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# An Analysis of the Intraurban Trip Distance Using the Time Geography Framework; Influenced by Individual Constraints or Spatial Opportunities*

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## Abstract

**Problem statement:** Trip distance, as a key variable of travel behavior, represents the level of sustainable transportation, quality of life, individuals' accessibility to spatial opportunities, and spatial balance among urban areas.

**Research objectives:** Despite numerous research relating to travel behavior, few scant studies have investigated the role of different factors in explaining trip distance for non-work purposes. So, the main purpose of this paper is to investigate the role of both individual and physical-spatial factors (at trip origin and destination) on trip distance using the theoretical framework of time geography.

**Research method:** The research method is descriptive-analytic based on logical reasoning and empirical observations. In this study, based on the g time geography framework, 9 factors at the individual level and 9 factors at the scale of the neighborhood are categorized into three sets of constraints including capacity constraints, coupling constraints, and authority constraints. In order to test the theoretical framework, 30 study districts in the metropolitan of Isfahan, Iran are selected and required data were collected using 1312 questionnaires. For analysis of the abovementioned factors, the potential impacts of the factors have been firstly explained and then, using the collected data and the linear regression technique, the expected relationships have been experimentally tested.

**Conclusion:** The results and the findings of the research show that the variables related to all three types of constraints affect trip distance; and the role of physical-spatial characteristics in explaining trip distance is stronger than individual factors. Distance from the city center is the most important factor affecting trip distance. Also, although it was theoretically expected that some factors such as gender, household size, commercial density, and land use diversity affect travel length, they did not significantly appear in the empirical analysis model.

**Keywords:** *Individual constraints, Spatial opportunities, Trip distance, Time geography .*

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## Introduction and problem statement

Following the increase in private vehicle usage and its negative reflection on the individuals and the society, a great number of researchers and planners have tried to recognize chief factors which affect travel behavior and prescribe strategies to impact individuals travel behavior. Theoretically, new urbanism and relevant views such as transit oriented development (TOD), compact city, smart growth etc. are the most important urban planning strategies in response to today's car oriented developments (Sun, Ermagun & Dan, 2016). Emprically, by shifting from trip-based approach to activity-based approach since 1970's, researchers have attempted to identify various factors including individual factors, socio-economic and spatial characteristics which affect travel behavior to enhance the efficacy of planning strategies (Cervero & Kockelman, 1996; Zhang, 2004). Using activity-based and disaggregate approach, previous research have measured different dimensions of the built environment and travel behaviour and analyzed their relationship. The built environment have mainly referred to density, mixing land use, street pattern and so on. On the other hand, travel behavior outcomes have often been modeled astrip frequency (Fan, 2007; Cao, 2010), travel mode choice (Zhang, 2004; Frank et al., 2007), travel time and trip distance (Helminen and Ristimaki, 2007; Cao and Mokhtarian, 2005), and frequency of travel with particular destination or travel for its own sake (Mirzaei, Kheyroddin, Behzadfar, & Mignot, 2018; Kheyroddin & Mirzaei, 2015). It is worth noting that despite existing rich literature on travel behavior, there is not still a comprehensive consensus on how individual and spatial factors affect travel behavior; because, travel behavior is a context-dependent behavior and context varies along different geographical, social and weather contexts. Hence, there is a doubt about the generalization of previous research to other countries. Although trip distance has been one of the key geographical variables in travel behavior, this variable has not been well explored within a spatio-temporal framework. In fact, the trip distance is an important indicator of sustainable transportation and quality of life because it is indirectly related to mobility and freedom of individuals to move around their environment (Mercado & Páez, 2009). Intra-urban trip distance can be influenced by a variety of factors such as access to necessary activities within neighborhoods or individual characteristics such as car ownership and employment situation.

In this view, current research, by adopting transport geography framework (Hagerstrand, 1970) and using descriptive-analytical methods based on logical reasoning and empirical tests, aims to explore the influence of effective individual and spatial factors on individuals' trip length. In this regard, the central hypothesis is that individuals' trip distance in Isfahan city is a function of all three sets of constraints including capability, coupling and authority constraints, but in terms of strength, it seems that:

1. Gender has stronger influence on trip distance than other capability constraints;
2. Among built environment attributes, distant to central business district (CBD) is the most important variable which affects trip distance;
3. Car ownership has stronger influence on trip distance compared to other authority constraints.

## Background

So far, a considerable number of research have analyzed different travel behavior components, specially travel mode choice and trip frequency. While most of these studies have emphasized on the role of built environment in explaining travel behavior by considering travel as a derived demand and micro-economic models (Kheyroddin & Mirzaei, 2015), a few studies have been conducted by using transport geography framework. This section specifically refers to previous studies regarding individuals' trip distance. Cervero and Kockelman (1997) using a large survey across 50 neighborhoods in the US showed that increase in four-way intersection numbers reduces

non-work trips length. Dargay and Hanly (2003) in England found that increased density, proximity to public activities and public transportation system, and close distance to city center decrease vehicle mile traveled. In another research, Khattak and Rodriguez (2005) by analyzing travel behavior in various neighborhoods in American's cities found that residents of neo-traditional neighborhoods travel shorter distance by automobile compared to those live in sub-urban neighborhoods. Moreover, due to the importance of meta-analysis studies, the results of two relevant meta-analysis studies will be pointed out (Ewing & Cervero, 2001, 2010). These meta-analysis researches have combined and generalized the results from several studies based on common metrics. Ewing and Cervero (2001) reported that trip distances are primarily a function of the built environment and secondarily a function of socioeconomic attributes. They also found that vehicle miles traveled (VMT) is significantly related to both factors. In addition, trip lengths usually are shorter in dense and diverse areas. Ewing and Cervero (2010) in another meta-analysis study showed that vehicle miles traveled (VMT) is most strongly related to the accessibility to destinations. Moreover, distance to CBD is negatively associated with VMT. Design (intersection density and street connectivity), small block size and large number of intersections clearly shorten trip length. They also showed that VMT has a low elasticity to job and population densities. Manoj and Verma (2016), based on data from Bangalore, India, investigated the influence of built environment measures on trip distance and mode choice. Their results showed that the residents of diverse area have shorter travel distance. Moreover, population density has a weak partial effect on trip distance in presence of other built environment and socio-demographic explainers. They, in another analysis, found that trip distance has a significant effect on mode choice. Their results showed that with the increase of trip distance the likelihood of car usage would increase over other transport modes. Ellder (2014) has analyzed the relationship between residential location, trip purposes, and daily travel distance in switzland. The results indicated that the influence of residential location on trip distance highly depends on travel purposes. Although travel distances travelled to wok and service errands were related to residential location, daily travel distance travelled to recreational and leisure activities greatly varied among individuals living in the same neighborhoods. Ding, Wang, Liu, Zhang & Yang (2017) studied the role of trip distance, as a meditator variable, in choosing travel mode. Their results showed that individuals' trip length is negatively associated with population density, job density, accessibility, and street connectivity and positively related to distance to transit.

## Theoretical perspectives

As mentioned earlier, since 1970s, analytical approach of travel behavior has shifted from traditional trip-based approach to activity-based approach. Trip-based approach analyzes travel behavior using aggregate data (average characteristics) at zonal level, while activity-based approach analyzes travel behavior focusing on individuals /households and built environment attributes. Hence, it can be said that activity-based approach represents travel behavior more realistically compared to traditional trip-based approach (Etminani-Ghasrodashti & Ardeshiri, 2015). From theoretical standpoint, time-geography approach (Hagerstrand, 1970) is the classical theoretical framework in explaining travel behavior. The current paper has chosen this approach to explain the role of different factors in explaining travel behavior.

Based on time geography framework (Hagerstrand, 1970; Lenntorp, 1976), individuals are able to reach several specific locations given a limited time. This framework is recognized as a space-time prism for its three dimensional view on space and time. In this view, two first dimensions are related to the space (two-dimension plane) and the third dimension is related to the time which is orthogonally integrated into the two-dimensional plane. The area that can

be potentially reached by people is called "action space". This area depends not only on available time but also attainable travel speed (Kitamura, Yoshii & Yamamoto, 2009). Hagerstrand (1970), who originally developed time geography, identified three basic sets of constraints including capability, coupling, and authority/steering constraints which collectively determine the potential path area or action space. The first set of constraints is capability constraints which, in one hand, refer to physical/biological factors or cognitive limitations of individuals and, on the other hand, refer to instrumental restrictions such as transportation technology and the maximum attainable speed with a given mode of transport. Thus, people have to allocate a considerable amount of their time to eating, sleeping, personal care etc. In addition, no one can physically be in two locations simultaneously. To overcome these types of constraints, individuals may travel by car instead of taking bus and walking to reach more places. The second is coupling constraints which refer to this fact that people cannot perform their activities in isolation and separately from other people, as action space of each person is often linked up with other people's action space (Mercado & Páez, 2009). For example, individuals can do shopping and be involved with other people during a certain period of time in which stores or malls are open (Schwanen, Kwan, & Ren, 2008). The third is authority constraints which refer to law, rules, norms, economic barriers, and power relationships. This set of constraints indicates that certain places can be reached during specific times because certain people or institutions put limitation on these places. As an example, car ownership and driver license could be considered as authority constraints (e.g. rules and/or economic barriers) in terms of having accessibility to road systems and highways (Schwanen & Lucas, 2011; Mercado & Páez, 2009).

According to previous discussions, factors, which affect individuals' travel behavior, can be explained and analyzed by using time geography framework and considering mentioned sets of constraints. The factors are mainly categorized into two classes including individual/household class and spatial class (such as neighborhood or traffic zone). Socio-economic characteristics such as age, gender, car ownership and etc. are considered as individuals' level factors. Many research found that these factors considerably affect travel behavior (Ewing & Cervero, 2010). Built environment characteristics also highly impact on travel behavior. Since trip distance or distance between activities depends on urban form, travel cost and individuals' travel decisions is influenced by urban form (Boarnet & Crane, 2001; Crane, 1996). The most important built environment dimensions, which have been considered in most previous studies, include density, diversity, and access to public transportation (Cervero & Kockelman, 1997; Munshi, 2016). In next sections, different factors will be introduced and analytical approach will be explained by an adaptation of space-time framework.

## Methodology

This research is a descriptive-analytical study based on logical reasoning and empirical investigation. As mentioned in previous sections, the main goal of this research is to analyze the impact of individual and spatial characteristics on trip distance using time geography framework. To achieve this goal and to test conceptual framework of the research, 30 case studies across the metropolitan of Isfahanwith diverse physical-spatial characteristics and different relative locations have been selected. The locations of case studies are shown in Fig. 1.

The data relating to individual/ household factors including socio-economic characteristics and travel behavior (trip origin and destination, travel time, travel purpose, travel mode etc.) have been collected using 1312 questionnaires conducted in 30 areas1. Spatial characteristics of the case studies were collected by calculating on detailed plan of Isfahan City using ArcGIS 10.2 software.

- **Explaining individual and spatial factors using time geography framework**

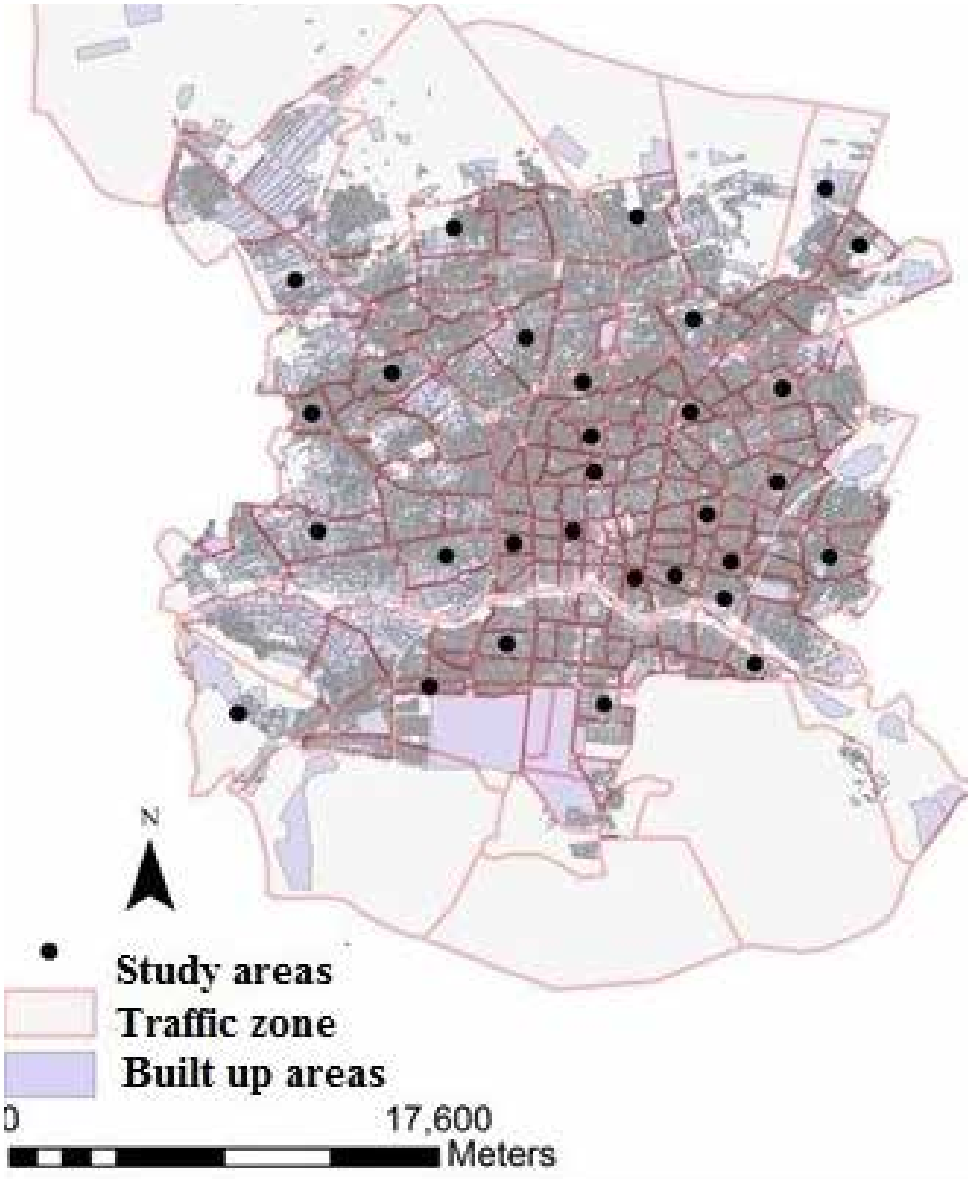


Fig. 1. The locations of study areas across Isfahan. Source: authors.

In general, the individual and spatial factors, considered in this research, are categorized into four groups including socio-economics, built environment attributes at trip origin and destination, departure time of travel, and travel mode. As well, non-work trip distance is analyzed as dependent variable. Non-work trips include trips for shopping, administrative services, strolling and leisure, health care, visiting relatives, and so on. It is worth noting that work and educational trips have been ignored because these kinds of trips are mainly mandatory activities and linked to a certain timetable and destinations. In this section, above mentioned factors have been categorized into three set of constraints (Table 1).

**Capability constraint factors:** capability constraints refer to physical and biological factors. Among different individual variables, age and gender are considered in capability constraints due to their nature. In fact, according to the gender and age classifications, individuals have different capability constraints which affect their trip lengths.

**Coupling constraint factors**: this set of constraints covers more variables compared to other types of

constraints. Among individual factors, two variables including job status and family size have been considered in coupling constraints. For example, employed people needs to adhere to a fixed time schedule depending on the type of work; and this set of constraints impacts on their trip lengths. Departure time of travel is also included in coupling constraints. In addition, since the interactions between people and activities are considered in coupling constraints, built environment can create coupling constraints (in terms of interactions and access to activities) and affect travel distance. In this paper, based on the literature, 9 key variables relating to the built environment factors at trip origin and destination have been defined and measured. These variables include population density, commercial density, entropy index (mixing land use), street density, distance to nearest bus station, bus lane density, distance to city center, traffic congestion.

**Authority constraint factors:** this set of constraints refers to lack of accessibility to certain places. These constraints are created in the form of general rules, laws, economic barriers, and power relationships (Mercado & Páez, 2009). In this research, car ownership, diver license, travel mode, and motorcycle/bicycle ownership have been defined as authority constraints. In this regards, lack of driver license could be considered authority constraints for driving which influences individuals' action space. Lack of car ownership (or lack of mobility tools in general), as an economic barrier, can impact on travel behavior.

## Findings and discussions

In pervious section, both individual and spatial factors were categorized into three set of constraints following Hagerstrand's classes of mobility constraints. This section aims to explore how the mentioned factors impact on individuals' trip distance.In this regard, the expected impact of different factors on trip distance is firstly deduced through a literature review and by logical inference, and then, the significance and strenght of the relationships have been statistically tested. According to suitable sample size and the nature of dependent variable (trip distance), linear regression is appropriate technique to analyze the relationships between variables. In this regard, An Ordinary Least Square model was developed between explanatory variables and non-work's trip distance as dependent variable. The results of this model have been summarized in Table 2.

**• Analysis and discussion on capability constraint factors**

Age and gender are considered as capability constraint factors. It is expected that elder people travel shorter distance for non-work purposes. This result is supported in previous studies (Boarnet & Sarmiento, 1998; Schmocker, Quddus, Noland & Bell, 2005). Age classifications have been constructed so as to reflect the possible non-linear effect of this variable on trip distance. Age group of 31-45 has been chosen as referenced group. Moreover, it is expected that women make shorter travel compared to men because of their physiologic and non-physiologic conditions such as domestic responsibilities (Kwan, 1999, 2000). Empirical analyses of the data show that respondents who are younger than 30 years old make longer distance trips compared to the elders. But, according to the results, age groups higher than 45 and gender variables do not significantly appear in the model.

**• Analysis and discussion on coupling constraint factors**

Totally, three variables in individual level including job status, family size and departure time of travel as well as 9 variables in spatial level (relating to physical-spatial characteristics of built environment) were considered as coupling constraints.

As for job status, it was expected that unemployed people travel longer distance due to more available free and flexible time. This result has been confirmed in other research (Vance & Iovanna, 2007). It was also expected that increase in family size leads to decrease in individual's trip length. This result can be due to the necessity of more presence of person in large families or due to complex travel decisions

Table 1. Classification of individual and spatial factors into three set of constraints. Source: authors.

| Constraints type | Individual/spatial variable | Description |
|---|---|---|
| **Capability constraints** | Age | Individuals above 14 years old |
| | Gender | male or female |
| **Coupling constraints** | Job status | Employed, self-employed, unemployed, students, others |
| | Family size | Number of family members |
| | Population density | Population/area size (persons/hectare) |
| | Commercial density | Number of commercial lots/ area size |
| | 1Entropy index | Mixture of residential, commercial and services, parks and green spaces, educational, public (health and sport), cultural-religious |
| | Street density | Street length/area size (Km/Km2) |
| | Blok size | Average block size within TAZ (km2/km2) |
| | Distance to bus station | Distance to nearest bus station (m) |
| | Bus lane density | Length of bus routes /area size (km/km2) |
| | Distance to CBD | Straight line distance from CBD (Km) |
| | Traffic congestion | Total number of trips generated and attracted to each zone |
| | Departure time | Time periods between 5 A.M and 12 noon. |
| **Authority constraints** | Car ownership | No. of vehicle per household |
| | Driver license | Having driver license |
| | Travel mode | Car ,bus, motorcycle, bicycle |
| | Motorcycle ownership | No. of motorcycle per household |
| | Bicycle ownership | No. of bicycle per household |

within such large families (Stradling et al., 2005; Scott and Kanaroglou & Anderson, 1997). Departure time of travel, occurring in peak or off-peak times or/and the working hours of the various service centers, can affect individuals' trip lengths. For example, individuals may make longer distance trips in the middle of day because of closed store around their neighborhood. In this regard, the results show that employers and student travel shorter distance in Isfahan. Since the survey of this paper was conducted during working hour of organizations, schools, and universities, it can be said that trip distance is significantly influenced by available time to people. These results emphasize on the importance of considering schedule time of administrative and educational activities in designing transportation policies. Other variables including family size and departure time of travel are not significantly related to trip distance.

In addition to individual variables, built environment

attributes were put in coupling constraints set. According to the literature, with the increase of population and commercial densities and mixing land use, it is likely that trip distance decreases. In fact, these conditions provide a threshold population and necessary infrastructure for other activities to be created in an area. Thus, these conditions will increase individuals' accessibility and subsequently decrease their trip distance. As for street density, it seems that this variable has a contradictory effect on residents' trip distance. For example, higher road density in residential area could provide more alternative routes for transit or encourage using car as travel mode. If later is true, it is more likely that trip distance increase significantly. On the other hand, higher street density may lead to creating more non-residential activities in the edge of streets. Accordingly, individuals can access various non-residential activities by short travel. In addition, access to different bus lanes and proximity to bus stations encourage individuals to use bus as travel mode. Moreover, it is expected that increase in distance to CBD leads to increase in non-work trip length due to concentration of activities within CBD. Regression analyses of the data also show that among built environment variables, 3 built environment variables at trip origin and 5 variables at trip destination have significant association with trip distance. In this regard, those who live farther from CBD travel longer distance to non-work purposes. Higher bus lane density around residential area encourages people to make longer trips. In contrast, traffic congestion at trip origin decreases trip distance. This result may be due to this fact that traffic congestion is a result of concentration of different activities in an area. Availability of a great number of activities in an area mainly leads to increase in people's accessibility to different land uses. Street density and traffic congestion at trip destination also increase individuals' trip distance. Increase in population density at trip destination reduces trip distance. This result may be attributable to existing higher residential land uses at trip destinations compared to other land uses. Although the influence of built environment at trip destination has been less considered in previous research,few existing studies showed that that there is a negative association between population density at trip destination and trip distance (Manoj & Verma, 2016). In addition to mentioned variables, block size, bus lane density at trip destination are positively related to trip distance. According to standardized coefficients (Table 2), distance to CBD is most important variable among the built environment variables which affect travel distance. It was expected because a decrease in block size leads to higher accessibility to main streets and other trip destination. Availability of various bus lanes, according to relatively cheap bus fare, encourages individuals to travel longer distances and experience new destinations. It is also expected that number of bus lanes are positively related to population and job density of an area. Longer trip distance of those who live far from the center may be due to concentration of large and trip generated land uses in city center and its periphery areas. These results support the policies of increased density and balanced distribution of trip generated activities between different areas.

**• Analysis and discussion on coupling constraint factors**

Car, motorcycle and bicycle ownership, driver license and travel mode have been considered as authority constraint factors. It was logically expected that car and motorcycle ownership as well as using car as travel mode encourage respondents to make longer distance travel. These results are consistent with previous studies. Bicycle ownership also encourages individuals to travel shorter distance. Driver license ownership allows respondents to use their cars instead of other travel modes. Analysis of the data, collected from Isfahan, supports the mentioned results. To analyze the role of travel mode, car is selected as the reference category because from a policy perspective it is insightful to compare distance travelled by car to distance travelled by other alternative transport modes (Bocker, Amen & Helbich, 2017). Choosing a bus as the travel

Table 2. the results of linear regression estimates for non-work trip distance.Source: authors.

| | B unstandardized coefficient | B standardized coefficient | Sig. | Collinearity statistics | |
|---|---|---|---|---|---|
| | | | | Tolerance | VIF |
| **Constant** | 3.578 | | 0.000 | | |
| | | **Capability constraint** | | | |
| Age (less than 14) | 0.096 | 0.071 | 0.031 | 0.542 | 1.847 |
| Age(14-30) | 0.079 | 0.112 | 0.002 | 0.439 | 2.277 |
| Age (31-45- ref. group) | | | | | |
| | | **Coupling constraints** | | | |
| Job (employed) | -0.072 | -0.068 | 0.018 | 0.703 | 1.423 |
| Job (student) | -0.054 | -0.070 | 0.099 | 0.32 | 3.127 |
| Job(unemployed-ref. group) | | | | | |
| | | **Built environment at trip origin** | | | |
| Bus lane density | 0.004 | 0.138 | 0.001 | 0.351 | 2.849 |
| Distance to CBD | 3.606-5E | 0.329 | 0.000 | 0.283 | 3.529 |
| Traffic congestion | - 5.094-5E | -0.112 | -0.017 | 0.264 | 3.782 |
| **Built environment at trip destination** | | | | | |
| Population density | - 1.257-5E | -0.231 | 0.000 | 0.352 | 2.837 |
| Street density | 0.006 | 0.144 | 0.000 | 0.379 | 2.637 |
| Block size | 0.185 | 0.183 | 0.000 | 0.531 | 1.884 |
| Bus lane density | 0.002 | 0.061 | 0.044 | 0.638 | 1.567 |
| Traffic congestion | 1.241-5E | 0.115 | 0.000 | 0.583 | 1.716 |
| | | **Authority constraints** | | | |
| | | **Travel mode** | | | |
| Car (referenced group) | | | | | |
| Motorcycle | -0.106 | -0.088 | 0.001 | 0.79 | 1.266 |
| Bicycle | -0.108 | -0.70 | 0.009 | 0.801 | 1.245 |
| Other vehicle | -0.166 | -0.110 | 0.000 | 0.9 | 1.111 |
| Driver license | 0.053 | 0.089 | 0.004 | 0.0599 | 1.67 |
| Bicycle ownership | -0.029 | -0.072 | 0.005 | 0.894 | 1.119 |
| Motorcycle ownership | 0.042 | 0.085 | 0.002 | 0.802 | 1.247 |
| **A**djusted R2 | 0.338 | | | | |
| **Significance level of model** | 0.000 | | | | |

mode is not significantly related to travel distance but statistically leads to shorter travel distance in comparison to choosing motorcycle, bicycle and other travel modes. Furthermore, people who have driver license generate longer trip distance. Bicycle ownership is negatively and motorcycle ownership positively related to travel distance. According to time geography notion, using car as travel mode can compensate some individuals' limitations such as time and biological limitations because of its speed. In fact, individuals might choose car to access farther places and overcome other constraints.

## Conclusion

The main purpose of this paper is to explore how individual characteristics and built environment attributes (at both trip origin and destination) impact on trip distance of individuals. This research has been developed based on classic time-geographic framework. Based on this framework, 18 variables, including 9 variables in individual level and 9 variables in spatial level, were firstly categorized into three set of constraints including capability, coupling and authority constraints and then the role of all the variables in explaining travel distance have been analyzed. To test the strength of conceptual framework of the research, 30 case studies across Isfahan metropolitan were selected and data were collected. To analyze the role of mentioned factor in explaining travel distance, this paper deduced the potential influence of individual and spatial factors on travel distance from reviewing literature and by logical reasoning. After that, it empirically tested the expected relationship between factors using linear regression model. The results of research show that factors relating to three sets of constraints affect individuals' trip distance; and physical-spatial characteristics of the built environment have stronger effect on travel distance than those of individual factors. Distance to CBD is the most important factor affecting travel distance. Although, it was theoretically expected that the variables such as gender, family size, commercial density, mixing land use would affect trip distance, these variables did not significantly appear in the regression model. Population density at trip destination was negatively associated with trip distance. Increasing population density, on one hand, provides a threshold population for creating other non-residential activities, and on the other hand, decreases the density of trip attractive land uses. These conditions lead to decreasing trip attraction from farther areas and encouraging short distance trip within neighborhood. As another point, bus lane density, both at trip origin and destination, is directly associated with trip distance. It seems that providing public transportation infrastructure, and according to low cost of transit fare, gives more opportunities to individuals to travel and experience farther distance.

As for research hypotheses, according to obtained results, it can be clearly said that the trip distance of respondents is a function of all sets of constraint factors because at least one variable from each mobility constraint category significantly appeared in the trip distance model. The results do not prove our hypothesis about the influence of gender on trip distance. Previous studies have also reported that gender has a contradictory effect on travel distance (Ellder, 2014; Ding et al., 2017). The findings support the second hypothesis because distance to CBD has the strongest association with individuals' trip distance. The last hypothesis about the impact of car ownership on travel distance is not proved by research results, but choosing car as travel mode is positively related trip distance. These results are mainly consistent with previous research (Manoj & Verma, 2016).

To sum up, the results of this paper show that for reducing individuals' trip distance and inducing people to use sustainable transport modes, it is necessary to implement various strategies. Making balance among urban areas, increasing density of various activities, providing public transportation infrastructures, particularly in the distant areas, and providing bicycle infrastructures are such useful strategies.

## Endnote

1. The travel data used in this study were partly drawn from a large household travel survey (HTS) conducted in Isfahan City in autumn 2012 by Isfahan Municipality.

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