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Review

Studying the effect of mixed urban uses on the travel behavior of citizens

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ABSTRACT:

The rapid development of urbanism, industry and automobile caused non-harmonic urban growth, air pollution, heavy traffics, accidents, and increasing time of travel. Lack of suitable applications of transportation exacerbated these issues. In this direction, the most important goal of urban transportation planning is to encourage citizens for using other vehicles. Mixed urban uses are very effective on the travel behavior of citizens. The increasing distance between source and destination of the travel and separation of industrial areas have increased financial costs and time of travel. Planning and designing residential environments based on increasing mixed uses and the connection between residential place and activities related to it have increased non-motor travels, reduced time, distance and energy consumption. The present paper aims to determine factors affecting travel behavior of citizens about mixed urban uses. The research showed that there is a significant relationship between mixed urban uses and travel of citizens inside the city.

Keywords:
Mixed use, Travel behavior, Automobile ownership

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INTRODUCTION

Today, cities encounter with many challenges such as urban sprawl, lack of security, landfill, sound pollution, air pollution and traffic jams. They also want to improve social well being, cultural inheritance, and prevention of infrastructural destruction. Therefore, the cities will reach their goals by improving quality of urban society and increasing economic opportunities with sustainable development. But in addition to the development, fair distribution of wealth and opportunities are important as well, so all citizens can involve in process of development. Demanding branched travel is from demanding the activity. It means that the place where an activity is occurred produce travel and transportation that makes different distributed uses by supplying facilities related to the travel. Therefore, land use and transportation demand are often interrelated. Planners of land use, transportation plan, distribution of activities and travels such that citizens do their activities in the destination with the lowest cost. The man-made environment is the factor of production and distribution of intra urban travels. Travel pattern can be defined in the form of travel source and destination and selection of vehicle. This pattern is affected by residential distance, activities related to residential place and cost of financial travel.

Research importance and necessity

Although multiple land use has been considered as a key component in the urban development, it has paid attention by the developed countries. Limited studies have been done in Iran in this regard. Therefore, multi urban land use is accounted as one of the criteria of sustainable development. It is noteworthy that mixed use acts very well when it is developed by a good program that emphasizes on the relation and connection of uses. The increase of transportation and number of travels are among the main factors affecting unstable environment in urban areas. Mixed uses reduce the number of travels, pollution, and time. The present research concerns about the effect of urban use mixes on intra urban travels in order to reach the urban sustainability.

Research hypotheses and questions

The hypotheses of the present research are as follows:

- Urban use multi reduces the number of intra urban travels

- Urban use multi can take step in the direction of sustainable development by reducing travel cost

Concerning the research title, the research questions are as follows:

Can urban use multi be effective on the number of intra urban travels?

Can urban use multi take step in the direction of sustainable development by reducing travel costs?

Objectives

There are three main goals in the present research, *viz*:

- Identifying and studying the effect of use diversity and distribution on travel production

- Evaluating and understanding the most important factors affecting travel method of citizens regarding urban use mix

- Studying different views and opinions on urban use mix

Background research on this concept

The mutual relationship between land use and production of intra urban travels were first studied in America after the Second World War in Europe. The hypothesis "urban sprawl increases the number of travels" was tested frequently (Cervero and Kockelman, 1997; Boarnet and Crane, 2001). Based on Zegras view (Zegras, 2004), spatial use distributions such as residential, official, and educational uses play an important role in efficient transportation. While transportation supply associates with transportation infrastructures and traffic control systems, land use solutions relate to sprawl of uses in one level or area. Distribution of activities affects the number of travels with different vehicles. On the

Table 1. Operational research background

Research	Year	Place	Research results
Effect of spatial urban structure on travel behavior of citizens (Hosseini and Bahrami, 2013)	2012	Rasht	The research revealed that there is a significant relationship between variables in improper urban spatial structure and intra urban travels of citizens.
Studying personal and spatial factors in intra urban travels (Pourahmad, 2011)	2011	Babol	Results showed that each testing variables described considerable part of variance in citizens' travel and spatial structure of cities affected intra urban travel methods significantly.
Studying role of spatial structure on tendency of citizens to personal travel (Firuzjaei, 2013)	2012	Babolsar	Urban spatial structure and spatial arrangement of land uses are considerably effective on travel pattern of citizens and their tendency for using personal vehicles in urban travels and they are very important in urban planning. Results indicated that spatial urban structure of Babolsar affects considerably tendency of citizens for using personal vehicles
Developing a model for evaluating effects of urban use mixes based on spatial analyses and indices (Javadi, 2013)	2013	Tehran	Results suggested ability of above mentioned model to identify effects of urban use mixes and to determine limitations and abilities of each stage and area for presented indices.

other hand, relative comfort in using different vehicles is different based the on place of activities (Mahmoudi, 1994). The increasing multiple land use increases application of non-motor vehicles. It seems that all travels are not affected equally by use and distribution. Increase of accessibility resulted from various land uses affects shopping travels more than other travels (Limanond and Niemeier, 2003). In an empirical study done in Ogbomoso Nigeria, the relationship between diverse land uses, the number of intra, and extra urban travels were tested. The study indicated that areas with high uses produced more intra and extra urban travels compared to low density areas. The result obtained from this research was different (Table 1) from that of previous studies (Tanimowo, 2006). The reason may be due to the difference between economic, social, and cultural conditions of the society under study with advanced countries. In a research done on Tehran, the effect of two commercial and industrial uses on travel production were studied. In this regard, units that are directly and indirectly effective on traffic production are identified and classified. Among 66 activities, 47 activities produced traffic directly and also 28 activities were studied that were acting as classes (such as Stock). As a result, suggestions and strategies are presented concerning criteria of positioning and geometric design of passages in addition to upstream designs and suitable behavioral patterns, increase of services and control of establishment and industrial-commercial units (Ramezanali, 2010). In the study conducted by Zeyayee and Mohsenyian (2010), traffic productions resulted from permission of linear commercial uses in some areas in Mashhad were analyzed by simulating establishment of units in EMME2. Results indicated that sudden and unplanned growth of attractive travel uses (Such as commercial uses) had many traffic consequences in short and long term for city and citizens. Such consequences include lack of parking and increasing demand for marginal parking, accidents, and disturbance in traffic circulation (Zeyayee and Mohsenyian, 2010). However, scientific researches on

Table 2. Theoretical research background.

Researcher	Research theory	Definition
Song and Knaap (2004)	Mixed uses	-Use mixes was considered as a key element in the development of transportation, traditional neighborhoods, smart development and modern urbanism
Vereker *et al.* (2004)		-Mixed uses are basically a form of urban development based on the concentration of different uses in a certain area
Jacobs (2009)		-Concept of mixed use is to develop stable form of uses based on urban development form and spatial planners believe that it is an important tool to reach sustainable development
Song and Knaap (2004); Brouwer and Louw (2005)		-Indices for evaluation of mixed uses: 1- Accessibility 2- Density 3- Patterning
Jacobs (2009); Vreeker *et al*. (2004); Rowley (1996)		-Advantages of mixed uses: 1- Reduction of intra urban travels with focus on reduction of dependency on automobile 2- Increase of urban lands used by municipality 3- Reinforcing efficiency of uses due to being next to each other 4- Increase of social relationship of citizens
Grozi and Bregh (2008); Hamidi (1997)	Travel pattern	-Movement and accessibility are basic in socio-economic activities in each city and human's travel in the city and accessibility to activities and services has changed it into a living creature
Grazi (2008)		-Travel behaviour is important because different methods have different socio-mental, economic and environmental costs (regarding consumed fuel)
Souche (2005)		-Environmental features that play main roles in determination of travel behaviour of citizens are spatial structure, urban form and urbanism level
Shewnen *et al*. (2005)		-Many results of new and polycentric urban forms have reflection on travel behaviour of citizens especially efficiency of urban forms is determined by distances and travel vehicle
Afnadizadeh and Hajian (1999)		-In vast cities, travel demand and its time have been increased as a result of spatial sprawl of activities and uses and personal car is required.

effectiveness of land use system on urban travels have been developed in recent ten years and ambiguous and conflict results were obtained in different geographical areas. In fact, results obtained from a special area can hardly be generalized to other areas (Southworth, 2001). On this basis, some researches obtained different find-

ings. In a research on "traffic is produced by low density and sprawl", Gordon and Richardson (1977) concluded that the reduction of residential density and occupation led to reduction of traffic density. This was experienced in dense cities such as Hong Kong and New York. Traditional process of travel prediction (known as the four stage model) includes socio-economic variables and pays less attention to spatial and physical variables. But today, it is nearly accepted that travel production is a function of accessibility of a place in urban services and it was confirmed in some empirical studies. Based on the study done by Ewing *et al.* (2007) in Florida State, after controlling socio-economic variables, it was clear that physical variables including residential density, mixed use, and accessibility do not have significant effects on production rate of household travel. Therefore, this idea "traditional models of traffic prediction are unimportant due to the ignoring effects of physical variables" is not true (Ewing *et al.,* 2007). In another study done by Frank (2000), variable of land use mix was used for measuring neighborhood of travel sources and destinations and for predicting air pollution production. Results showed that amount of pollution per travel is affected by travel distance and vehicle speed and it has no significant relationship with mixed use variable (Frank, 2000). Ewing *et al*. (2005) believed that land use diversity is not only effective on travel, but also urban density should be considered. According to some researchers (Boarnet and Crane, 2001), many researches done in this regard cannot be generalized due to three reasons: firstly, urban density has not been considered along with land use diversity, secondly, travel reduction in high dense areas may be due to causes such as low income that is not mentioned in traffic engineering models. Thirdly, in most studies, the cause and effect relationship has been ignored (the reason of travel) and only coupling relationships were studied.

Research Methodology

It is an applied research regarding type and objective. It means that this research (provided by cognitive ground of fundamental researches) has been used to settle human requirements, improve, and optimize instruments, methods, objects, and patterns in direction of well being and comfort development and promotion of life style (Hafeznia, 2007) and its method is descriptive-analytic. In these researches, the researcher explains the reasons of the problem and its dimensions in addition to picturing the reality (Hafeznia, 2007). Information was gathered from library using documents, books, papers, global informational network, and information related to research titles. Concerning that this research is theoretical, theoretical issues will be stated to guide us in practice.

Theoretical basics

Urban mixe use

Land use implies to allocation of the land for different goals. The aim of urban land use planning is to allocate areas to different uses. Urban land use planning includes stages of identification, analysis, planning, and implementation (Table 2). The stage of identification includes different sub-stages and the most important one is to provide analytic models for better identification of status quo of urban uses (Kaiser *et al.,* 1995). One of the main and important tasks of urban and regional planners is to allocate land to different urban uses regarding the role and function of the city, urban economy and effect of uses on each other (Parhizgar and Shokouhi, 1998). CIAM supports functionalistic city where there are four main urban functions: (house, job, recreation and transportation) (Brouwer and Louw, 2005). Different zoning methods of land uses have been experienced in urbanism history and their advantages and disadvantages have been identified (Song and Knap, 2004). In addition to advantages, this spatial planning has disadvantages such as severe dependency to automobile, insufficient facilities, high infrastructural costs per person, increase of travel time, traffic jams, loss of social feeling (Jacobs,

2007). Negative effects of this view relate to positioning of activities during the time and motivated critiques of theorists such as (Jacobs, 2009), that new theories of urbanism support mixed uses that are necessary for urban sustainability (Brouwer and Louw, 2005). In recent decades, mixed uses have been considered as a key element in the development of transportation, traditional neighborhoods, smart development and modern urbanism (Song and Knap, 2004). Mixed use is a form of urban development based on concentration of different uses in a certain region (Song and Knapp, 2004; Vreeker *et al.,* 2004). Development of mixed urban uses is a new approach in spatial connections and arrangement of uses (Brouwer and Louw, 2005). The concept of mixed use is to develop stable form of uses with respect to form of urban development and spatial planners and believed that it is an important tool for reaching sustainable development (Jacob, 2007). Advantages of mixed uses from economic, socio-environmental views are as follows:

- Reduction of intra urban travels with focus on reduction of dependency on automobile
- Reinforcement of uses' efficiency due to being next to each other
- Increase of social relationships of citizens (Jacobs, 2007; Vreeker *et al.,* 2004; Rowley, 1996)

It should be noted that mixed uses work in the best way when they are developed by a good plan that focuses on the connection between uses. Therefore urban societies can combine uses without guidance on mixing different uses and the connection between them. Unpredicted results may be created (Taleie, 2006). The necessity of evaluating urban uses is the relationship between them because negative effects may disturb activity of uses and positive effects increase efficiency of urban activity (Hosseinian, 2008). Song (2004) evaluated diversity in mixed uses only by calculation of Entropy index and ignored other methods. Brouwer and Louw (2005) considered an index known as mixed uses to evaluate diversity. Indices for evaluation of mixed use can be classified based on different concepts (Song and Knapp, 2004; Brouwer and Louw, 2005; Land Instituote, 1987). Accessibility shows how residential units can access easily to other mixed activities.

- Density: It showed the amount of mixed uses
- Distribution: It showed the arrangement of different uses in the region under study.

Although the model Alanso-Mills-Muth has many applications in urban economies but in reality the model suggests that no city is mono-centric rather many employments are occurred outside the city center and this is accompanied with residential uses (Alanso, 1988; Mills, 1984; Muth, 1967; Fujita, 1969).

Travel pattern

Messenger *et al.* (1996) stated that selection of travel pattern is not only based on physical specification of neighbours, but also it is affected by the region we want to go there. On the other hand, distinguishing this level will affect structure of neighbouring parts and their residents. Although many discussions have been done in this regard, analysis of the relation between designs of neighboring parts and travel pattern is very complex. Experimental evidences suggest the effects of residential density on travel pattern of citizens. Designers of transportation believed that supply of a stable system is only possible by balancing residential density. Such an idea results from those who made a connection between traffic density, energy consumption and residential density. In other studies, this factor was considered as the main variable (Messenger *et al.,* 1996). In 1997, Cervero addressed two points about the relation between physical form and travel pattern as follows:

- The form of the city, structure design and use are framework for designing human behavior and it includes selection of work or living place, automobile ownership and decision for travel. Therefore, increase of residential density reduces the distance travelled by the vehicle.

- There are activities such as supplying demand and asking for urban system collection. Effect of the

number of population and residential density on public transportation and its relation with attraction of residential regions and different populations are parts of urban system communication that has been ignored in some studies.

According to Badae *et al.* (2000), instead of studying socio-economic variables or physical features of neighboring parts for directing behavioral designs, we should study methods that distinguish behavioral reactions of citizens. Of course, this is based on physical changes of form and urban design that are half of the effect of socio-economic features. Few studies have been conducted on this variable. On the other hand, the important role of this variable is effective on identification of travel designs resulting in reduction of description of density (Cervero and Kockelman, 1997). Accessibility and movement are fundamental in socio-economic activities in each city and human trips for accessing activities and services have changed it into a necessary activity (Grazi and Bergh, 2008, Hamidi, 1997). Citizens choose among cycling, walking, vehicle, and motorcycle for displacement between house and travel centers concerning different personal and environmental conditions. The importance and behavior of the travel is that different methods of travel accompany with socio-psychological, environmental, and economic costs concerning the consumed fuel (Grozi and Bregh, 2008). Some of environmental features that play basic role in determination of travel behaviour of citizens are spatial structure, urban form, and urbanism level (Schwanen *et al.,* 2001; Souche, 2010).

Spatial structure of the city created by spatial distribution of activities and uses and as a result of socio-economic and natural processes that shapes the form and context of the city and plays role in citizens' movement (Zangiabadi, 2002). Since during few last decades, increasing growth of population has caused development of cities, by advancement of information technology and globalization, decentralization of population and employment to suburbs has become important. Due to spatial sprawl, daily trip patterns have been changed and people have to travel long distances to supply their basic requirements, especially with their personal car (resulting in improvement of economic status and increase of car ownership). Therefore, the consequence of this wide urban structure is the demand reduction for public transportation, increase of fuel and pollution, traffic density and difficult access to urban services and facilities (Schwenen *et al.,* 2005; Bento *et al.,* 2005; Aboulhasani, 2003). Vehicles are the main emitters of greenhouse gases throughout the world (especially CO_2). Therefore, travel method has been emphasized in urban interactions. The contribution of transportation in emission of Co_2 has been estimated by 21% and it was increased rapidly in two decades ago (Grozi and Bregh, 2008). Features of urban form are important factors in travel behaviour that affects access to travel. Many studies emphasized on effectiveness of travel behaviour of citizens on urban form (Leck, 2006; Polzin, 2004).

Urban development pattern affected by transportation system can be effective during travelling (Polzin, 2004). Movements that are shaped for transportation infrastructure based on capacity and amount of demand affect urban structure and an integrated transportation system is created as a result of spatial structure and different urban forms (Mirkatouli and Manafiazar, 2009; Rodrigue *et al.,* 2009). Concerning different spatial position of urban activities and land use pattern traffic, behavior of people has been focused on. On this basis, the ability and easy access to facilities and activities have close relationship with land use pattern (place of activities and facilities in space). Therefore, it is important to identify spatial structure of the city with focus on land use pattern related to studying the behaviour and easy access to services and strategies effective on it (Wickler, 2002; Jahanshahi, 2008). Many studies indicated that land use planning with high density and mixed use reduces application of automobile (Shedel, 2006; Leck,

Table 3. Definitions of sustainable development

Researcher	Research theory	Definition
Koushiyar (2003)	Sustainable development	Generally, indices of sustainable development can be illustrated in four groups: Social index, economic index, fundamental index and environmental index
Magtin (2008)		Specifications of sustainable development are: looking to future of environment, equality and participation
Magtin (1908)		This development meets requirements of the present generation and no harm is incurred on future generations for supplying their needs
Creezak (2010)		Supplying a safe and satisfactory future for everybody in a society where equality and attention to basic needs are considered
Magtin (2008)		It means a movement towards social equality due to moral and applied reasons

2006). Travel demand with personal cars is minimized by reduction of duration and number of travels. As a result, people are reluctant to deriving and they choose walking for reaching their goals (Pozlin, 2004; Leck, 2006; Jahanshahi, 2008). This reverse relationship is present between population and travel density and vehicle (Masha, 2008) and tendency to suburbia and urban expansion due to low density, spatial sprawl, and land use separation in urban spaces had direct effects on urban circulation (Palomares, 2010). Most results of new and polycentric urban forms had reflections on travel behaviour of citizens. Efficiency of urban forms is determined by travel vehicles and distances (Schwenen *et al.,* 2001). Today, in big cities, movement and demand for travel and its time duration have been increased as a result of spatial sprawl of activities and uses and it is inevitable to use personal cars (Afandizadeh and Hamian, 1999). The increasing application of cars in cities results the increase of travel time and travels related to shopping and leisure times because facilities of retailing and recreation have been decentralized towards suburban places (Hall, 2007).

Sustainable development

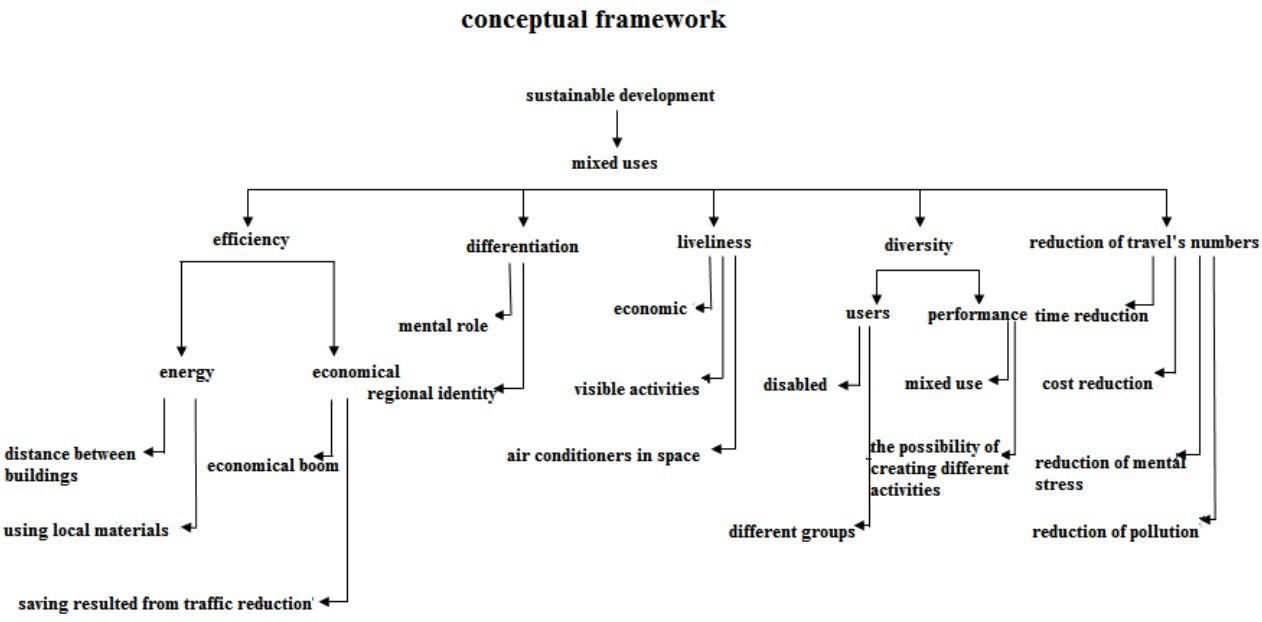

Figure 1. Conceptual framework

Sustainable development of urban areas is one of the political goals in geography and seeks reinforcement of social, economic, cultural, environmental, and physical dimensions in cities (Saied Maleki). In the definition of sustainable development defined by Beratland Burstadly, the framework of activities has been emphasized on that does no damage to the environmental system (Magtin, 1908). This development ensures that application of sources and environment in present time does not damage the vision of its usage in future generation. Life quality of those who use capacities of surrounding ecosystems is improved. Generally, indices of sustainable development can be illustrated in four groups:

Social index, economic index, fundamental index and environmental index (Koushiyar, 2003) development and growth should be balanced with requirement of nature and environment. Requirements of the present generation are met without considering requirements of future generations (IWC, 1999). The term "sustainable development" means to reach social and economic development in a way that it does not deny natural sources of the country (USCB, 2005). The sources should be applied in a framework consisting of environmental, social, and economic factors and it improves the present life quality in addition to maintaining life quality of future generations (Figure 1). Safe and satisfactory future is supplied for everybody in the society where equality and attention to basic requirements of human are considered (Creezak, 2010). Sustainable development seeks to strategies and instruments of development in order to respond following requirements:

- Coherence and integrity of development and preservation
- Meeting basic requirements of human
- Accessing social justice and equality
- Supplying independency and right of social vote and cultural diversity

Keeping ecological solidarity

It maintains and promotes economic opportunity and social well being. In addition, this development supports environment which human and economy are dependent on (An act approved in legislation parliament of Minnesota State) (Creezak, 2010). Sustainable development is one in which requirements of present generation are met in a way that no harm is incurred on future generations for supplying their requirements (Magtin, 2008) (Table 3). Sustainable development is a movement towards social equality due to moral and applied reasons (Magtin, 2008). According to Alkin, sustainable development has four features as follows: looking to future, environment, equality, and participation (Magtin, 2008). In direction of urban sustainable development, conditions should be provided to improve a ground for human sustainable development and urban social well being. In this ground, followings are referred to: social justice (Hardi, 1997), climatic design in accordance with human environment (Bahreini and Shieh, 2001), reinforcement of social structures such as commitment and responsibility, reinforcement of social and familial foundations and restoration of environment (Bahreini, 1999) and creation of structural discipline in urban space for aesthetic perception and urban beauty (Linch, 2002) and improvement of using urban space and increasing satisfaction (Bahreini, 1999) and integration of visual structure of the environment and urban landscape (Gordon and Richardson, 1997).

CONCLUSION

Intra urban travels associate with uses. Therefore, land use planning should be in accordance with travels. Introduction of automobiles to urban societies creates easiness and increase of travel speed, develops urban spaces, establishes different uses, and constructs passages and communication networks as the main skeleton of the city. This development results in the increase of demand and number of travels and in case, this does not accompany with systems of development control and

management, it will exacerbate weak expansion of the city. This event has been occurring in large cities for many years. As a result, the ownership and increase of personal cars have been increased and high traffic, emission of pollutants, increase of travel duration, time, and cost are its negative consequences that disturb life quality of citizens and sustainable development of urban form and several socio-economic, physical, and environmental problems have been created. In spite of information about above problems and their consequences, the best practical and scientific strategy for minimizing unpleasant effects of personal cars is urban development based on public transportation (ToD). This strategy in many modern countries with dispersal context could overcome problems by using public transportation system as the main transportation leverage. The aim of this paper is to determine factors affecting travel behavior of citizens related to urban use mixes. Context and form of the city affect intra urban travels directly and urban sprawl causes that many citizens to use personal cars to access their daily needs. In addition, effects of spatial factors such as residential place (internal, middle, and external regions) and the distance between residential place and each destination cannot be ignored.

At the end cities should respect nature, consider the urban ecological environment as an asset, integrate environmental issues into urban planning and administration, and accelerate the transition to sustainable development.

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