, pro-sumptuous people tend to drive large cars and SUVs, and transit-oriented people tend to drive pickups, which are not fuel-efficient cars.
- *New vehicle:* There is a significant negative correlation between new vehicles and depression-oriented people only. This group of people has lack of vitality and prefer old vehicles more than new ones.
- *Foreign vehicle:* Driving-oriented and work-oriented people, who are both showy and live a healthy and pro-sumptuous lifestyle, mostly choose foreign vehicles. However, motorcycle-oriented and vitality-oriented people tend to drive domestic vehicles. It's also interesting to note that most of the existing motorcycles in Iran are domestic, but large cars and SUVs are foreign cars.
- *Driver with damage accident:* The only groups of individuals who have a significant correlation with drivers who have experienced damage accidents are danger-oriented people, who are part of risk-oriented people. This group of people has high pro-risk and low pro-law attitudes. According to Figure 3, women and youths (18 to 30) have a higher relative frequency in this category.

- *Driver with injury accident:* Drivers that have experienced injury accidents are mostly motorcycle-oriented drivers, who have a danger-oriented approach. According to Table 9, this group of drivers not only drives motorcycles and mini cars, which are more vulnerable in accidents and motor vehicle collisions, but also have a pro-negligence safety attitude. Pro-negligence safety attitude means that the driver neglects the fastening of seatbelt or observing the safe distance control with the front vehicle.

6. Discussion and conclusion

The aim of this study is to achieve a deep understanding of the correlation between vehicle type and subjective factors, i.e., transportation attitudes, safety attitudes, personality, and lifestyle for the first time in Iran. Due to the behavioral, cultural and domestic characteristics of Iranians, a specific questionnaire was designed to learn about transportation and safety attitudes, personality and lifestyle, which are the key points for implementing this study. After collecting data from Tehran residents, statistical analyses were used to examine the correlation between subjective variables and vehicle type. These statistical analyses are made of two main stages: (1) applying factor analysis to determine the latent variables and (2) clustering individuals by using those latent variables through the application of cluster analysis. In this study, based on weight and performance, vehicle types are categorized into seven: mini, compact, medium, large, SUV, pickup, and motorcycle. Furthermore, we offered more classification schemes based on fuel economy level, production country, vehicle emission, vintage, and motor vehicle collisions.

One of the results of this paper is a two-level clustering, where the maximum observed difference in the first level was the difference in viewpoints regarding safety. In this manner, individuals were divided into two main clusters: risk-oriented and safety-oriented. To make the effect of other latent factors clear, people of each cluster were divided into sub-clusters. In the second level, risk-oriented people were divided into four sub-clusters, including depression-oriented, motorcycle-oriented, danger-oriented, and driving-oriented people, and safety-oriented people were divided into three sub-clusters, including work-oriented, transit-oriented, and vitality-oriented people. Each of these identified sub-clusters has various differences in lifestyle, personality, transportation and safety attitudes.

The applied correlation analysis for this survey shows that there is a significant correlation between each of these identified clusters and vehicle types. The most popular vehicles for each of these clusters are as follows: pickup for depression-oriented people, motorcycle and mini cars for motorcycle-oriented people, compact cars for risk-oriented people, large cars and SUV for driving-

oriented people, SUV for work-oriented people, pickup and mini cars for transit-oriented people, and compact and medium cars for vitality-oriented people.

The purpose of this study was the analyzing and description of the current status. In this regard, the comparison of results with the actual situation would be valuable and beneficial. For example, our result displayed pickups with more probability are chosen by depression-oriented people. As mentioned, pickups in Iran are used only for the purpose of work and shipment, and only the low-income people of the community choose this type of vehicle. Therefore, this positive correlation between the depression-oriented sub-cluster and the pickup corresponds to reality.

As another example, the results represented that driving-oriented people have a significant positive correlation with large and foreign vehicles. It should be noted that a notable proportion of large and foreign vehicles in the database belongs to the BMW manufacturer. It is clear that this brand in the world, and especially in Iran, is a symbol of the luxury vehicles for the car lover people. This fact is consistent with our results that those who have more tendencies to driving and using foreign vehicles are more likely to choose a large vehicle.

Furthermore, this study reveals a significant correlation between motor vehicle collision of each vehicle type and groups of individuals who differ in attitude, personality, and lifestyle. It is interesting to note that danger-oriented people, who have a pro-risk attitude, and motorcycle-oriented people, who have a pro-negligence attitude, have a direct correlation with damage and injury accidents respectively.

Descriptive statistical analyses were used to conduct this pioneering study on vehicle type choice in Iran. For further research on this topic, developing a discrete choice model (e.g., integrated choice and latent variable model (ICLV)) is recommended, to take a closer look at the correlation between subjective variables and vehicle type. Besides, paying attention to socio-economic factors, personal attribute, occupation, life cycle, and built environment is also recommended for having a better perception of how people choose their vehicle types.

Previous studies have shown a theory of self-selection effect, based on safety attitudes, in choosing the vehicle type [54]; this has not been analyzed. Exploring this self-selection effect could make the transportation behavior of individuals and their vehicle type choice clearer.

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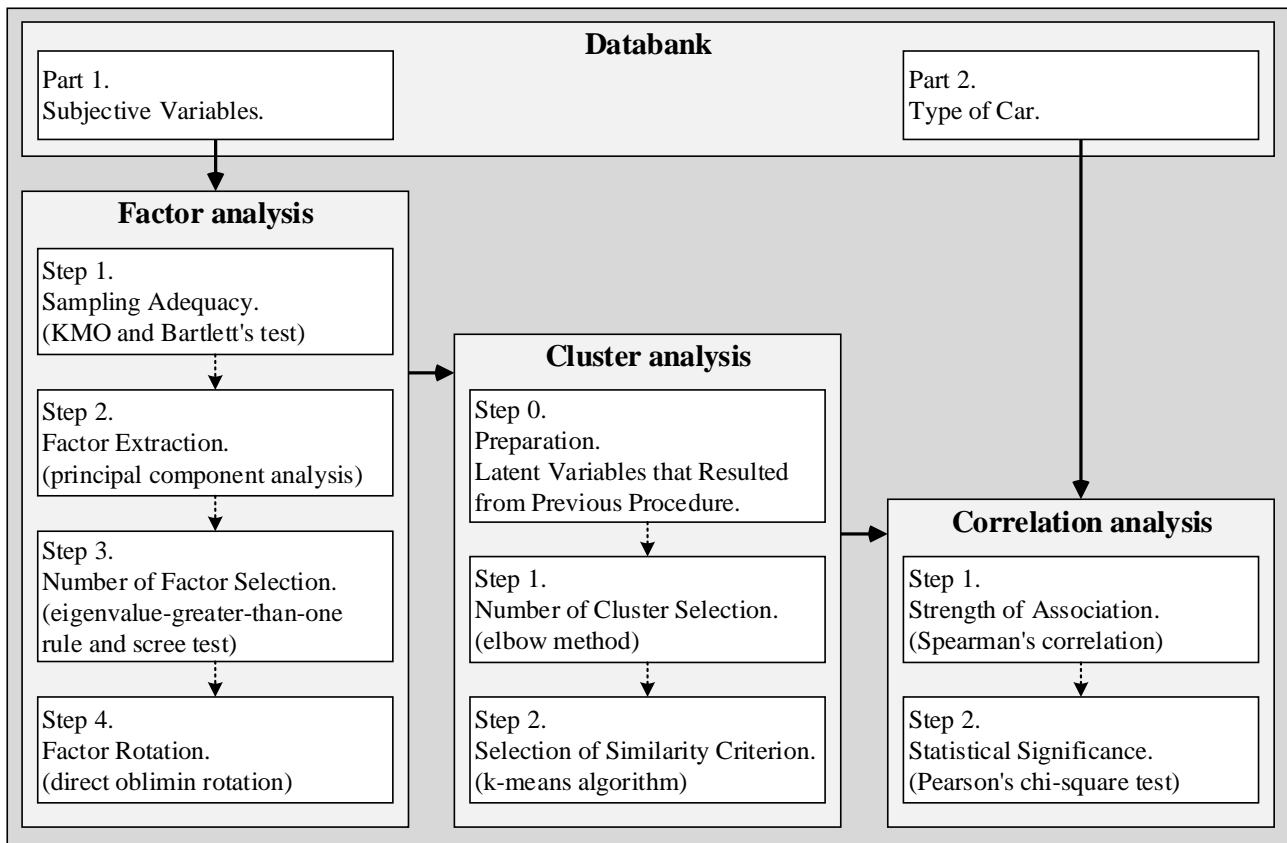


Figure 1. The structure of the proposed algorithm.

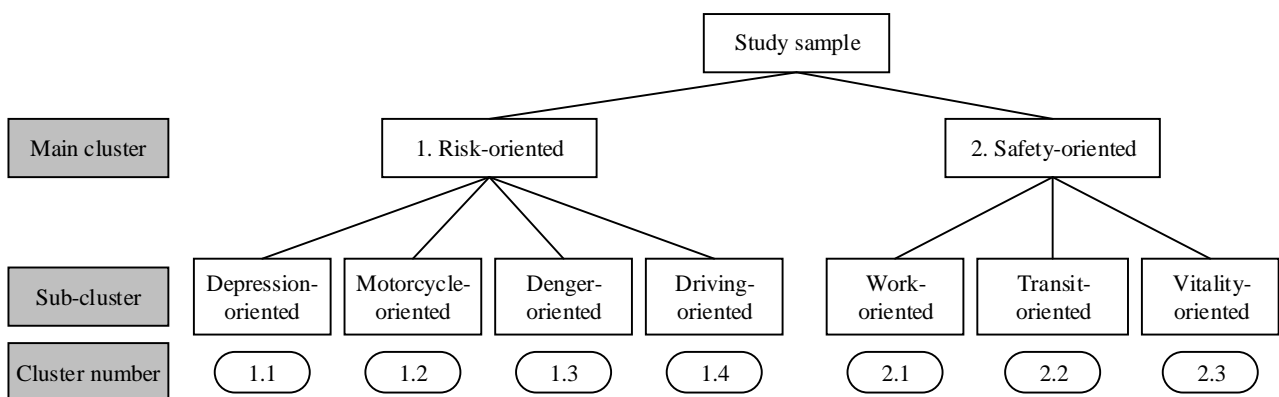
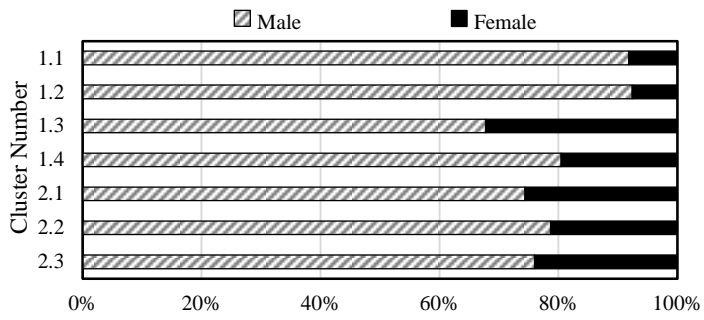
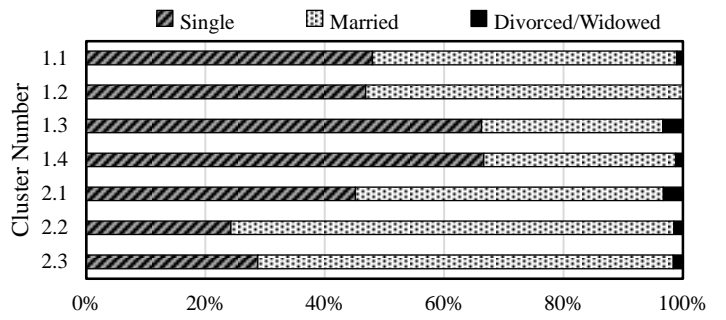


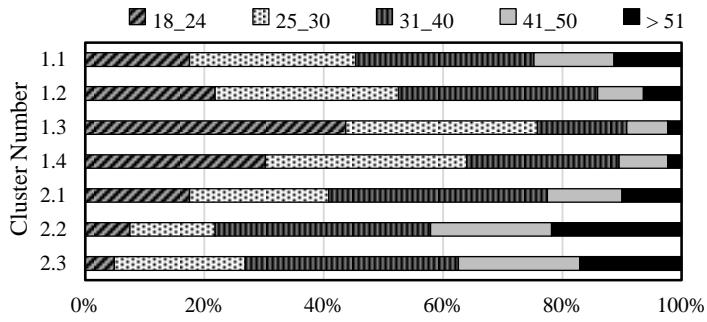
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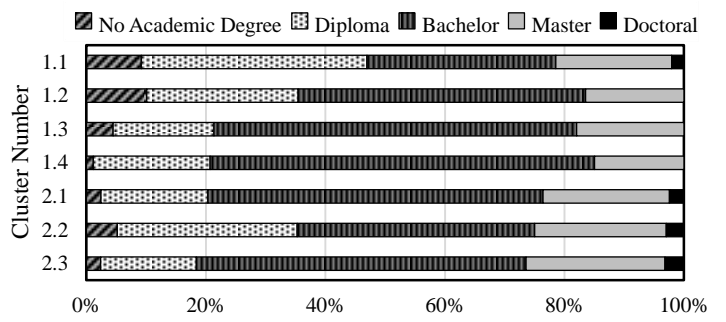
(a) Gender distribution.



(b) Marital status distribution.



(c) Age distribution.



(d) Education distribution.

Figure 3. Cluster composition.

Tables:

Table 1. Databank composition.

Variable	Category	Percentage
Gender	Male	79.6
	Female	20.4
Marital status	Single	54.0
	Married	44.2
	Divorced/Widowed	1.8
Age (years)	18-24	18.7
	25-30	25.1
	31-40	31.2
	41-50	13.7
	> 51	11.3
Education	No Academic Degree	4.8
	Diploma	23.3
	Bachelor	50.3
	Master	19.8
	Doctoral	1.8

Table 2. Vehicle and driver classification.

Variable	Category	Percentage	Definition
Vehicle type (based on weight and function)	Mini	15.0	Curb weight from 810 to 999 kg.
	Compact	24.6	Curb weight from 1000 to 1100 kg.
	Medium	28.1	Curb weight from 1101 to 1200 kg.
	Large	13.2	Curb weight 1201 kg and over.
	SUV	6.8	-
	Pickup	6.5	-
	Motorcycle	5.8	-
Vehicle emission	Low	24.1	European emission standards higher than Euro 3.
	High	75.9	Others
Vehicle consumption	Low	51.8	Fuel consumption less than 7 liters per 100 kilometers.
	High	48.2	Others
Vehicle age	New	22.6	Vehicle age less than 3 years.
	Old	77.4	Others
Vehicle Production Country	Iranian	76.8	Produced by Iran.
	Foreign	23.2	Others
Driver damage accident	Yes	37.7	Driver with damage accident experience.
	No	62.3	Driver without damage accident experience.
Driver injury accident	Yes	4.6	Driver with injury accident experience.
	No	95.4	Driver without injury accident experience.

Table 3. Pattern matrix for transportation attitudes.

Regarding transportation, state your agreement with any of the following statements.	Component			
	Pro-transit	Time-dissatisfied	Pro-driving	Pro-government
I am willing to use public transportation to reduce air pollution.	0.839			
I try to decrease my car usage to improve the air quality.	0.818			
One of the reasons I use public transportation is to get rid of the troubles related to car usage.	0.608			
I am used to my car, and life would be hard without it.	-0.552			
I believe that car usage is the best means of transportation.	-0.535			
The long travel time to the destination highly annoys me.		0.796		
Being stuck in a heavy traffic makes me nervous.		0.795		
I am not interested in driving.			-0.851	
Driving is one of my hobbies.			0.823	
The main cause of most car accidents is the low quality of cars.				0.755
Only the government and car factories are responsible for reducing air pollution.				0.722
Component correlation (<i>r</i>)				
Pro-transit	1.000			
Time-dissatisfied	0.089*	1.000		
Pro-driving	-0.243**	-0.010	1.000	
Pro-government	-0.145**	0.080*	0.146**	1.000
KMO = 0.746	Sig. of Bartlett's test = 0.000			

*Correlation is significant at the 0.05 level (2-tailed).

**Correlation is significant at the 0.01 level (2-tailed).

Table 4. Pattern matrix for safety attitudes.

Regarding safety, state your agreement with any of the following statements.	Component			
	Pro-risk	Pro-negligence	Pro-law	Pro-motorcycle
I think it would be alright to drive at a speed higher than the speed limits if the traffic flow permits.	0.833			
It will be no problem driving over the speed limit if I have a high driving skill.	0.752			
Driving at high speed is one of my hobbies.	0.734			
Sometimes, it is necessary not to follow traffic rules to arrive at my destination in time	0.697			
When the car in front is at a low speed, we can overtake the car from the right side.	0.581			
I always obey the traffic rules even if there is no police enforcement.	-0.529			
I believe there is no need to fasten seatbelt in urban routes.		0.756		
Experienced drivers do not need to fasten their seatbelts.		0.688		
The risk of death in crashes is very low, so caution can be ignored.		0.665		
Driving short distances also requires the seatbelt to be fastened.		-0.590		
I believe it's very important to keep the safe distance from the front car while driving.		-0.560		
If driving laws are much tougher, many crashes will be prevented.			0.828	
There should be severe penalties for drivers who violate the speed limits (Even for a 10 km/h more).			0.723	
Motorcycles have low safety, and it is not logical to ride them.				-0.847
I believe the best mode of transportation is motorcycle.				0.795
Component correlation (<i>r</i>)				
Pro-risk	1.000			
Pro-negligence	0.325**	1.000		
Pro-law	-0.232**	-0.120**	1.000	
Pro-motorcycle	0.170**	0.219**	-0.009	1.000
KMO = 0.829	Sig. of Bartlett's test = 0.000			

*Correlation is significant at the 0.05 level (2-tailed).

**Correlation is significant at the 0.01 level (2-tailed).

Table 5. Pattern matrix for personalities.

State your agreement with any of the following statements.	Component					
	Showy	Social	Patient	Adventurer	Procrastinator	Conservative
I will be distinguished from others by having a nice car.	0.654					
I am a person who seeks for variety.	0.625					
I am afraid of being jinxed by someone.	0.614					
I would like to be alone at my leisure times.		-0.782				
We usually have outdoor fun collectively with others.		0.723				
I behave calmly to get my rights back.			0.845			
I am a patient person.			0.808			
I love the excitement that usually rises while riding a Ferris wheel or having thrill activities.				0.798		
Compared to others, I am afraid of fewer things.				0.589		
Taking the responsibility of leading or managing a situation is not easy for me.					0.674	
I am a punctual and disciplined person.					-0.661	
I waste a lot of time before starting work.					0.578	
I would like to tell others about my achievements.						-0.780
I trust others at a glance.						-0.701
	Component correlation (<i>r</i>)					
Showy	1.000					
Social	-0.038	1.000				
Patient	-0.063	0.049	1.000			
Adventurer	0.019	-0.005	-0.070	1.000		
Procrastinator	0.100**	-0.056	-0.154**	-0.091*	1.000	
Conservative	-0.099**	0.028	0.076*	-0.078*	-0.051	1.000
KMO = 0.603	Sig. of Bartlett's test = 0.000					

*Correlation is significant at the 0.05 level (2-tailed).

**Correlation is significant at the 0.01 level (2-tailed).

Table 6. Pattern matrix for lifestyles.

State your agreement with any of the following statements.	Component				
	Lively	Pro-sumptuous	Unhealthy	Unsociable	Workaholic
I often feel I have no control over my life.	-0.767				
Life sometimes seems desperate and gloomy to me.	-0.732				
I am satisfied with my life overall.	0.630				
I often participate in social activities.	0.467				
I will always buy the most expensive stuff if I can afford it.		0.882			
I enjoy having luxury appliances and brand clothes.		0.843			
I usually follow my sports schedule on a regular basis.			-0.906		
I have no sports activities during the week.			0.866		
I spend most of my time with friends and family.				-0.744	
I always go outdoors on weekends to have fun.				-0.690	
I usually do not go outdoors for fun on weekdays.				0.554	
I would like to assign most of my time to work.					0.794
If I have enough money, I am no longer interested in my job.					-0.589
	Component correlation (<i>r</i>)				
Lively	1.000				
Pro-sumptuous	-0.104**	1.000			
Unhealthy	-0.235**	-0.008	1.000		
Unsociable	-0.130**	-0.068	0.165**	1.000	
Workaholic	0.112**	-0.012	0.007	-0.040	1.000
KMO = 0.637	Sig. of Bartlett's test = 0.000				

*Correlation is significant at the 0.05 level (2-tailed).

**Correlation is significant at the 0.01 level (2-tailed).

Table 7. Main cluster centers.

Factor		Main Clusters	
		1 Risk-oriented (47.8%)	2 Safety-oriented (52.2%)
Transportation attitude	Pro-transit	-0.458	0.421
	Time-dissatisfied	-0.030	0.028
	Pro-driving	0.301	-0.276
	Pro-government	0.316	-0.290
Safety attitude	Pro-risk	0.638*	-0.585*
	Pro-negligence	0.343	-0.315
	Pro-law	-0.287	0.263
	Pro-motorcycle	0.334	-0.306
Personality	Showy	0.346	-0.317
	Social	-0.059	0.054
	Patient	-0.413	0.378
	Adventurer	0.256	-0.234
	Procrastinator	0.337	-0.309
Lifestyle	Conservative	-0.180	0.165
	Lively	-0.397	0.364
	Pro-sumptuous	0.347	-0.319
	Unhealthy	0.172	-0.157
	Unsociable	-0.080	0.073
	Workaholic	-0.240	0.220

Note: The numbers in parentheses represent the percentage of cases in each cluster.
The main factors in each cluster are shown in boldface.
* The main feature that used for naming clusters.

Table 8. Sub-cluster centers.

Factor		Sub-Clusters						
		1.1 Depression-oriented (13.2%)	1.2 Motorcycle-oriented (10.7%)	1.3 Danger-oriented (12.2%)	1.4 Driving-oriented (11.8%)	2.1 Work-oriented (16.9%)	2.2 Transit-oriented (18.4%)	2.3 Vitality-oriented (16.9%)
Transportation attitude	Pro-transit	-0.351	-0.088	-0.865	-0.494	0.263	0.436	0.562
	Time-dissatisfied	0.523	-0.885	0.126	-0.040	0.409	0.038	-0.365
	Pro-driving	-0.134	-0.136	0.635	0.843*	0.168	-0.716*	-0.242
	Pro-government	0.376	0.166	-0.087	0.801	-0.011	-0.314	-0.543
Safety attitude	Pro-risk	0.433	0.431	0.940*	0.743	-0.564	-0.523	-0.673
	Pro-negligence	0.232	1.077	0.259	-0.111	-0.431	-0.014	-0.526
	Pro-law	-0.013	-0.173	-0.858	-0.110	0.581	0.087	0.138
	Pro-motorcycle	0.309	1.183*	-0.043	-0.019	-0.406	-0.307	-0.206
Personality	Showy	0.763	-0.040	-0.121	0.709	0.283	-0.601	-0.608
	Social	-0.467	-0.014	0.265	0.026	0.324	-0.450	0.331
	Patient	-0.552	-0.344	-0.899	0.185	0.459	0.129	0.570
	Adventurer	-0.048	0.070	0.446	0.569	-0.518	-0.396	0.225
	Procrastinator	0.627	0.774	0.101	-0.143	-0.180	0.048	-0.826
Lifestyle	Conservative	-0.295	-0.424	0.279	-0.302	0.087	0.381	0.008
	Lively	-1.016*	-0.469	-0.276	0.242	0.175	-0.064	1.017*
	Pro-sumptuous	0.413	-0.036	0.149	0.827	0.408	-0.581	-0.759
	Unhealthy	0.792	-0.056	0.153	-0.302	-0.340	0.151	-0.311
	Unsociable	0.632	0.191	-0.720	-0.465	-0.258	0.626	-0.198
	Workaholic	-0.087	-0.651	-0.409	0.134	0.595*	-0.021	0.109

Note: The numbers in parentheses represent the percentage of cases in each sub-cluster.
The main factors in each sub-cluster are shown in boldface.
* The main feature that used for naming sub-clusters.

Table 9. Correlation analysis results between clusters and type of car.

Main cluster	Sub-cluster	Mini	Compact	Medium	Large	SUV	Pickup	Motorcycle
Risk-oriented	Depression-oriented						0.091*	
	Motorcycle-oriented	0.116**				-0.076*		0.251**
	Danger-oriented		0.095**					
Safety-oriented	Driving-oriented	-0.098**			0.130**	0.119**		
	Work-oriented					0.080*		
	Transit-oriented	0.085*	-0.093*	0.095**	-0.112**		0.102**	
	Vitality-oriented		0.094*					-0.081*

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

Table 10. Correlation results between clusters and vehicle/driver classes.

Main cluster	Sub-cluster	Low emission	Low consumption	New vehicle	Foreign vehicle	Driver with damage accident	Driver with injury accident
Risk-oriented	Depression-oriented	-0.080*		-0.096**			
	Motorcycle-oriented		0.106**		-0.076*		0.091*
	Danger-oriented					0.103**	
Safety-oriented	Driving-oriented	0.119**	-0.109**		0.147**		
	Work-oriented	0.101**			0.085*		
	Transit-oriented		-0.073*				
	Vitality-oriented				-0.146**		

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

Biography

Ali Mohammadi has received his BS in Civil Engineering from Isfahan University of Technology, Isfahan, Iran in 2011 and his MS in Civil Engineering from Sharif University of Technology, Tehran, Iran in 2013. He is currently a PhD candidate in Civil Engineering Department at Sharif University of Technology. His research interests include land-use and travel demand modeling, use of non-motorized modes of travel, and physical health and transportation.

Mohammad Kermanshah received his BS degree in 1974 from Shiraz University, Iran, his MS degree from South Dakota School of Mines & Technology in USA in 1978, and his PhD degree from the University of Davis, California, USA in 1984. He is now a Professor of Civil Engineering at Sharif University of Technology, Tehran, Iran. His research interests include transportation modeling, urban transportation planning, and transportation demand management.