

# Analysis of Sustainable Travel Pattern in Downtown Neighborhoods by Using a Combination of Space Syntax And GIS (Case Study: Districts 1 and 7 Qom City)

Manuchehr Tabibian <sup>a</sup>, Mahsa Mostaghim <sup>a</sup>\*, Shirin Toghiani <sup>b</sup>, Amir Gandomkar <sup>b</sup>

<sup>a</sup> Department of Urban planning, Najafabad Branch, Islamic Azad University, Najafabad, Iran.

<sup>b</sup> Department of Urban planning, Najafabad Branch, Islamic Azad University, Najafabad, Iran.

Received: 08 December 2018- Accepted: 28 May 2020

---

## Abstract

Transportation, as a core component supporting the interactions and the development of socioeconomic systems, has also been the object of much consideration about to what extent it is sustainable. Automobile dependence is a situation that is often related to an unsustainable urban environment. However, such an observation is at odd with the mobility choice and preferences of the global population where the automobile is rapidly adopted when income levels reach a certain threshold. Other transport alternatives commonly do not measure up to the convenience of the automobile. Automobile dependency is thus the outcome of market forces expressed as consumer preferences and national manufacturing policies. Private and flexible forms of transportation, such as the automobile, are thus fundamental to urban mobility and should not be discarded as options for the sake of ideological perspectives about what should sustainability implies. The purpose of present research is to analyze the status of sustainable urban transport in areas located in the central Districts 1 and 7 Qom city in Iran are selected as the sample and the current transport system of this area of cities has been studied. The research method is descriptive-analytical and is carried out with an emphasis on the relationship between the urban form and the patterns of travel using GIS and statistical analysis together. The results of statistical surveys show that commercial land use has a greater impact on the pattern of personal vehicle-travel compared to the public transport. Regarding the density in height, it was found that by increasing the density, people tend to walk more and desire to use personal vehicle decreases. It can be said about the communication network that the high proportion of spaces related to the network is increasing with the desire of individuals to drive with personal cars. For this reason, we tried to further assess this communication comprehensively and in an integrated manner through space syntax data. Finally, the conceptual and operational model for achieving the research objectives has been described and the research achievements are clearly provided in the assessment of the hypotheses and the answers to the questions.

**Keywords** :Sustainable development, Sustainable transport, Urban neighborhoods, Central areas, Qom city

---

## 1.Introduction

During the history of human civilization, the issue of transport has been of particular importance and in a way that has always had a significant impact on the development of human societies. According to the Athens Charter, cities must have four vital functions - housing, job, recreation, communications (city transport) well in their essence (Ostrovsky, 1992: 160). Therefore, urban communication and traffic networks, in a word urban transportation, are of great importance. Transport is one of the most important pillars of urban development that is essential for the relocation of people and goods and constructive productivity in urban areas will only be achieved by meeting the needs of transportation. Sustainable urban transport is in fact the smooth movement of vehicles, people

and goods, which requires the comfort of the people and the environmental sustainability with the optimum cost and effort (Ahmadi and Moharamnejad, 2006: 3). Transportation, as one of the most pivotal controlling elements of development, plays a significant role in the field of sustainable development. Hence, the term "sustainable transport" has been created which is a statement of macro and micro policies that can be used together to plan development on the basis of the concept of sustainability (Tafazoli et al., 2011: 2). A modern city must have a robust and efficient transport system for communication, access and communication between its different regions. A comprehensive, sustainable transport system reduces numerous problems such as air pollution, noise pollution,

---

\* Corresponding Author Email address: mahsamostaghim97@gmail.com

the separation of wildlife habitats, heavy traffic, and so on. Today's societies need a sustainable transport system to reduce these problems and create effective and efficient transport systems (Ahmadi and Moharramnejad, 2006). The present research studies the relationship between the constructed elements of urban spaces including land use, density and the network of traffic on the citizen's travel pattern by comparing the different patterns of spatial syntax patterns of urban areas in order to ultimately benefit from research findings for consistent designing and physical planning with sustainable transport. To adopt an appropriate method and tool for quantitative analysis and comparison of the relationship between these elements and the pattern of travel, the use of existing knowledge and the development of an effective method are required. In this thesis the theory of space syntax, which is an efficient method for analyzing the relationships between the constructed environmental syntax and citizen behavior, along with the GIS, which is a comprehensive system for analyzing and modeling location data, are used for analysis and the evaluation of the relationship between the factors associated with the urban form and the travel pattern. System of transport is one of the important discussions about the environment and urban form. Urban form largely reflects the state of the existing transport technology that has existed at the different levels and during the development of the city. (Barrett 1996, 171) Clark and Bertolini defined sustainability with reduced mobility and negative travel (Clerk, And Bertolini, 2003, 36). Eckin et al. argue that the sustainability of the urban form should be sought in the form and size appropriate for walking, routing and efficient public transportation, and this system should have a compactness that encourages social interactions. The transport system should provide access to city's facilities and services at minimum cost (Elkin et al., 2001). Also, these systems must be designed and planned to reduce environmental and social costs, such as: compliance with transport capacities and the balance between the needs for mobility, security and access requirements, environmental quality and living standards in the neighborhood unit. (Jordan and Horan 1997, 72). According to Duncan and Hartmann, a sustainable transport system reduces the excess distribution and waste in operation within the areas, and this results in the optimal use of renewable energy sources, re-utilization, minimum use of land, the balance and equality of people's access and their equipment and furniture, as well as the maximum welfare of citizens and quality of life for future generations. Financially it also maximizes the efficiency and support of the dynamic economy (Duncan, and Hartman, 1996). Urban form planning (land use, density, and traffic network) play a

key role in achieving these goals, and at all times it is assumed that limiting the physical separation of activities significantly reduces travel needs. Some scholars emphasize that our knowledge of the urban form and the behavioral impact of travel is very limited. So, according to Burnet and Crane: "Hope for the benefits of reducing travel in urban design has been lost, and in exchange for knowledge and activities on the implementation of other transport systems has expanded." (Baronet and Crane, 2001) Robert Cervero also believes that there are still many lessons that need to be learned about the behavior and needs of citizens in neighborhood units, neighborhoods and urban areas (Cervero, 1998).

## **2. Questions and Hypothesis**

- 1-What are the sustainable travel patterns in downtown neighborhoods?
- 2-What is the relationship between spatial configuration of neighborhoods and citizens' travel patterns?

-There is a relationship between spatial alignment indices and levels of land use diversity, compaction density and path connectivity.

-The level of diversity of land use affects the dependence of the car on the neighborhoods.

-The level of compactness in neighborhoods affects the efficiency of public transportation.

-The level of network connectivity in neighborhoods has an impact on walking and cycling.

## **3.Theoretical Foundations**

Transport systems play a major role in the economic life of the countries as well as the daily lives of citizens. The subject of transport and traffic, which today plays a very important and critical role in the quality and socioeconomic structure of a society as a sociopolitical phenomenon, forms the basis of the modern urban life and the needs of human displacement. (Ahmadi and Moharramnejad, 2006: 2). Therefore, any displacement should be the most efficient both in terms of cost and profit and in terms of environmental compatibility (Nakha'i et al., 2011: 2). But with a bit of neglect, the situation of the current and future generations may be compromised, so we must move towards the use of sustainable transport systems to minimize some of these problems (Ahmadi and Moharramnejad, 2006: 2). Therefore, sustainable urban development with an emphasis on environmental protection, conservation of natural resources, pollution reduction,

decentralization, the use of alternative energy in transport and transportation, recycling of waste, increasing sustainable employment, etc., which has led to the raise of new patterns of urbanization such as healthy city, ecological city, compact city, etc., show the necessity of evaluating, examining and analyzing the efficient and sustainable transport structure (MozafariPour and Hatami, 2011: 2)

#### *4.1. Sustainable transportation*

Sustainable transportation is a term that has been introduced in the field of sustainable development, and various definitions have been proposed for it, most of which are based on a common ground. The Council of European Union Ministers of Transport defines a sustainable transport system as a system which: Provides access to the basic and developmental needs of individuals, companies and communities in a safe manner and in a way that is compatible with human health and his surrounding ecosystem and, justice is done between human beings belonging to a human race on one hand, and, on the other hand, between the various generations of man in the present and the future, enjoy the right to enjoy such a situation. It is affordable and, while having operational effectiveness, allows you to choose between different transport types. It also supports the creation of a competitive economic environment and a balanced development between geographic regions (Danesh-e-Shahr 1, 2012: 3).

The Center of Assessment and Decision Making for Sustainable Transport defines sustainable transport as a system that is accessible, secure, environmentally friendly and affordable (Danesh-e-Shahr 2 (No. 128), 2012:13 quoted by ECMT, 2004).

Commission of the European Communities defines sustainable transport system as one that has the following requirements:

Is capable of providing fair access for individuals, groups and companies in a safe and environmentally-friendly manner.

Has the efficiency, diversity and acceptable cost and provides a framework for a civic economy as well as a balanced regional development.

Minimizes contamination and uses renewable sources with side effects as little as possible (Soltani, 2011: 79).

Transport Association of Canada defines the sustainable urban transport system as follows:

A system in which the generation and accumulation of contaminants in a region is proportional to the absorption capacity of that region and recyclable components and minimum land use have been strengthened by the use of renewable resources. A system that provides for fair access for people and their products to achieve health and quality without harming the lives of each generation. A system that has the function of maximum efficiency and its financial costs can be met (Danesh-e-Shahr 2 (No. 128), 2012:13 quoted from ECMT, 2004).

#### *4.2. Sustainable urban transport dimensions*

As with sustainable development, which has three important "environmental", "social" and "economic" dimensions, the issue of sustainable transport also serves as a professional and specialized branch of sustainable development with all above three dimensions.

#### *4.3. Environmental dimension of sustainable transport*

Environmental dimension of sustainable transport includes transport modes and practices that reduce energy consumption and pollutant emissions and other harmful ecological impacts. The transport system is a major contributor to air pollution, while transport as an indirect factor contributes to water contamination. In addition to the above issues, noise pollution caused by vehicle traffic also affects the ecological degradation of the environment. The absorption of sunlight by black surfaces of asphalt, noise pollution and landscape contamination caused by urban traffic is another of the impacts of environmental instability in the transport sector.

#### *4.4. The social dimension of sustainable transport*

This dimension emphasizes the need for quick and easy access to transport services for all communities of society and for ensuring social justice. At the same time, it emphasizes the preservation of facilities and natural resources, including non-renewable energies for future generations with unlimited horizons. Also due to the dangers of human injury in transportation, there has been always an effort to solve some of the problems in this section through the use of transport controls.

#### 4.5. Economic dimension of sustainable transport

The economic and financial dimension includes the propriety of organizational structure, actions and investment for transport infrastructure. So, in addition to environmental considerations in achieving sustainable transport, a healthy and dynamic economy is also a prerequisite for achieving sustainable transport. Some of the economic benefits that a sustainable transport system can bring are: quick access to the workplace, easier and faster transport of goods, and so on. In contrast, countries' dependence on petroleum products is one of the economic factors involved in sustainable transport and sustainable development. As a result, reducing dependence on imports of non-renewable energy is one of the important points in achieving economic

dimension of sustainable transport (Knowledge 2, 1391: 13-15).

As seen in this section, sustainable transport dimensions have complex interactions with each other. For example, when the topic of fossil fuels comes up it can be seen in all three dimensions that: the overuse of non-renewable fossil fuels will reduce the future generations' share of these resources, and therefore excessive fuel consumption, threatens intergenerational justice (social dimension). Also, these fuels have high air pollution (environmental dimension) and ultimately dependency of countries on petroleum products are among the economic factors involved in the sustainable transport

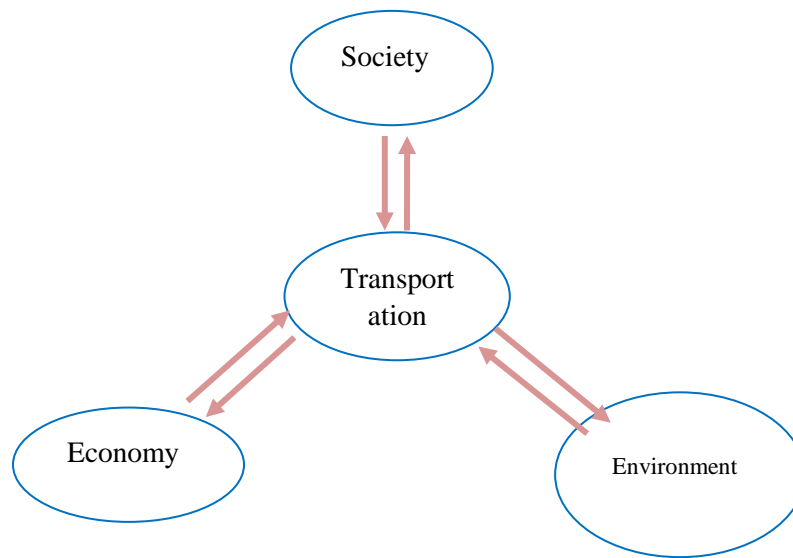


Fig. 1. Relationships Between Dimensions of Sustainable transport (Source: Mirzaee, 2011: 37)

Therefore, in any type of transport planning, especially in the field of sustainable transport, it is necessary to consider the outcome of the decisions taken in each of these three dimensions in the short or long term.

#### 4.5. Sustainable transport axes

When the issue of planning in each area and level is raised, one of the main issues to be considered is the main axes of the plan or in other word “what are the axes of the present plan?” The main axes for sustainable transport planning, which are similar to each other in various sources, are proposed in the further consideration of Todd Litman as one of the greatest theorists in sustainable transport.

#### 4.6. Sustainable transport indicators

Over the past decade, several different sets of indicators have been defined to explain the concept of sustainable transport. Scientific academies and transportation consultants have been among the most active in this field. For a sustainable and comprehensive transportation system, it is better to consider a balanced set of indicators that has a combination of economic, social and environmental objectives (Ahmadi and MoharramNejad, 2008: 10) According to Litman (VTPI, 2009), sustainable transport should focus on the following axes:

**The decision-making process in transport planning:** A sustainable transport planning requires the transformation and the transmission of the intellectual paradigm. More comprehensive analyzes of the indirect and aggregate effects of travel events in different sectors are needed. In addition, management solutions to people's demand and participation should also be considered in the decision-making process. In this regard, prioritizing various travel methods is necessary based on the value and cost (direct and indirect) of travel.

**Vehicle dependency:** Sustainable transportation should seek to reduce the imbalance in the provision of transport services and support the development of balanced transportation systems and reduce dependency on cars.

**Justice in the provision of transport services:** Since justice is a pivotal feature of sustainable development, transport services should be provided in a way that will not jeopardize the needs and desires of future generations. In addition, various social and income groups should have the ability to use these services.

**Design and implementation of transport infrastructure and facilities:** Sustainability requires that transportation facilities such as roads, public transportation, parking, etc. be designed and implemented in a way that encourage people to use sustainable options and serve to meet long-term goals. The maximum use of resources and the minimization of waste in the construction and operation of the facility should also be considered.

**Land use:** The pattern of land use development and other physical characteristics can be used to prevent the increase in the range and intensity of use of vehicles and to increase the tendency to alternative options. Meanwhile, the role of the accessibility to the service is very important and should be included in the land use planning / transportation consolidation plan.

**Developing regions:** These areas, while having more limited resources, face the opportunities that can be used to expand non vehicle-dependent transport (Soltani, 2011: 80).

## **5. Background Research**

There have been many studies about transportation and urban planning. In these studies, some have investigated the role of land use or population density in the transportation system, while others have focused on locating urban land uses with an emphasis on transportation planning. But in this section, we have tried to merely refer to studies closely

related to the present research, with a sustainability approach, several of which are summarized below:

**Yusak O.Susilo et al:2012** in own article with Title "The influence of individuals' environmental attitudes and urban design features on their travel patterns in sustainable neighborhoods in the UK" explain The influence of urban design features on travel behaviors was mixed, higher incidences of walking in denser, mixed and more permeable developments were not found and nor did residents own fewer cars than the population as a whole. Residents did, however, make more sustainable commuting trips than the population in general. Sustainable modes of travel were related to urban design features including secured bike storage, high connectivity of the neighborhoods to the nearby area, natural surveillance, high quality public realm and traffic calming. Likewise the provision of facilities within and nearby the development encouraged high levels of walking.

**Paulus TeguhAditjandra et al :2013**"The influence of neighbourhood design on travel behaviour: Empirical evidence from North East England" The results show additionally that the traditional neighbourhood group is more sensitive to factors of perception and attitudes in relation to neighbourhood design that lead to walking, cycling and public transport use travel patterns, suggesting that land-use policy designed to accommodate lower carbon-based travel together with measures to encourage active travel will have greater impact on the traditional group than the suburban group. This finding suggests that generic measures imposed by many governments, and certainly implied by current UK land-use policy, to promote sustainable mobility should be selectively targeted.

**KelcieRalph et al: 2016** in own article with Title "Millennials, built form, and travel insights from a nationwide typology of U.S. neighborhoods" explain This finding implies that dramatic changes in the built environment—doubling or even tripling development density or transit service—may do little to get young people out of their cars when initial densities or transit services are low, as they are in most of the U.S. Conversely, reducing vehicle miles traveled among drivers appears to require more modest built form changes, a finding that offers some room for optimism among those concerned with auto

**VikramNichani et al: 2019** in own article with Title "A population-based study of the associations between neighborhood walkability and different types of physical activity in Canadian men and women" Different perceived neighborhood walkability characteristics might be associated with participation and time spent in different types of physical activity among men and women living in Alberta. Interventions designed to modify perceptions of

neighborhood walkability might influence initiation or maintenance of different types of physical activity.

**CarolineHachem & VermetteKuljeetSingh:2019** in own article with Title" Mixed-use neighborhoods layout patterns: Impact on solar access and resilience” Explain suggest the disruption response of the hexagonal and circular layouts exceeds that of the rectangular layout by the majority of indicators, with the hexagonal layout outperforming the circular by a narrow margin.

**JueyuWang & GregLindsey:2019** in own article with Title “Neighborhood socio-demographic characteristics and bike share member patterns of use”explain A limitation of our analysis is that patterns of use of casual users are not investigated. Our findings have implications for efforts to serve members in neighborhoods with higher concentrations of minorities and residents of lower SES and illustrate the need for more detailed surveys of members to obtain

additional information about individual characteristics associated with behaviors of bike share users.

**SeanNash & RaktimMitra: 2019** in own article with Title “University students' transportation patterns, and the role of neighbourhood types and attitudes” explain their travel behaviour. Neighbourhood type of residence was an important indicator of a student's transportation life-style. Strong associations between travel attitudes, residential location preferences and a student's transportation life-style was also observed. Post-secondary students are at an important stage in their life-course where they begin to form habitual travel behaviour as young adults. Findings from this study contribute an improved understanding of travel behaviour, which may also inform planning, policy and service provision relating to transportation, land development and affordable housing.

Table 1  
Sustainable transport indicators in three social, economic and environmental dimensions

Organizations	Social	Economical	Environmental
Victorian Transportation Institute	Accidents and injuries of motor vehicles	Average household cost share in ransportation	Per capita energy consumption in the area of transportation
	Per capita use of cars	Average travel time for Non-recreational trips	Per capita emissions of air pollution in the field of transportation
	The ratio of residents living in a distance of 500 meters of Public transportation	Accessibility to the Public transportation servicesfor low-income residents	Pedestrian and bike road quality
	Quality of travel services for citizens with special mobility needs	Quality of service delivery ( home door service )	Land use mixing
	The quality of the facility services of Public transportation	The ability of non-aboard people to reach the location of services and their employment	
	Average number of major services required for residents at a walkable distance between houses and public services	Per capita road Paved roads and parking facilities	
Transportation Association of Canada	Population density in EUA	Employment density EUA	Land use
	Per capita car ownership EUA	The share of the fare and the maintenance budget	Per capita fuel consumption per person-Travel in EUA
	High-occupancy vehicle lane (HOV ) length Per 100,000 km EUA	Per capita total road cost in the city ( Region )	Per capita fuel consumption in EUA
	Length of Arterial and freeway routes per 1000 km in EUA	Per capita total cost of Public transportation in the city ( region )	Per capita carbon dioxide emissions in EUA
O. IlkerKolak et al.	The share of inland passenger transportation by car	share of transportation section in employment	the amount of energy consumption
	Transport share of GDP	Total household expenses for transportation	Greenhouse gas emissions of transportation modes
	The number of injured and killed caused by an accident	Time to arrive at the next public transportation station	Greenhouse gas emissions of Road transportation

	Quality of public transportation facilities	Time to arrive at work / school or university	The probability of total acidification (the probability of acid rain ) caused by the Road transport
	-	Ownership of cars	Nanoparticle emissions due to Road transport
University of Winnipeg	Injuries and death	Traveling with Personal vehicles	fossil energy used in transportation
	Passenger transfer	Length of surfaced streets	Greenhouse gases emissions
	Shift of load	Tax in the field of transportation	Release of other air pollutants
	Number of trips by car and plane	Public transportation fees	Save in energy consumption
World Bank	Road accidents	Surfaced Roads	Per capita energy consumption per unit of GDP
	Passing by Cars	Average passenger - Kilometers per one million dollars of GDP	Use of Traditional ( fossil ) fuel
	Road Trip	Road transport Vehicles	Carbon dioxide emissions
	Spread of Cycling among People	Motor vehicles	The rate of emissions of other pollutants such as methane and harmful gases to the ozone layer
Ontario Round Table on the Environment and the Economy	Percentage of city trips without personal car	transportation share in employment	The trace of ecology in transportation
	Number of killed and injured	Tax rate in transport sector	Destruction of habitats and land use
	Crime	The cost of daily trips	Average air pollution
	Destroying localities and cultures	Average travel time	
	Inequality	Access to vehicles	

## 6. Theoretical Framework Of Research

Although the extension of the vehicle trips and the dominance of the model of machinated city highlights the necessity of pedestrianization in the cities of Iran (Fayzi et al., 1391: 189), the reality is that the performance of a pedestrian axis is subject to different conditions They do not follow the standard notions and an executive model for a city should not be considered as a model for other cities. The successful world experiences have shown that the planning and design of pedestrian spaces will be successful when social, cultural, climate and even behavioral patterns of the people in addition to physical factors are considered (Bemanian et al., 2012: 3). Therefore, in planning and organizing, it is necessary to identify and analyze the

interactions of the pedestrian system with other areas of life. So, the essence of planning and design of the pedestrian is that the movement and behavior of vehicles should be adapted to the needs of man and the city's social life, and the safety and comfort lost before the invasion of cars returns to the city (ibid., 2012). Therefore, in order to organize the pedestrian environment, it is necessary to adopt a comprehensive approach including the observance of all standards and pedestrian aspects (such as infrastructure and pedestrian facilities in order to increase safety and comfort of pedestrians, developing and strengthening social relations and interactions, expanding public transportation, anticipating the route for the disabled, the bike lane, etc.) to

achieve sustainable urban development and transportation, and humanistic urbanization (Fayzi et al., 2012). : 189).

The first level is the understanding of the process and various variables of the urban form in the form of land use, density and network utilization on the citizen's travel pattern and shows the dependence of the components. Which is expressed with the help of previous studies and theoretical foundations.

- The second level is selection of a function as a criterion for a sustainable physical system through the variables related to the three components of land use, density and urban traffic network, and the establishment of these relationships have a great influence on the efficiency of the physical system in promoting sustainable and green trips in cities.
- The third level of this model is about selecting the values for spatial configurations in urban areas, each of which communicates with the values of the components and

variables of the city's physical system, in such a way that its understanding is effective on the optimal control of this system. In general, the model illustrates that the main three components of the land use, density, and urban traffic network affect directly the pattern of travel in a two-way interaction and at the same time, these factors influenced by the spatial configuration allows different patterns of travel spatial behavior that are in turn an area of study. Therefore, the value added of this model and its testing can be explained in several basic principles.

- 1) The relationship between the three components of land use, density, and the traffic network of the city with each other.
- 2) The effect of the variables related to each of these components on the citizens' travel pattern.
- 3) The impact received by these factors from the elements of spatial syntax and the indirect effects of these factors on the pattern of travel.

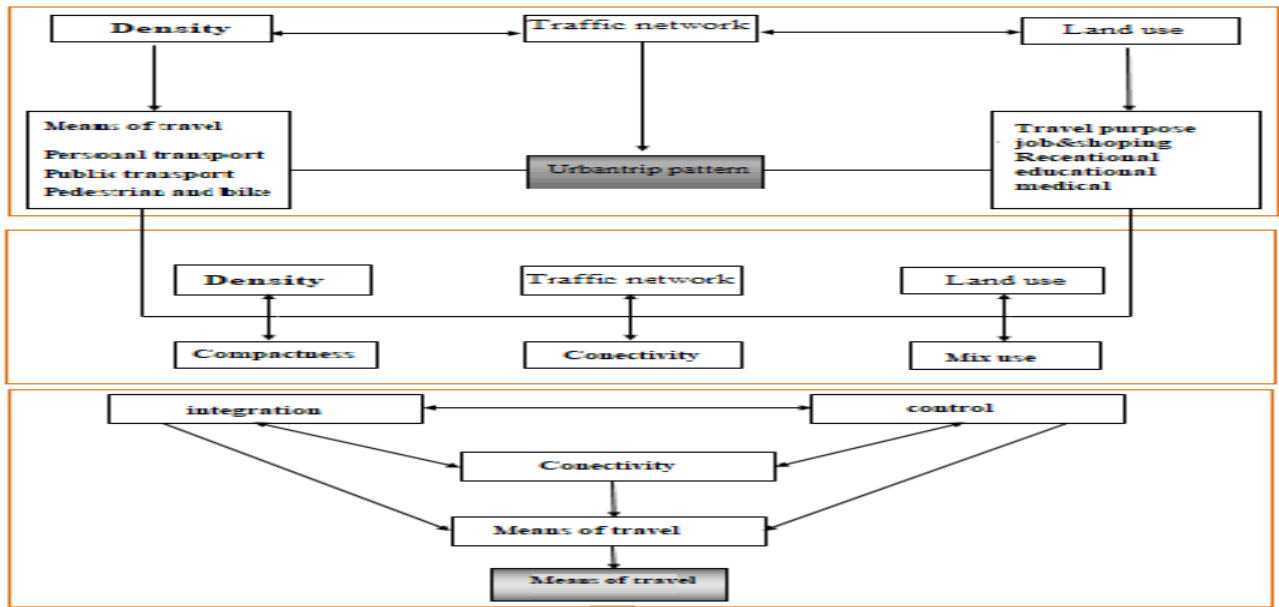


Fig. 2. Theoretical Model Of Research

## 7. Research Methodology

In this research, library documents such as books, articles, maps and more were used to collect information. In this section, we tried to make the collected materials have three features of accuracy, being up to date and completeness. Field method: in this part of the study, by visiting the site and using a questionnaire and interviewing the residents of the area, the information needed was collected. The

collection of information related to the land use and the communication network and space syntax was done by decision support software. The analysis related to the research papers are in line with the questions raised. First, using the literature studies of theoretical models in order to determine the criteria of the land use, density and network arrangement, and a model for evaluating the impact, space



design concepts will be examined. The sampling method in this study is cluster type with a sample size of 380 persons, about 10% of the total population that actually covers the opinions of the residents of the studied neighborhoods. In the following, by conducting field studies and recognizing the characteristics of the studied areas in different dimensions, the main criteria are in accordance with the theoretical models and are selected for the present study. In order to test the hypotheses, a questionnaire is completed according to the selected criteria of those selected as the sample of the statistical population. The raw data collected are processed and classified according to the research requirements and

entered into the SPSS software for statistical analysis, and entered into GIS software for the analysis of spatial data and generation of maps based on statistical data and then analyzed using space syntax software.

## 8. Studied Area

The areas studied in this research are districts 1 and 7 of Qom in the central context of the city. With an area of nearly 127 hectares, this area has a population equivalent to 115,251 people in 13,842 households. Therefore, the statistical population includes households living in this area.

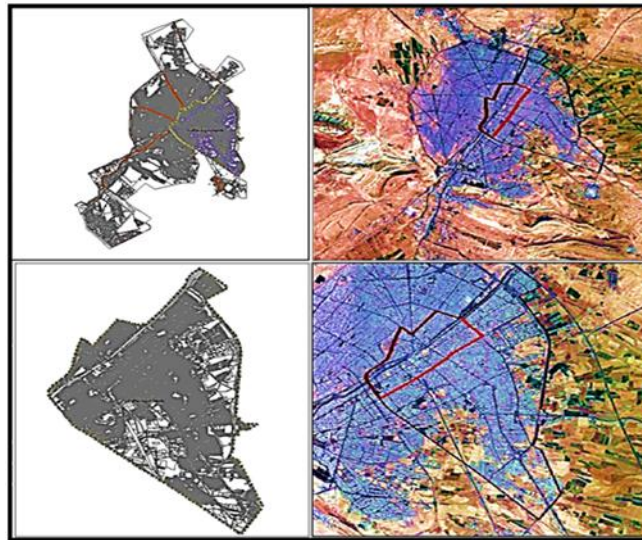


Fig. 3. Map of the study area in Qom

## 9. Findings

### Land Use, Density, and Communication Network Analysis

In order to investigate the simultaneous effect of land use, density and communication network in the studied area, two-variable regression analysis was used with dependent variable (travel destination and travel vehicle) and two independent variables of land use and density.

It is worth noting that in this section, first, the weight of each land use in different regions is calculated to the weight of that land use and in total land use of each region is applied in order to somehow act as a coefficient of adjustment. The reason for this is that the weight of the total

number of land uses in one axis is important to other existing uses of that zone. In this analysis, which took place in two parts of Travel purpose and means of travel, the following results were obtained:

### A) Travel purpose

Regarding the travel purpose, the corresponding model was significant and the correlation coefficient was 0.729 and the coefficient of determination was 0.531. In this model, the beta coefficient of the total interconnection of the zones is significant and equal to 0.807, but this coefficient is not significant for the land use. Below are the figures and tables associated with this analysis.

Table 2  
Simultaneous Effect Of Land Use And density on the travel purpose

Model Summary <sup>b</sup>				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.729 <sup>a</sup>	.531	.497	2228.52553
a. Predictors (Constant): land use and density dependent variable: Travel purpose				

Table 3  
Examination of factors of density and land use on the travel purpose

ANOVA <sup>b</sup>						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.521E8	2	7.604E7	15.310	.000 <sup>a</sup>
	Residual	1.341E8	27	4966326.041		
	Total	2.862E8	29			
a. Predictors (Constant): land use and density dependent variable: Travel purpose						

Table 4  
Simultaneous effect of the factors of density and land use on the travel pattern

Coefficients <sup>a</sup>									
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
		B	Std. Error	Beta			Zero-order	Partial	Part
1	(Constant)	1656.509	889.556		1.862	.073			
	<b>Land use</b>	-.031	.033	-.151	-.928	.362	.323	-.176	-.122
	<b>Density</b>	60.305	12.156	.807	4.961	.000	.719	.691	.654
dependent variable: travel purpose									

**B) Means of travel**

In the model analysis with respect to means of travel, the model has a significance level above 5%, while the coefficient of correlation is 0.741 and the coefficient of determination is 0.549. In this case, the beta coefficient of

the land uses is significant and the degree of interconnection is not significant. The following tables and figures depict this analysis.

Table 5

The impact of network communication on the impact factors of density and land use on means of travel

Model Summary <sup>b</sup>				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.741 <sup>a</sup>	.549	.515	5116.95858
a. Predictors (Constant): land use and density dependent variable: means of travel				

Table 6

The impact of network communication on the impact factors of density and land use on means of travel

ANOVA <sup>b</sup>						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	8.593E8	2	4.297E8	16.409	.000 <sup>a</sup>
	Residual	7.069E8	27	2.618E7		
	Total	1.566E9	29			
a. Predictors (Constant): land use and density dependent variable: means of travel						

Table 7

The impact of land use factor on the communication network and means of travel

Coefficients <sup>a</sup>									
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
		B	Std. Error	Beta			Zero-order	Partial	Part
1	(Constant)	2414.948	2042.526		1.182	.247			
	کاربری	.271	.076	.568	3.557	.001	.713	.565	.460
	تراکم	43.206	27.910	.247	1.548	.133	.581	.286	.200
dependent variable: means of travel									

The first level studies of this paper are based on statistical analyses. As indicated in this chapter, first, the relationship between the uses and the pattern of trips in the zones was analyzed, then the importance and weight of use among the total uses were analyzed, and on the other hand, the relationship between density and pattern of travel in the

zones was analyzed and finally, by analyzing the two-variable regression, the effect of these two factors (land use and density) on the amount of travel in different axes of communication network were investigated. Finally, these two factors as a direct variable are significant and their coefficients can be used.

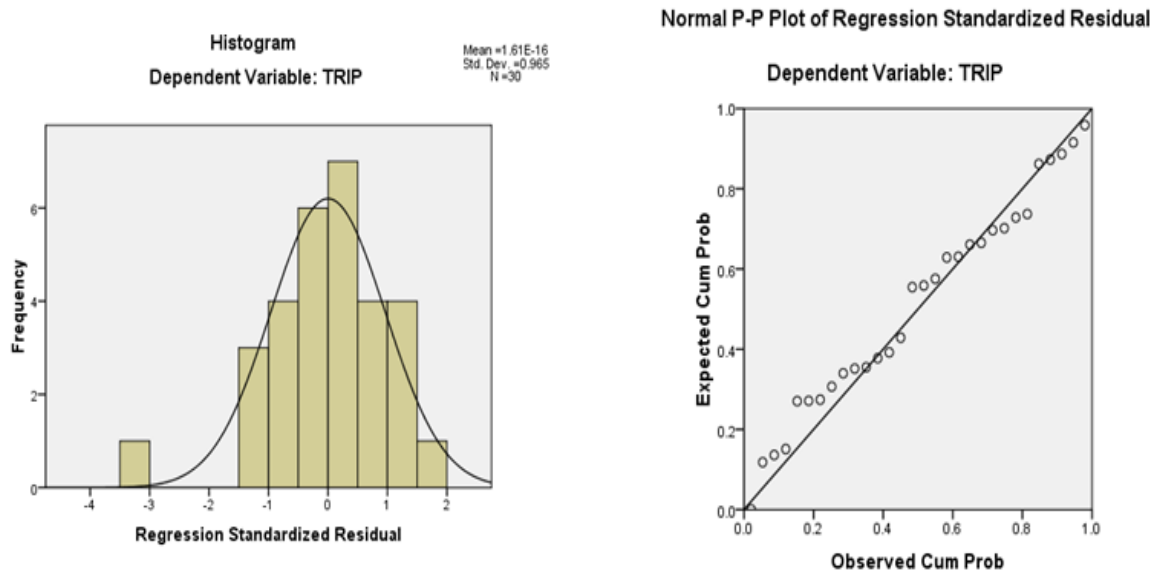


Fig. 4. Histogram and Regression Line of the Effect of Urban Form Factors on Travel Pattern

As for the validity of the model, as explained earlier, the factor of inflation of variance and tolerance of independent variables (here, commercial use and interconnection) should be investigated. The factor of inflation of variance is, in fact, the inverse of tolerance, the greater the magnitude of this factor than 2, the collinear value is greater and the validity of the model is reduced. In the tolerance section, the

closer this value is to 0, the coherence between the independent variables is higher and therefore the model is not highly valid. In this table, as can be seen, the factor of inflation of variance is 1.526, which is lower than the 2 and it means that the variables do not have a linear relationship with each other and can well explain the model.

Table 8

The effect of spatial syntax and commercial use factors, the main factor affecting the travel pattern

Coefficients <sup>a</sup>								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	4071.457	2717.135		1.498	.146		
	Commercial use	.241	.102	.380	2.370	.025	.655	1.526
	Spatial interconnection	103.512	37.129	.447	2.788	.010	.655	1.526
dependent variable: means of travel								

As mentioned in the previous chapters, considering the research variables and the relationships between them determines the levels of analysis and testing of assumptions and the achievement of research questions. On this basis, based on the results of statistical analysis of independent

variable relations (factors of Land use, density and network) was tested on the dependent variable (travel pattern / travel purpose, means of travel). Since most of the studies are based on this, a more comprehensive response is needed to use new tools and more complementary approaches to

obtain more accurate results. For this reason, in this section, using a combination of space syntax data and values of its selected indicators, such as the control index, the index of interconnection, and the depth index in the GIS environment with values of the travel pattern the correlation were measured. On the one hand, it should be acknowledged that most of the values of urban form and travel patterns data are location-dependent and need analysis with its own techniques and tools. Based on the research model, the goal is the measurement of determining power of space syntax in influencing the urban form effect on the travel pattern and to what extent the indirect relationships can be explained through these indices.

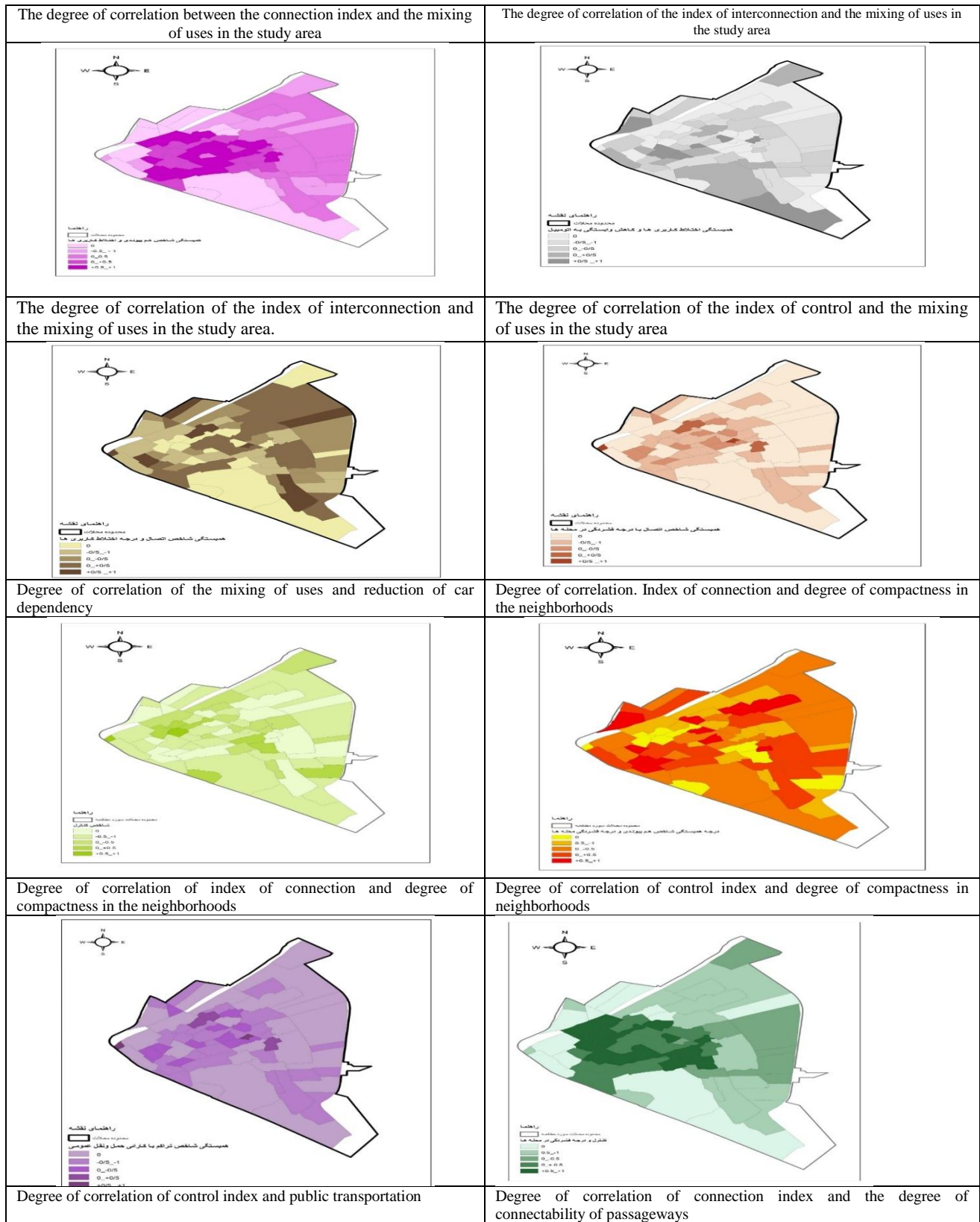
**11. Space syntax and Travel Purpose**

Land use, density and traffic network of the city as one of the physical factors affecting the travel pattern in several researches have been studied.

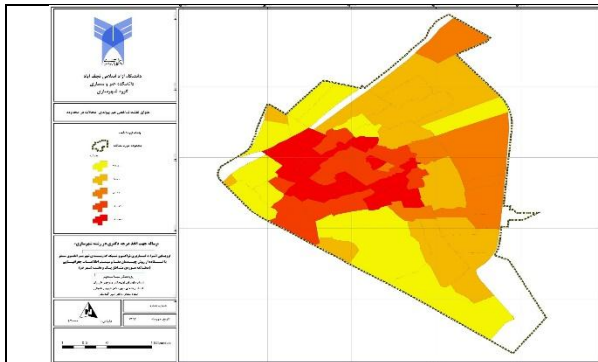
The purpose of the study at this level is to explain the effect of connection, interconnection, and control on the diversity level and the number of uses on the dependencies of personal vehicles. Accordingly, there is a two-way relationship between the diversity level in neighborhoods. Based on calculations, the effects of use diversity on the space syntax index and the effects of land use on the level of vehicle dependency is tested, and its rates are as described in the table below. The degree of dependence on the car on household trips within the study area as the main dependent variable and representative of the travel pattern. This variable can be measured through the relationships between space syntax and use diversity indices. The type of relationship and the intensity of the relationship in this model is unknown. The positive or negative relationship is considered as an indicator of relationship’s strength. Also, the nature of relationships in this model is a correlation that was tested.

Table 9  
Modeling Relationships Between Compactness in the Neighborhoods, space syntax, and Public Transportation Efficiency Indices

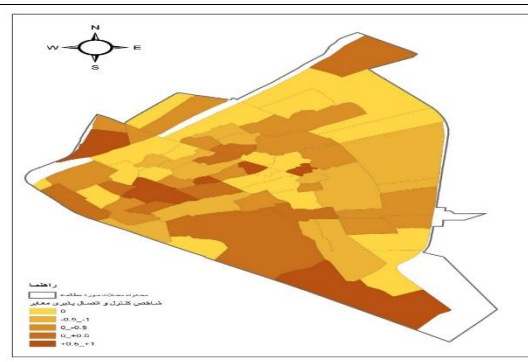
Its impact on vehicle dependency	The type of relationship with the diversity level in neighborhoods	Its impact on the efficiency of public transportation	Its relationship with the compactness of neighborhoods	Its impact on the range of walking and cycling	The type of relationship with the level of the network connection in neighborhoods	Indicators	Component	Method
Negative	Direct relationship	Positive	Direct relationship	Positive	Direct relationship	The extent of the role of a street in the original skeleton of a range	Connection	Space syntax and GIS
Positive	Inversely	Positive	Direct relationship	Positive	Direct relationship	Local radius (Standard 3 to5 indicates the number of direction shifts) The extent of the range of space hierarchy Number of passages connections to each other (number of blind alleys) The degree of continuity of an axis with the whole zone ( The amount of space and distance needed to reach from one point to another )	Interconnection	
Negative	Direct relationship	Positive	Direct relationship	Positive	Direct relationship	The ability of detecting paths from and into a street Number of selection options (route selection )	Control	



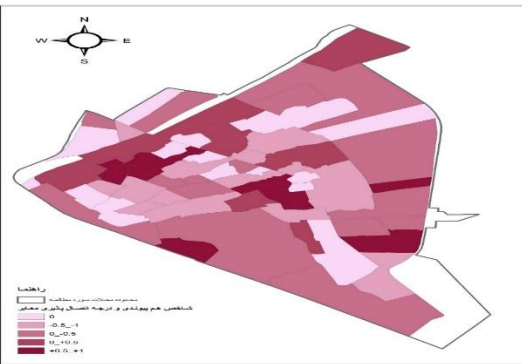




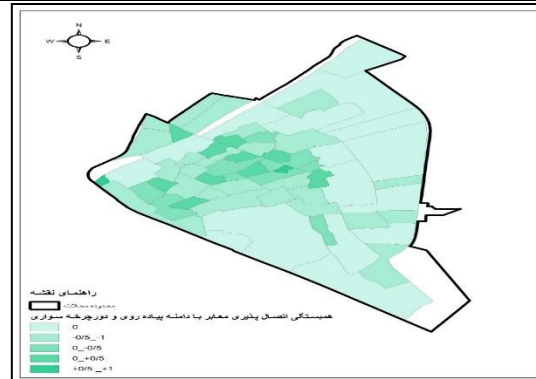
Degree of correlation of interconnection index and the degree of connectivity of passageways



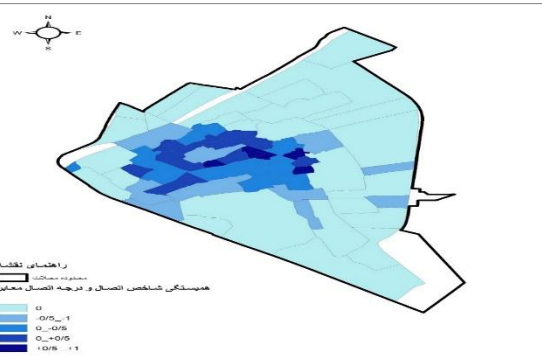
Degree of Correlation of Index of Control and the degree of connectivity of passageways



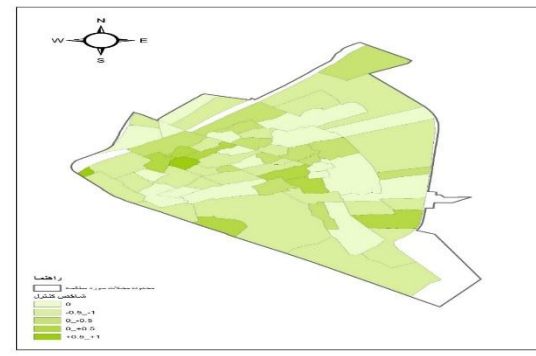
. the degree of connectivity of passageways and bicycle and pedestrian domain index which is shown below.



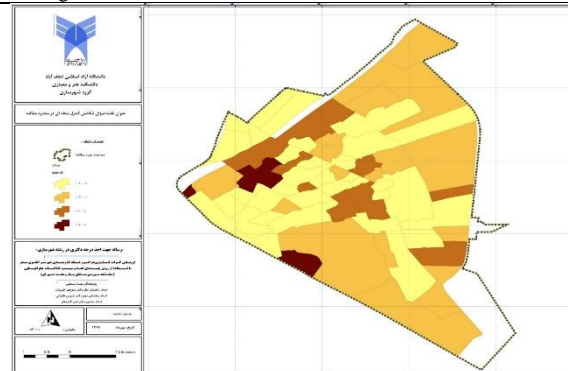
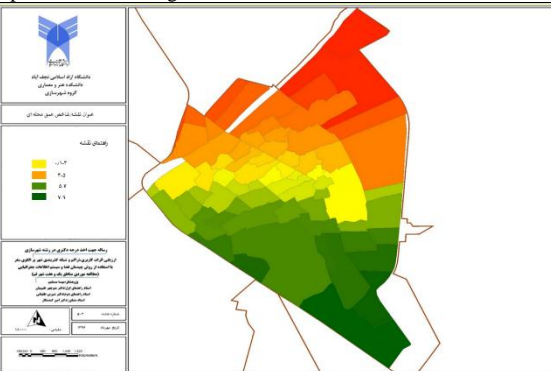
Degree of correlation of control index and degree of compactness in neighborhoods



Degree of correlation of index of connection and degree of compactness in the neighborhoods



Degree of correlation of index of connection and degree of compactness in the neighborhoods



## **12. Discussion and Conclusion**

The present study investigates the effects of land use, density and urban network elements. Of course, it should be noted that the pattern of travel in the city comes from many components that are evaluated in the present study, considering the importance of urban form elements in shaping the travel pattern (and in particular the elements of land use, density and traffic network). Another important point is that, in addition to the impact of these elements, the interconnection between them is also important. Therefore, in addition to examining the impact of these relationships in general, the relation between them in the form of the concept of space syntax of the city was also evaluated.

The first objective of the study was to determine the role and position of each element of the three main factors of the urban form (use, density, and traffic network) on the pattern of travel, and how much share each use has among other uses in relation to the pattern of travel. For this purpose, by collecting and preparing land use information in the central part of the city, on the one hand, and the travel destination area (on the basis of the consultant's plan), on the other hand, this relationship could be tested through multivariate regression analysis. For this purpose, all land use categories were firstly studied in relation to the pattern of trips made in separate regions and due to the high linear correlation between the variables, the model was not highly valid. But at the same time, in this analysis, the entirety of the model is significant, and among uses, only the commercial beta coefficient was at a significant level. However, due to the collinear relationship between the variables, in order to reduce the land use categories, and the combination of variables that are highly correlated with each other, factor analysis was used to examine the relationship with the travel pattern again by decreasing the categories. By reviewing the remaining five factors and the pattern of travel, it was firstly established that the entirety of the model is significant and there is no collinearity between the variables, and secondly, among the five factors, only the beta coefficient of the first factor, including the commercial use, was at a significant level.

In the next section, another classification was made based on the theoretical foundations mentioned in the previous chapters, as well as in the context of the comprehensive Qom transport and travel plan. In this section, land use in the central part was divided into five categories of shopping, housing, business affairs, personal affairs, leisure and recreational time, and their relationship with the travel pattern was reviewed again. In the study, the overall validity

of the model was significant and the factor of inflation of variance between the variables was lower than 2, which means the high validity of the model, among the five categories, only the commercial beta coefficient was significant. Therefore, in the studies conducted among the uses in central Qom and the pattern of travel in different areas, which were carried out in three ways, it became clear that commercial use, administrative use, cultural-recreational, health and medical uses have a special significance and role that each role can be easily explained in relation to the pattern of travel in terms of the choice of travel means and travel purpose of the trip, because in the above models this use is significant and can somehow provide a good fit of the model.

### **Part II**

In the second part, the goal was to determine the relationship between the density and the pattern of travel in different zones. After determining the importance and place of different uses on the travel pattern, the result was that an analysis could be made of the relation between the two variables of use and density in the communication network and in each route, this time linearly and not zonal, the communication network hierarchy as independent variables and travel pattern as the dependent variable. In fact, the main question in this section was that the land use and density in each of the passageways have a role to play in the pattern of travel. For this purpose, two-variable regression analysis was used. The model was significant and the beta coefficients of each of the independent variables were at a significant level. On the other hand, to validate the model, a coherent analysis of the independent variables was used and the results showed that the independent variables had no linear relationship with each other and the factor of their inflation of variance was at an acceptable level. In fact, in this section the impact of each commercial use and interconnection factors on the flow of travel and the weight of each one on this dependent variable became clear.

A remarkable thing to note here is that in the analyzes conducted, commercial use along with residential use could have explained the model. For example, as we mentioned in the general survey of land use and travel amount of each zone initially, there was a significant relationship between the commercial use and the model. An analysis in response to this section is that in the study of the land use of this city in its passageways, it is observed that, for example, the green space use is not available in 20 zones, and it exist only in 10 zones. Or law enforcement, religious, cultural,



and most other uses follow this trend. While these uses do not exist and a zero value is put in front of them, traveling has been done in these zones. The reason for these trips in terms of purpose and means of travel in those zones is that there have always been a commercial and residential uses in those zones, and it explains a large part of the travel pattern of that area.

In fact, the relation between density and use in each zone in relation to the pattern of travel and, on the other hand, in relation to the communication network, linearly explains the pattern of travel this time. And in each zone or route of some commercial or other type of use that exists, one can predict other facts from that window, so the author concluded that, by analyzing the linear arrangement of space and the layout of the spatial zone in the GIS, relations can be explained in the form of the concept of space syntax. Using the space syntax theory to explain the relationships between the variables and the elements make up the content of this section. First, by Depth Map, which is a software in space syntax theories, the level of interconnection of each of the passageways was determined in the central part of Qom. In fact, in this section, the importance and position of each of the passageways in the spatial structure of the city was determined. It is clear that, the more connections a passageway has with others, and also has a better position, the more likely it is to be chosen. Accordingly, the Depth Map software assigns a number to each of the passageways (from main passages to dead ends) that specifies the sum of these numbers in a zone indicates the interconnection of that zone. In fact, it can be said that the more the interconnection of a zone, it is more likely that the pattern of travel in that zone is different. Then, the relationship between it and the amount of travel was examined in this section. In the performed surveys, using the linear regression analysis between the spatial interconnection of the zones and the amount of made travel, it was concluded that the interconnection of the zones and the flow of travel in them are highly correlated. This means that the spatial syntax of the passageways has a strong role in the flow of traffic in these zones. Using the analysis explained before, the

importance and position of the use and density elements was determined in relation to the pattern of travel in the communication network at the level of the zone. Given that space syntax analysis is in a zonal and linear fashion, the effect of each of these elements is explained in the zones and selected routes. For this purpose, the relevant section of GIS was used. With determining the effects of uses and density on the pattern of travel in the communication network axes, they can be used in this section to provide a model for measuring and predicting the effects of these factors in different areas. In fact, the main question in this regard is the most efficient way to measure the effects of land use and density on the pattern of travel. Calculating the use coefficients, the density ratio and its values in the communication network hierarchy in its effect on the pattern of travel in different zones can be used to measure the level of access to sustainable transport and travel patterns in different urban areas. It can be used and measured in both linear and zonal forms. Finally, it is necessary to say that two basic analyzes are needed for measuring the impact of elements of urban form on the pattern of travel. First, it should be checked that any use has any influence on the choice of the means of travel and the travel purpose, in comparison with other uses or a certain amount of density in height, through the studies and analyzes carried out in the first part of Chapter 4. And finally it was concluded that the use of space syntax theory can have much effect on the clarification of reality. The second issue is the analysis of the same elements in relation to the spatial syntax indexes in both linear and zonal terms, which means that the significance of the assumptions of the subject in this section is more fully evaluated. For this purpose, using the spatial coefficient analysis, the importance and magnitude of the use have been identified. Based on this, we have tried to provide a model for measuring and predicting policy in these three essential areas. In the studies of the Comprehensive Plan of Qom, the level of service of all passageways was studied in relation to the spatial syntax, the pattern of travel and the travel purpose, and the final result was obtained.

### 13. Offers

In this section, it should be noted at the outset, given that the main topic of the research is the study of the relationship between the urban form and the pattern of travel, and during the research efforts have been made to identify this relationship and its relative extent, the main purpose of this study is also to discover a pattern for measuring these relationships. On the other hand, travel and variables that affect it have many components, such as the economic condition of society, personal vehicle ownership, urban transport methods, and many other components that can have a significant impact on it. Considering what was mentioned in the theoretical basis and research background, it seems that the study of the combination of land use and the network of communication on the one hand and its separate analysis on the other hand are in the field of space syntax theory, which is discussed less and can be suggested as a continuation of the present work in the GIS environment. It is suggested that further consideration be given to the following topics.

Regarding the title of this study, the main suggestion in this research is the importance and method of calculating the impact of the use, density and communication network on the pattern of travel. In this regard the following suggestions are presented:

**Suggestion 1:** Consideration of the suggested methodology for coding all elements of land use, network density and travel pattern, and measuring the relationships by integrating the raster and vector maps in the GIS environment.

**Suggestion 2:** Use of the proposed method to assess the pattern of travel in the central regions of the cities after issuing permits for the construction of different uses in the city and predicting the extent to which these permits affect the pattern of travel in different parts.

**Suggestion 3:** Comparing different urban areas in terms of spatial syntax and its impact on the dominant travel pattern in order to guide it to the desired state.

#### **Offer for future research**

The following research can be complementary to the present research in the field of urban form and travel behavior:

**Suggestion 1:** the investigation and identification of the range of deployment of different uses and the location of activities, taking into account the theory of space syntax and its related analysis in the eight districts of Qom

**Suggestion 2:** the feasibility study of the displacing activities and density zoning of the area in order to improve the travel condition.

**Suggestion 3:** The study of the role of each passageway of Qom in the city's travel pattern and identifying and

proposing streets for the improvement of the spatial syntax system.

### References

- 1) Ahmadi, M. & Moharamnejad, N. (2006) "The survey of Tehran traffic statistics based on sustainable urban transport indicators", Seventh Conference on Transport and Traffic Engineering, Tehran, Tehran.
- 2) Bemanian, M. R., Yari, F. & Seyed Ali Hosseinpour and Mostafa Shamshirband (2012) "Strategic Analysis of Utilization of Enclosed Spaces in Urban Design with Emphasis on Urban Pollution Reduction" The 4th Conference on Urban Planning and Management, Mashhad.
- 3) Boarnet, M. G., & Sarmiento, S. (1998). Can land-use policy really affect travel behaviour? A study of the link between non-work travel and land-use characteristics. *Urban Studies*, 35(7), 1155–1169.
- 4) Cervero, R. (1989). America's suburban centers: the land use-transportation link. Unwin Hyman Boston.
- 5) Danesh-e-Shahr Magazine (2012) "Exploring Types of Clean Transportation in Cities", Tehran University of Science and Technology, No. 126
- 6) Danesh-e-Shahr Magazine (2012) "Investigating and Proving Policies to Achieve Sustainable Transportation in Tehran", Tehran University of Studies and Planning, No. 128.
- 7) Deakin, E. (2001) " Sustainable Development and Sustainable Transportation: Strategies for Economic Prosperity, Environmental Quality, and Equity" Department of City & Regional Planning and UC Transportation Center, University of California, Berkeley
- 8) Environmentally Sustainable Transport ( EST)-The Organization for Economic Cooperation and Development(OECD,2001)
- 9) Feizi, M. & Rajabi, A. & Hosseini, Y. (2012) "Recognition of the pedestrian movement in the sustainability of urban densely populated spaces" *Journal of Urban Management*, No. 30 Pages 179 to 194.
- 10) Gilbert G. and Tanguay H. ( 2000) " Sustainable Transportation Performance Indicators Project " the center for sustainable transportation
- 11) Green Community Checklist –The US Environmental Protection Agency ( EPA,2003)

- 12) Litman, T. & Burwell, D. ( 2006) " Issues in sustainable transportation " Victoria Transportation Policy Institute
- 13) Litman, T. ( 2010) " Developing Indicators for Sustainable and Livable Transport Planning " Victoria Transportation Policy Institute.
- 14) Lyons Regional Indicators – (Nicolas, Pochet and Poimboeuf , 2003)
- 15) Mirzaii, M. (2011) "Analysis of Development of Sustainable Urban Transportation System (Case Study of Isfahan City)" Master's Thesis for Urban and Regional Planning, Isfahan Art University, School of Architecture and Urban Planning
- 16) MozafariPour, Najmeh and Hatami, Maryam "Evaluation of Comprehensive Transportation Systems MRT Using Analytical Dynamic Analytical Method for Achieving Sustainable Urban Development in Iran" Third Conference on Urban Planning and Management, Mashhad
- 17) Nakha'i, I., Hirash Mohammadipour and Gholamreza Moraveji (2011) "Evaluation of sustainable transport systems using multivariable decision making methods in a non-deterministic environment: a case study in Tehran", 11th International Conference Transportation Engineering and Travel Engineering, Tehran
- 18) Nakha'i, I., Hirsh Mohammadipour and Gholamreza Morouji (2011) "Evaluation of sustainable transport systems using multivariable decision making methods in a non-deterministic environment: a case study in Tehran", 11th International Conference Transportation and Transportation Engineering, Tehran
- 19) Soltani, A., Saghapour, T., Izadi, H. & Pakshir, A. (1390). The production of intra-city trips and the impact of land use diversion, a case study of four residential areas in Shiraz. *Urban and Regional Studies*, 12.
- 20) Strovsky, W. (1993) "Contemporary Urbanism (From First Origins to Athenian Charter)" by Ladan Etizadi (1993), Shahid Beheshti University, Tehran.
- 21) SUMMA ( Sustainable Mobility Measures and Assessment )-European Commission
- 22) Sustainable Transportation Indicators – Victoria Transport Policy Institute (2003)
- 23) Sustainable Transportation Performance Indicators ( STPI)- Center for Sustainable Transportation
- 24) Tafazoli, M. & Seyyed Hosseini, S.M. & Nabizadeh, M. (2011) "Prioritize major policies for sustainable transport based on effectiveness in each of the three dimensions of sustainable development, based on a combination of three dimensions." Eleventh Conference International Transport and Transportation Engineering, Tehran
- 25) TERM –The European Union's Transport and Environment Reporting Mechanism ( EEA,2002)
- 26) USDOT Environmental Performance Measures-The US Department of Transportation ( FHWA, 2002)
- 27) World BUSINESS Council Sustainable Mobility Indicators – The World Business Council's Sustainable Mobility Project ( Eads,2001)

#### **Online References**

1. <http://www.ITDP.org>
2. <http://walksteps.org/case-studies>
3. <http://walksteps.org/tactics-categories>
4. <http://walksteps.org>
5. <http://www.walkscore.com>
6. <http://www.walkscore.com/professional/research.php>
7. <http://www.VTPI.com>.
8. <http://www.UITP.com>.