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# Analysis of the Effects of Social and Economic Factors on Energy Consumption, with Emphasis on Family Travel Patterns
## (Case Study: Malek-Shahr and Amir-Arab Neighborhoods in Isfahan)

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**ABSTRACT:** The high consumption of non-renewable energy and fossil fuel pollution has been a significant issue in recent decades. The transportation sector, which is affected by travel patterns, has a substantial stake in energy use; these patterns depend on various factors, including social and economic factors. The purpose of this paper is to examine the effects of social and economic factors on energy consumption, with an emphasis on family travel patterns; for this purpose, the Malek-Shahr and Amir-Arab neighborhoods in Isfahan, Iran, were selected as the research cases. A mixed-paradigm methodology was used. The required information to examine the measures and the related factors was obtained by documentation and field study; the classified random sampling method was used to complete the questionnaires. In addition, the Mann-Whitney U test was used to examine the significant differences between the neighborhoods considering social, economic, and travel pattern variables. Also, factor analysis and regression were applied to carry out path analysis and explain how the factors and variables were related. The results indicate that the Malek-Shahr neighborhood has a significantly better social and economic status and more arbitrary travel patterns than the Amir-Arab neighborhood. It was also found that there was no significant relationship between the social factor and the travel patterns in both neighborhoods. The economic factor played a major role in this respect; this was more pronounced in the Amir-Arab neighborhood afflicted by a lower economic status.

**Keywords:** *Social and Economic Factors, Energy Consumption, Travel Pattern, Malek-Shahr Neighborhood, Amir-Arab Neighborhood*

## INTRODUCTION

With the growth of urban populations, increase in global warming, and the resulting serious concerns regarding the increase of greenhouse gases and the environmental constraints on energy use, communities have sought to establish sustainability policies as one of the most important procedures needed in social life. The transport sector has recently been affected by issues related to sustainability; estimates show that most of the world's energy consumption is related to motor vehicles running on fossil fuels (Joumard & Gudmundsson, 2010; Moughtin & Shirley, 2005). Indeed, in the last decade, the transportation paradigm based on management and increase in delivery targeted by an increase in the number or width of roads has been replaced by Transportation Demand Management (TDM) (Meyer, 1999; Batur & Koç, 2017). In this approach, the intention is to improve the possible travel alternatives and encourage clean transportation instead of enhancing the physical status of roads. Accordingly, various studies have been carried out on changing the pattern of unclean travel to a clean travel pattern, with each study examining certain factors and the degree of their influence. The results of these studies seem to point to the significance of social and economic factors and the relationship between these factors and patterns of travel (Lund, 2003; Bhat & Eluru, 2009; Chee & Fernandez, 2013).

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However, adequate research in Iran, as one of the largest primary energy consumers in the Middle East (CDIAC, 2008), has not been carried out; some metropolises such as Tehran and Shiraz (Hosein Jangi & Habibzadeh, 2017; Hasanpour & Khaksari, 2016; Etminani et al., 2016) have been targeted, but less research in this regard has been done in detail on a local scale in the metropolis of Isfahan, a city that has been identified as one of the most polluted cities in the country (Economic World, 2018). Therefore, this research tries to identify the variables associated with social and economic factors and travel patterns and determine the relationship between the two based on a study of Malek-Shahr and Amir-Arab neighborhoods in Isfahan. Thus, the main question of this research is, firstly, what is the relationship between the social and economic factors and travel patterns in the Malekshahr and Amir Arab neighborhoods, and secondly, what kind of relationship is it?

Accordingly, the literature on sustainable transport and energy consumption, travel patterns, and economic and social factors is reviewed, and the required variables are subsequently identified. Following the literature review, we present the methodology and the available findings. Finally, the conclusions regarding the effects of social and economic factors and travel patterns are given, followed by recommendations for clean travel.

## Review of Related Literature

### Sustainable Transportation and Energy Consumption

Cities are the major consumers of energy in the world; according to estimates, urban populations account for at least two-thirds of the overall energy consumption; this is while the energy demand will continually increase due to population growth and expansion in urban infrastructure, despite widespread restrictions on supplying energy from oil and gas until 2030. (Bose, 2010).

One of the most important non-renewable energy consumer sectors in the world in general, and in cities in particular, is the transportation sector, which has experienced an unprecedented increase in recent decades (Moughtin & Shirley, 2005). Estimates indicate that energy consumption and greenhouse gas emissions in this sector will increase more than any other sector by 2025 compared to 2000 (Muharram Nejad & Ahmadi, 2006).

A significant portion of the energy consumption and greenhouse gas emissions is related to personal transportation, with estimates in the reports of international institutions and national organizations about consumption showing that although the share of urban transportation in the total amount of CO2 emissions differs in various countries, in general, it can be said that the urban transport sector has a share of between 8% and 13% of these emissions of which 70-90% is from personal automobiles (UNEP, 2009).

Considering the increase in the energy consumption associated with private transportation and its resulting pollution on the one hand, and the related social and economic issues such as lower levels of security and vitality, and decrease in the interactions between neighbors as well as the increase in density costs and the higher number of accidents on the other (Kenworthy, 2000), in recent decades there has been a paradigm shift in the transportation sector like many other sectors resulting in the dominance of stable transportation. This means that, unlike the past, modern transportation should be based on stability principles and create a balance between transportation, security, availability, and environmental quality (Jabareen, 2006). In addition, it is necessary that based on this paradigm, stability be targeted in terms of economy (by using resources and preserving capital), socio-ecological considerations (by reducing the detrimental effects of transportation such as energy use and pollution), and social issues (by seeking the advantages of public transportation) (Zhou, 2012).

Therefore, in recent years, travel as one of the most important areas for transport sustainability has been placed on the agenda of policymakers and urban authorities. An approach based on an increase in the transport sector has changed to the Transportation Demand Management (TDM) approach, such that in many developed countries today, instead of focusing on policies that quantitatively increase road networks and personal transportation, the focus is on the policies of clean and green transport, and the expansion of its related travel patterns, such as walking, cycling and public transportation (Meyer, 1999; Batur & Koç, 2017).

### Patterns of Travel and the Related Social and Economic Factors

The travel pattern, which is understood as to how and to what extent existing vehicles are used, is one of the most important issues related to clean and sustainable transportation. This is because it generally affects the efficiency of urban mobility, such that the improvement of alternative travel patterns is now a major approach in the management paradigm and the reduction of travel demand, with methods of clean travel being emphasized (Seyyed Hosseini, 2015; Schiller et al., 2010; Meyer, 1999). However, the type of use and the travel patterns are themselves influenced by numerous and varied factors; accordingly, various frameworks and models for identifying the factors influencing the patterns of travel have been proposed by different studies. As a result, the factors affecting patterns of travel can be divided into three categories (Seyyed Hosseini, 2015; Grazi & Van den Bergh, 2008; Wang & Liu, 2015):

- Travel agents: including travel purpose (activity selection), travel mode, travel time, travel cost, travel distance, frequency of travel.
- Internal factors (social and economic characteristics of travelers): income, vehicle ownership, driving license, job status, employment type, gender, age group, family structure, level of education, attitudes, and personality types.

• External factors and the related transportation facilities (policies, economic and physical environment of travel): the built environment, infrastructure, quality of transportation services, transportation policy.

The studies that have been carried out emphasize that social and economic factors significantly impact the pattern of travel and the choice of vehicle type, rendering transportation studies unconcerned with such aspects ineffective. However, there is no standard method for measuring the impact of social and economic factors on travel patterns. Thus the selection of the related variables is usually based on previous work. Therefore, in this study, the theoretical literature related to the socio-economic factors of travel patterns were reviewed, and seven measures related to travel patterns and 12 measures related to social and economic features were selected, as shown in Table 1, and a questionnaire was compiled.

## MATERIALS AND METHODS

This research is in the category of applied research in terms of purpose. In addition, based on Johnson & Christensen (2014), the methodology paradigm is of the mixed research type. In the first stage, qualitative research methodology focused on the subject and prevented generalization. Subsequently, qualitative research methodology was used for the two neighborhoods of Amir-Arab and Malek-Shahr as the study cases. In the second stage, to explain the subject (analysis of the relationship between the social and economic factors and travel patterns), the non-experimental research method from the quantitative research methodology paradigm was used.

The required information was gathered to examine the measures and related factors using the documentary and field methods (observation and questionnaire). First, based on the map of Isfahan and observation, the measures related to access to bus stations, the metro, and taxis were identified in the two neighborhoods. Then, a questionnaire was prepared and distributed according to a classified random sampling method based on proportional allocation regarding the other criteria. The statistical population in this study was all households living in the Malekshahr and Amir Arab neighborhoods; however, since no list of these households existed, doorplates were used as alternative data. 1850 residential units in the Amir-Arab neighborhood and 2190 in the Malek-Shahr neighborhood were included, with a 90% coefficient and a 5% error; 117 questionnaires from the Amir-Arab and 139 from the Malek-Shahr neighborhood were selected and analyzed as the statistical sample.

After collecting the required data, the descriptive and inferential statistics of the measures and factors were analyzed using SPSS and AMOS Graphic software. The mean and standard deviation of each one was described and, subsequently, due to the non-parametric nature of the variables, the Mann-Whitney U test was used to compare the measures in the Malek-Shahr and Amir-Arab neighborhoods concerning the various social and economic factors as well as the clean and unclean travel patterns. Finally, to examine the relationship between the factors and variables, the first stage was done based on factor verification analysis of the components. In this stage, if the measures were in one component based on the Maximum Likelihood method, and the KMO test was higher than 0.5, and Sig less than 0.05%, the relevant factor was considered acceptable. In the next stage, on condition of confirmation, the relationship between the factor and the measures and the relationship between the social and economic factors and the clean and unclean travel patterns was investigated with linear regression. The desired Beta as factor effects on the measure was taken into account. Finally, all of the above was described in path analysis in a diagram. It should be noted that how motorized and non-motorized vehicles are rated in light of their impact on energy use is based on an inverse relationship: the less the walking and cycling, the more the driving.

Table 1: Components and measures of social and economic factors and travel patterns.

| Components | Measures | Studied in |
|---|---|---|
| Social | Age, gender, status, education level, driving license. | (Maduwanthi et al., 2015; Cao et al., 2009; Ewing et al., 2009; Lachapelle & Frank, 2009; Cao et al., 2006; Handy et al., 2006; Handy & Clifton, 2001; Stead, 2001; Boarnet & Sarmiento, 1998; Kockelman, 1997; Cervero & Kockelman, 1997; Naess & Sandberg, 1996; Flannelly & Mcleod, 1989; Hanson, 1982; Chatman, 2009; Rodriguez & Joo, 2004; Pushkar et al., 2000; Ewing et al1996,.; Cervero,1996; Ewing,1995; Naess,1993; Prevedouros & Schofer, 1991) |
| Economic | Employment status (full-time or part-time), occupational place of household head, number of household employees, household expenses, housing ownership, vehicle ownership, motorcycle ownership, bicycle ownership. | |
| Clean Travel Pattern | Frequency of taxi trips, frequency of metro travel, frequency of bus trips, frequent walking trips, frequency of bike trips. | (Seyyed Hosseini, 2015; Lachapelle & Frank, 2009; Ewing et al., 2009; Lund et al., 2004; Bento et al., 2003; Rajamani et al., 2003; Cervero & Kockelman, 1997; Hanson, 1982) |
| Unclean Travel Pattern | Frequency of travel by car, frequency of motorcycle trips. | |

These two neighborhoods were chosen because they have different backgrounds despite their close vicinity in the 12th region of Isfahan; Malek-Shahr is a sector with a proper structure that was designed beforehand and is considered relatively rich. On the other hand, the Amir-Arab neighborhood was shaped by the migration of Iranians residing in Iraq who were driven out of this country in the 1981s. It was formed without any previous design, as shown in Figure 1. (Iravani et al., 2009). As a result, despite their similar situation and relatively similar facilities in terms of transportation types, these two neighborhoods are socially and economically very different.

## RESULTS AND DISCUSSIONS

### Examination and Analysis of Social and Economic Characteristics in the Selected Neighborhoods

In this section, the measures related to the social and economic characteristics of the Malek-Shahr and Amir-Arab neighborhoods have been compared using the Mann-Whitney U test and are presented in Table 2.

As can be seen, there is no significant difference between the Malek-Shahr and Amir-Arab neighborhoods as regards the indicators of social and economic status, including age, gender, driving license status, employment status (full-time or part-time), occupational place of household head, number of household workers, housing ownership, and motorcycle and bicycle ownership. However, in Malek-Shahr, education, household costs, and vehicle ownership are significantly higher. Therefore, it can be said that overall, despite the similarity in most of the measures, Malek-Shahr is better than Amir-Arab in terms of its social and economic status.

### Examination and Analysis of the Travel Patterns in the Selected Neighborhoods

This section analyzes travel pattern measurements in the two neighborhoods using the U-Mann-Whitney test, as shown in Table 3.

From the examination of the patterns of travel, the following results were obtained:

- In Malek-Shahr, most transportation inside the neighborhood is by private car, taxi, bus, motorcycle, metro, walking, and bicycle in order of importance.
- Most outside neighborhood transportation are by taxi, private car, metro, bus, motorcycle, and bicycle, in order of importance.
- In the Amir-Arab neighborhood, most inside neighborhood transportation are by motorcycle, walking, private car, bicycle, taxi, bus, and metro. Most outside neighborhood transportation is by bus, taxi, motorcycle, private car, metro, and bicycle.
- In Malek-Shahr, the use of a private car, taxi, and metro inside and outside the neighborhood are significantly higher than in the Amir-Arab neighborhood, as is the use of buses

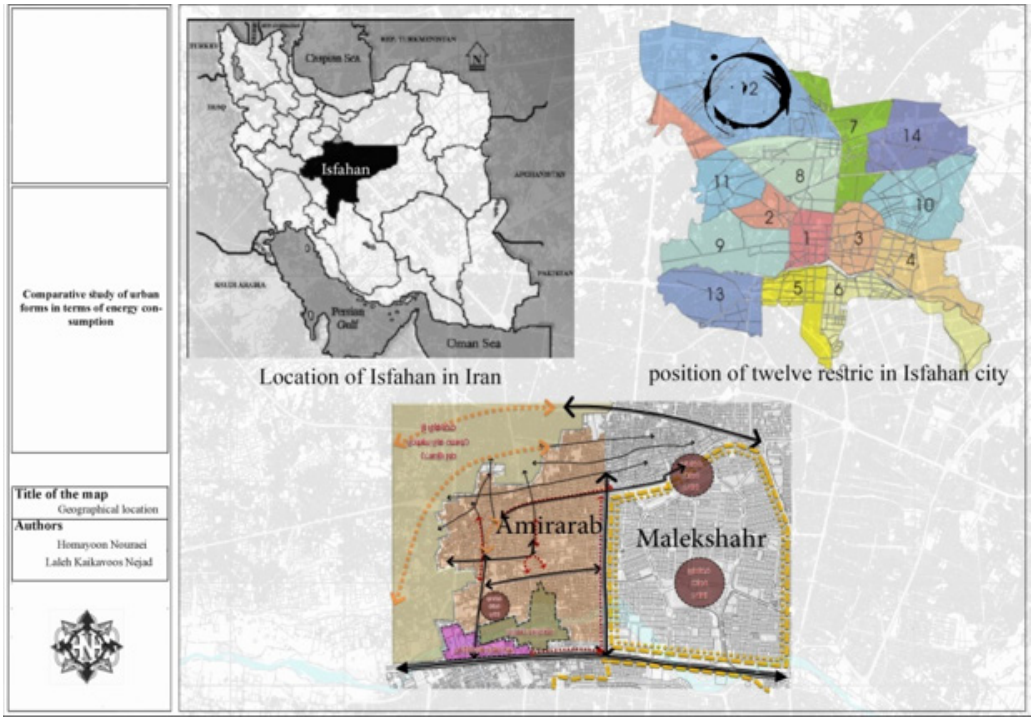


Fig.1: Malek-Shahr and Amir-Arab neighborhoods and their situation in Isfahan

Table 2: Status of social and economic measures in Malek-Shahr and Amir-Arab neighborhoods

| component | Social and economic measures | Malek-Shahr | | Amir-Arab | | Results of Mann- Whitney U Test | |
|---|---|---|---|---|---|---|---|
| | | Mean | Standard deviation | Mean | Standard deviation | Sig | Mann-Whitney U |
| Social status | Age | 3.32 | 1.23 | 3.20 | 1.29 | 0.539 | 7779.000 |
| | Gender | 1.61 | 0.49 | 1.61 | 0.59 | 0.529 | 7815.500 |
| | Level of education | 2.94 | 0.98 | 2.32 | 1.06 | 0.000 | 5516.500 |
| | Driving license status | 1.64 | 0.48 | 1.55 | 0.5 | 0.130 | 7373.000 |
| Economic status | Employment status (full-time / part-time) | 2.15 | 0.68 | 2.00 | 0.79 | 0.121 | 7281.000 |
| | Place of employment of household head | 1.94 | 1.07 | 2.05 | 1 | 0.236 | 7471.000 |
| | Number of household workers | 2.52 | 0.95 | 2.67 | 1.19 | 0.385 | 7643.000 |
| | Household costs | 2.21 | 1.07 | 1.78 | 1.01 | 0.000 | 6018.500 |
| | Housing ownership | 1.62 | 0.48 | 1.58 | 0.49 | 0.467 | 7768.000 |
| | Car ownership | 2.47 | 1.03 | 2.06 | 0.99 | 0.001 | 6316.000 |
| | Motorcycle ownership | 2.04 | 1.04 | 2.01 | 0.89 | .0829 | 8010.500 |
| | Bicycle ownership | 2.78 | 0.96 | 2.59 | 1.00 | 0.138 | 7293.000 |

Table 3: Measures related to travel patterns in Malek-Shahr and Amir-Arab neighborhoods

| Component | Measures related to Travel pattern | Level of analysis | Malek-Shahr | | Amir-Arab | | Results of Mann- Whitney U Test | |
|---|---|---|---|---|---|---|---|---|
| | | | Mean | SD | Mean | SD | Sig | Mann-Whitney |
| Unclean travel pattern | Frequency of travel by car | Inside the neighborhood | 3.79 | 1.75 | 2.66 | 1.54 | 0.000 | 5006.000 |
| | | Outside the neighborhood | 4.02 | 1.84 | 3.37 | 1.79 | 0.003 | 6447.500 |
| | Frequency of travel by motorcycle | Inside the neighborhood | 2.42 | 1.55 | 2.97 | 1.67 | 0.007 | 6588.500 |
| | | Outside the neighborhood | 2.58 | 158 | 3.61 | 1.82 | 0.000 | 5564.000 |
| Clean travel pattern | Frequency of travel by taxi | Inside the neighborhood | 2.94 | 1.66 | 2.45 | 1.61 | 0.011 | 6686.500 |
| | | Outside the neighborhood | 4.04 | 1.56 | 3.67 | 1.55 | 0.040 | 6961.000 |
| | Frequency of travel by metro | Inside the neighborhood | 1.81 | 1.41 | 1.00 | .00 | 0.000 | 5616.000 |
| | | Outside the neighborhood | 3.70 | 1.57 | 3.09 | 1.71 | 0.003 | 6406.500 |
| | Frequency of travel by bus | inside the neighborhood | 2.85 | 1.60 | 2.21 | 1.52 | 0.001 | 6240.000 |
| | | outside the neighborhood | 3.28 | 1.90 | 3.97 | 1.69 | 0.002 | 6408.500 |
| | Frequency of travel by walking | Inside the neighborhood | 4.19 | 1.57 | 3.04 | 1.58 | 0.000 | 4987.500 |
| | | Outside the neighborhood | 6.00 | 0 | 6.00 | .00 | 1.000 | 8131.500 |
| | Frequency of travel by bicycle | Inside the neighborhood | 4.70 | 1.60 | 3.48 | 1.62 | 0.000 | 4868.500 |
| | | outside the neighborhood | 5.21 | 1.1 | 4.60 | 1.09 | 0.000 | 5560.000 |

inside the neighborhood.

• In the Amir-Arab neighborhood, the frequency of transportation by bus and on foot inside the neighborhood and by bicycle and motorcycle inside and outside is significantly higher than in Malek-Shahr.

• None of the respondents travel outside their neighborhood on foot, and in this regard, there is no meaningful difference between the two neighborhoods. Therefore, as regards clean and unclean travel patterns and the use of cars and motorcycles in comparison with other transportation methods in the studied neighborhoods, it can be said that in general, Amir-Arab has a clean travel pattern in contrast with Malek-Shahr, and is thus more sustainable in terms of transportation.

**Examination and Analysis of the Relationship between Travel Patterns and Social and Economic Factors in the Selected Neighborhoods**

After determining the measures related to the model of travel and the social and economic factors in the two neighborhoods, in this section, the relationship between the patterns of travel and these factors has been analyzed with confirmatory factor analysis and the regression beta coefficient. The results are shown in Figures 2 and 3 and Tables 4 and 5.

The above figures and tables indicate that:

- In both neighborhoods, all measurements have the ability to come together in the form of the desired components, and the KMO index found for all components is higher than 0.5. In addition, all relationships are significant, and the variance is 35% to 57%.

- The social factor does not significantly affect either clean or unclean travel patterns in both neighborhoods. In contrast, the economic factor has a significant impact on both. It is worth noting that the impact of the economic factor on the clean travel pattern is negatively correlated with the unclean travel pattern, which shows that due to the improvement of the economic situation of the residents, the use of unclean and personal vehicles has increased. This issue is more pronounced for the Amir-Arab than the Malek-Shahr neighborhood, given

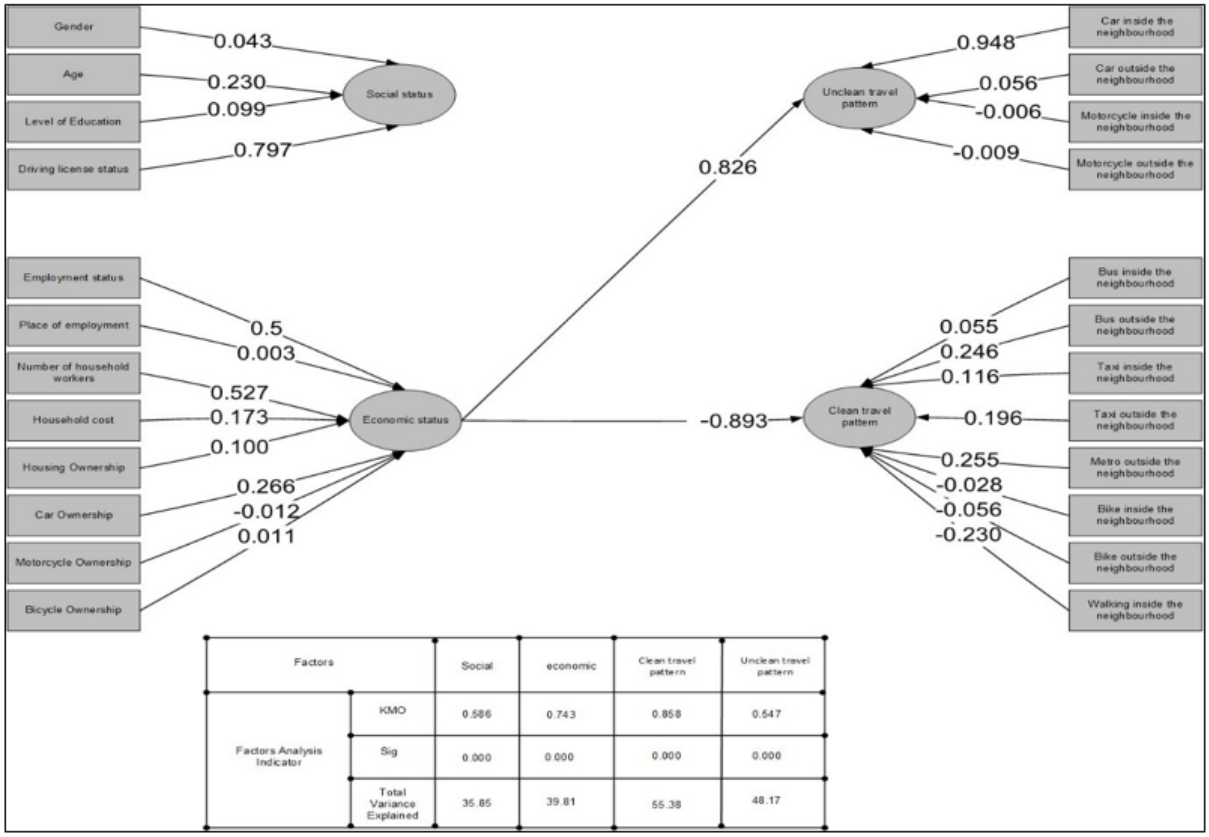


Fig. 2: Analysis of relationship between travel patterns and social and economic characteristics in Malekshahr neighborhood

Table 4: Variance results and relationship between travel patterns and social and economic characteristics in Malekshahr neighborhood

| Factors | | Social | Economic | Clean travel pattern | Unclean travel pattern |
|---|---|---|---|---|---|
| Factor Analysis Indicator | KMO | 0.612 | 0.682 | 0.823 | 0.613 |
| | Sig | 0 | 0 | 0 | 0 |
| | Total Variance | 44.68 | 35.28 | 49.78 | 57.06 |

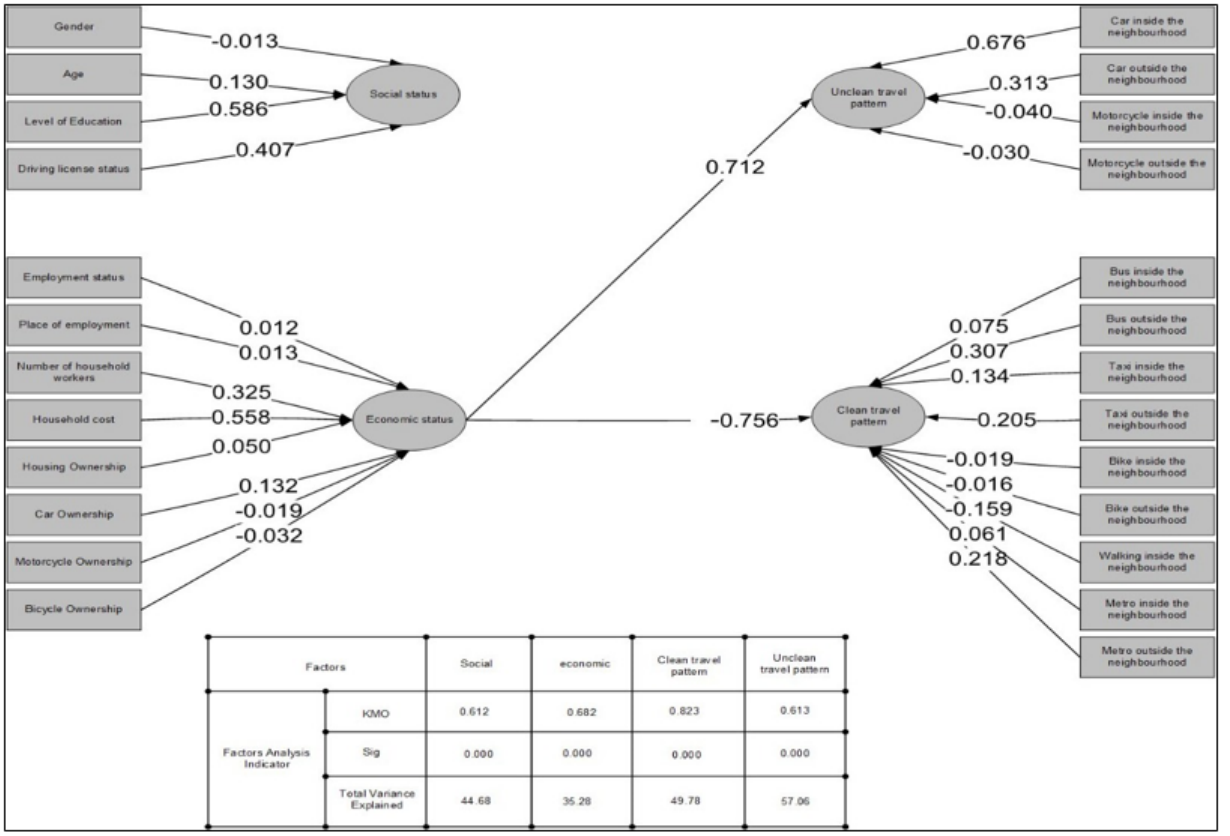


Fig. 3: Analysis of relationship between travel patterns and social and economic characteristics in Amir Arab neighborhood

Table 5: Variance results and relationship between travel patterns and social and economic characteristics in Amir Arab neighborhood

| Factors | | Social | Economic | Clean travel pattern | Unclean travel pattern |
|---|---|---|---|---|---|
| Indicators of factor analysis | KMO | 0.586 | 0.743 | 0.858 | 0.547 |
| | Sig | 0 | 0 | 0 | 0 |
| | Total Variance | 35.85 | 39.81 | 55.38 | 48.17 |

the coefficients.

- Although the lack of a meaningful relationship between the social component and the travel pattern, this component in Malek-Shahr is most significantly affected by the status of education and driver's license, in Amir-Arab, it is affected more by driver's license and age.

- The most important indicators of the economic factor in both the Malek-Shahr and Amir-Arab neighborhoods, with a small displacement in sequence, are the household costs, the number of employees, and car ownership. In addition, motorcycle ownership in both neighborhoods has a reverse relationship with this factor. This means that as motorcycle ownership grows, the economic situation weakens.

- Among the measures indicating an unclean travel pattern, the frequency of travel by car inside and outside the neighborhood has the most significant impact, and motorcycle transportation has an inverse relationship.

- There is a difference in the pattern of clean travel in the two neighborhoods; in the Malek-Shahr neighborhood, there are many measures of travel by bus, metro, and taxi. All three have the highest impact on the factor outside the neighborhood. This issue for the Amir-Arab neighborhood is associated with a considerable measure of travel by metro and bus outside and on foot inside the neighborhood.

## CONCLUSION

The purpose of this study was to investigate the effects of social and economic factors on energy consumption, emphasizing travel patterns; accordingly, the study was carried out in the two neighborhoods of Malek-Shahr and Amir-Arab in the city

of Isfahan. The reason for studying these two neighborhoods was that, despite their similar location and similarity in terms of access to different modes of transportation, these two neighborhoods are distinctly different in terms of their social and economic status.

In line with the above objective, the social and economic status of these two neighborhoods was firstly compared using the U-Mann Whitney test, and it was determined that the Malek-Shahr neighborhood has a significantly better social and economic status in terms of education level, household expenses, and vehicle ownership in comparison with the Amir-Arab neighborhood. Also, the comparison of the pattern of travel in the two neighborhoods suggests that the pattern of travel in the Amir-Arab neighborhood is significantly cleaner in terms of trips inside and outside of the neighborhood and, consequently, more stable than it is in the Malek-Shahr neighborhood. In terms of the pattern of inside neighborhood travel, private car is less used, and most of the trips are by motorcycle or walking in the Amir-Arab neighborhood. Moreover, most outside neighborhood trips are carried out by public transportation, and there is less personal ownership than there is in Malek-Shahr.

On the other hand, the study of the relationship between the social and economic factors and the patterns of clean and unclean travel showed that in both neighborhoods, the social factor has no significant relationship with the pattern of travel. In contrast, the economic factor plays a major role in this respect. This issue is more pronounced in the Amir-Arab neighborhood, which is weaker economically.

Overall, based on the above considerations, on the one hand, in line with some past research, the economic factor plays a decisive and meaningful role in choosing the type of vehicle for travel and therefore needs more attention and consideration. On the other hand, its impact will increase as the economic situation improves. In contrast, the results of previous research on the impact of social factors on travel patterns cannot be confirmed based on this research; here, it was found that there was no significant relationship between the social and economic factors either in the Malek-Shahr or Amir-Arab neighborhoods. Of course, this could be due to the social homogeneity of these neighborhoods. Also, the lack of a significant difference can be attributed to the average social level of the Malek-Shahr, and the relatively low social level of the Ami Arab neighborhood. A closer relationship will likely result in improvement in social status.

Given the effects as mentioned above, and considering that in both the Malek-Shahr and Amir-Arab neighborhoods, households costs, households employees, and vehicle ownership were stronger economic factors (which means that with the increase in these measures, the unclean travel pattern will increase), it is suggested that while creating and developing the necessary modalities for a clean travel pattern such as expanding public transportation and encouraging walking and cycling, the costs relating to usage (and not necessarily buying) a car should be increased significantly. This is because, principally, the cost of using a private car in Iran is much lower than world standards. Meanwhile, removing personal cars from capital goods rather than consumer goods can reduce car ownership and, consequently, reduce their use.

Also, considering that in the current situation, motorcycles are considered as part of unclean travel patterns due to noise pollution and other negative aspects, it was shown that their use in the two neighborhoods was inversely related to the economic situation being used much more in the Amir-Arab neighborhood. It is suggested that clean electric motors with special facilities replace existing motorcycles.

Finally, it is suggested that studies with more variables and more research cases be conducted to complete this study. In addition, studying the relationship between travel patterns and interventionist factors such as environmental variables (urban form), transportation facilities (the level of vehicle comfort in the transportation network) can complement the results of this research.

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