Ontology Space International Journal
ISSN: 2345-6450
OISSN: 2423-7299
Journal homepage: soij.qazvin.iau.ac.ir
Winter 2024, Vol. 13, Issue 1, No. 48, Pages: 1- 15

Assessing the Effects of Spatial Land Use Distribution in Pathway Networks on Travel Patterns of Citizens (Case Study: District 7 of Qom City)

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Received: 28 December 2017.- Accepted: 07 June 2018

Doi: 10.22094/soij.2023.708138

Abstract

Every day, millions of urbanists have contact with the pedestrian, vehicle networks, and various types of transportation and use urban transportation to meet a range of occupational, educational, shopping, recreational, and other needs. Not all of these have the same pattern in every urban district, and they are subject to various factors and variables. A bunch of these factors is subject to spatial configuration elements, one of the most important of which is the configuration of land use in a pathway network, which has been investigated in this study. Through studies in this field, one can assess the possible consequences of land use deployment on citizens' travel patterns and determine how they should be distributed when promoting a sustainable travel pattern. For this purpose, this study focused on District 7 of Qom City as the Central Business District (CBD). The research was conducted with a descriptive-analytic process in which information was collected using library and field studies. Pearson's correlation test and accordingly the multivariable regression analysis were implemented to analyze the data and test the hypotheses using computer software such as GIS and Spss Depth Map. The findings of the research indicated a significant relationship between the urban travel pattern and the land use pattern in the city and the study area. Moreover, the correlation between the integrity index and the degree of commercial concentration, the connectivity index with the degree of residential land use concentration, and the integrity index with land uses such as transportation and warehouse led to dominant travel patterns in each of these routes and zones. Therefore, the dominant pattern of travel is unbalanced according to the spatial structure of the region, and the sustainability rate of travel styles is very low. Observing the hierarchy of urban services, the land use distribution with respect to the functional radius and, on the other hand, the need to redistribute the land use because of the decentralization principle from the central part of the city are the main aspects of modifying and improving the current situation, which are emphasized in this article.

Keywords: Travel pattern, sustainable transportation, land use, Qom city

1. Introduction

1.1 Problem statement

Moving and traveling are the main and important parts of citizens' lives. Nowadays, the concentration of activity and population in urban areas has reduced the accessibility in cities and increased the number of mobilities, and trips generally rely on private transport. The continued concentration on cars in urban planning reduces the quality of urban environments day by day, and cities end up with a host of problems, such as increasing living costs, air pollution, increasing accidents, increasing fossil fuel consumption, and in summary, degradation of life conditions, resulting in a decline in quality of life.

A major factor that clearly affects urban transport is the way of loading land use in urban areas. Urban land use largely reflects the state of the art of transport technology that has dominated various levels during city development (Barrett, 1996, 17). Urban land use planning plays 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. Research shows that at present, the central part of the city contains a large number of intra-city trips due to travel attractions, and many of the city-wide journeys take place in this part of the city. Therefore, a more suitable pattern of land use is necessary in this part of the city to provide a way to promote more sustainable ways of traveling. Intensive land use as a characteristic of most metropolitan areas of the world provides higher accessibility. This can help reduce the length of trips and combine trips for different purposes. On the other hand, the potential infrastructure for public transport and pedestrians is wider in city centers. In many of these cases, the city center has a form of excellence in new urbanism, which seeks to reduce both overall motor travel and the use of personal transport in particular (Hensher et al. 2004, Jahanshahi, 2003: 113). Therefore, this study tries to address this conflict and scrutinize the relationship between the type and severity of the impact between land use and the pattern of travel. The present research was carried out on the Qom metropolitan city by selecting District 7 of this city. Most

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commercial centers of Qom City and the holy shrine of Masumeh (as) are located in this area. Due to the historic district, a high percentage of the area is allocated to main activities. The inappropriate distribution of land traffic in this part of the city has led to an increase in city-based car travel, waste of time, increased costs, and, consequently, a decline in urban productivity. Nonetheless, the proper distribution of land use and the redistribution of facilities will create social justice and enable citizens to access more services and facilities. In this regard, reducing problems such as the lack of proportion between land uses, the lack of traffic planning, and the lack of coordination between these two can solve many problems that burden most of our cities.

1.2. Importance and necessity of research

The growth in transportation and increase in the number of trips are among the main factors affecting the increase of environmental instability in modern urban environments. Increasing energy and fuel consumption, traffic congestion, air pollution, using urban spaces for the development of transport infrastructure, etc. are all examples of undesirable effects of transportation growth (Jahanshahi, 2009: 24). Due to the expanding need for human and goods transportation in the wake of the economic and health situation, the transport infrastructure has grown exponentially and become a powerful tool for determining the growth of cities (Yaliniz et al, 2011: 889). The car-driven development pattern has led to an increase in crashes and dispersal of settlements, extensive suburbanism, increased distances between communities, and reduced urban land efficiency. Therefore, specialists first sought to expand sustainable transportation, such as walking, cycling, and public transportation, as a way out of existing problems. They believed that sustainable ways of traveling, in addition to reducing the use of personal transport, had other benefits, namely improved air quality and better access to different businesses. Mere attention to the development of public transport without communication with urban development has caused many problems in the development process of cities and led to outcomes such as large-scale suburbanization. Sustainable transportation, urban design, and urban development have benefits that mutually reinforce each other. Investing in sustainable travel practices will boost their value and provide new opportunities for development by providing more access to neighboring real estate (Barvan et al., 2010: 120: 2010). Hence, the attention of urban experts was drawn to the integrated and coordinated planning of urban development and urban land use, leading to sustainable urban development. Today, urban centers have driven back in favor of the suburbs and have faced severe physical degradation in many cities of the country with their suburban expansion due to dispersed planning. This along with the lack of urban travel and the lack of attention to sustainable transport mechanisms makes the problem even more difficult. Due to the inconsistent process of urban development and physical development, the precise definition of land-city relations and travel patterns are essential for the planning, design, and management of these two. With a single-core structure and high population, construction, activity, and densities, Qom City has faced a decline in the quality of life. The increased use of fossil fuels because of reliance on personal vehicles for travel in this area, high crash rates on the one side, and the need for urban management measures in the framework of approved plans and programs on the other side, are all in the compass of land use. The trend of land use change in this part of the city has increased the number of daily visits to the central part of the city, and the increasing dependence on the city center has led to an increase in the number of visits by personal vehicles. The results of this research can be useful in orienting the policies of the central part of the city to the survival of this area and thus to promote its environmental sustainability.

1.3. Research background

The relationship between land use and travel behavior, as well as the effects of different land use variables on travel behavior, have been investigated in several studies. This section provides a brief overview of the excerpts.

The results of a regression analysis (Dargay and Hanly, 2003) in examining the effect of land use patterns on travel behavior in England show that distance traveled by personal vehicle is reduced by increasing density, proximity to public services and public transportation, and reducing distance from city center. According to this study, land use characteristics play a very important role in the demand for travel and the use of cars. The results of a regression analysis (Khattak and Rodriguez, 2005) concerning the effect of neotraditional development on travel behavior in American cities indicate that households living in neighborhoods with neotraditional development travel less distance with cars and walks more. The reason for this is the high density and mixed-use in neotraditional developments. Regression and correlation analyses (Vance and Hedel, 2007) in examining the impact of city forms on travel by car indicate that activity density close to public transport stations has a major impact on the reduction of personal vehicle use. Increasing activity density in neighborhoods and reducing the distance to public transport stations will reduce the number of travels. The results of a regression analysis (Pan Sand and House, 2009) for travel behavior between four neighborhoods with different typologies in Shanghai show that there is less dependency on cars and journey times are shorter in the old and central contexts of the city due to higher pedestrian and bicycle forms of mobility. A correlation analysis was conducted by Abbasi and Hajipour (2012) to investigate the impact of the city shape on personal transport dependence and increasing air pollution in the Shiraz metropolitan area. The results show that increasing mixed-use and density reduces the use of personal vehicles and fuel consumption in the transportation sector, thereby reducing air pollution. Accordingly, inhabitants of the old context are less dependent on personal cars and endure less pollution than those of other neighborhoods. A study of use dispersion and mixed-use effects on travel behavior in the Shiraz

metropolitan area indicates that the travel behavior of residents of neighborhoods with high mixed-use and appropriate distribution of use is different from other neighborhoods (Abbasi and Hajipour 2012). The analysis results (Hatami and Zakir Haghighi, 2016) show that the urban functional axes with their internal uses are each the determinant of citizens' travel patterns. In this research, the ABC integrated transport system is proposed to improve the quality of the public transportation system. Since it is necessary to conduct research and review the literature (national and international), it can be argued that land use planning has been considered regarding the sustainable pattern of travel in recent years. However, what seems to be a more in-depth study is that the spatial distribution of uses affected by the arrangement of pathway networks can affect the citizen's travel patterns. Therefore, the present study first examines the use configuration status on the axis of a pathway network. Then, the effect of land use is studied on the pattern of travel in selected routes to identify the importance of each use in the formation of travel and its variables. The results of this research can reflect the establishment of land use in the central area of cities and is a useful input for urban management decisions for the deployment of uses in the central context of (District 7) Qom City.

Table 1
Confronting questions, goals, and research hypotheses

Goals	Questions	Hypotheses
Investigating the relationship between elements of network configuration on land use placement. Explaining the relationship between placement and configuration of land use on travel patterns	How do the elements of spatial configuration of pathways affect land use placement? How does the spatial configuration of land use on the axis of pathway networks affect the citizens' travel patterns?	There seems to be a significant relationship between integration, connectivity, pathway integrity indexes, and the degree of land use concentration. The difference in travel patterns seems to be affected by the configuration of land use in the hierarchy of access networks.

1.4. Study area

District 7 of Qom, which is also the origin of the city, continues to be the main center of Qom after thousands of years. Some of the main historical elements of this part of the city include the bazaar, the Jama Masjid, Haj Asgar Khan Bath, the mosque of Imam Hassan (as), the Grand Mosque, and most importantly, the holy shrine of Masumeh (as). At present, the land area of this district is 472 hectares with a population of 48762 people, and the existing land uses are mainly commercial and residential.

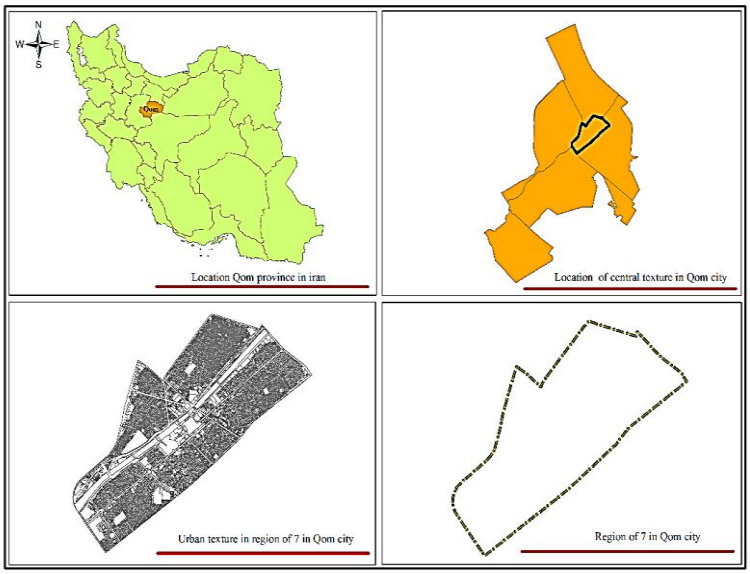

Fig.1. Study area

This area extends to Imam Street (Saeedi Square) from the north, Boulevard 15 Khordad from the east, Ammar Yasir Boulevard from the south, and Fatemi Street (Janbazan Square) from the west. The structural elements in each city, including the bazaar, the Jama Masjid, schools, urban squares, administrative centers, commercial centers in religious cities, and holy shrines, are located in this region. In addition to these elements and regarding the centrality of the holy shrine of Masumeh (as), the multiplicity of effective uses influences the production and attraction of travel, which is the focus of this study.

1.5. Research method

The present research is an applied-development study in terms of the purpose using a descriptive-analytic method. Theoretical foundations and criteria were extracted using documentary studies. Subsequently, the extracted criteria for theoretical literature are used by conducting field studies in accordance with the present situation. Using the information, the different types of land use distribution will be first determined on the transport network to the impact of the spatial configuration of the network (space-configuration indexes). Then, theoretical models are used to determine the land use criteria and the pattern of travel using literature studies. Field studies are then conducted to confirm that the main criteria are consistent with the theoretical models and are selected for the present study. Maps were created using ArcGIS and Depth Map software.

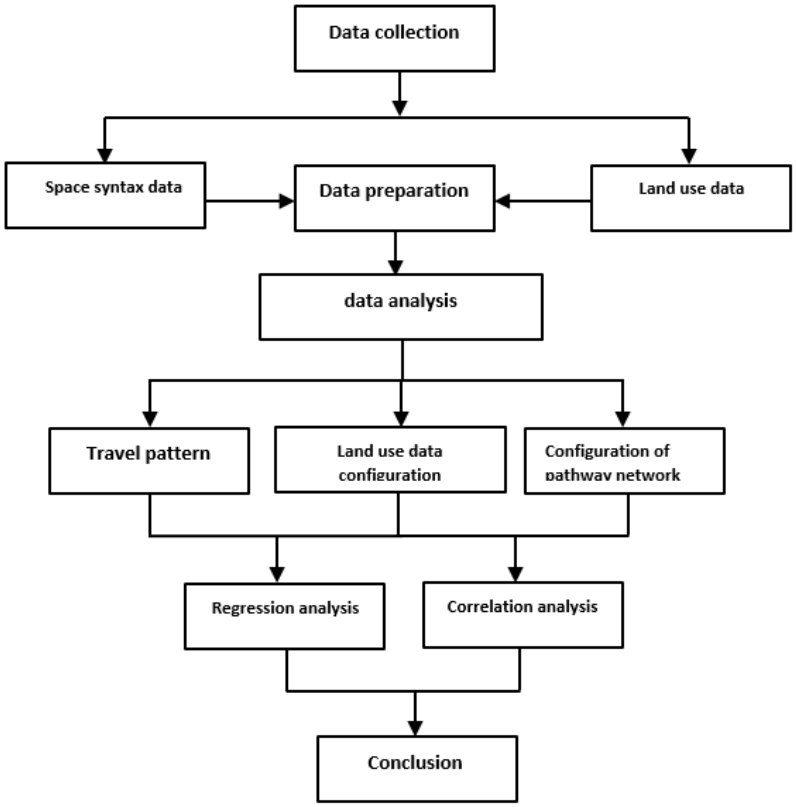

Fig. 2. The analytical model and data preparation process

A quantitative method and analyses of primary and secondary data were used as the research strategies. The extracted land use data were purposely refined to exclude those not needed for the analysis, and the remaining data were processed for the analysis. Thus, the analyses included land use in the central district of Qom on the one hand, and, on the other hand, data on the travel pattern as the two main sections of this research. The distance of the dominant travel pattern in a link to the impact of the use configuration and the subsequent network configuration can be identified as the problem in this research. Therefore, the main equation of this study is based on its main information (network configuration and land use configuration in the first section), and determining the unknowns of this equation (the land use configuration impact on travel patterns), which is the mainstay of all the topics.

2. An overview of the Theoretical Literature

2.*1. Land use*

Different definitions have been given about the concept of land use, but they generally rely on the following common points:

* Land use means the spatial or geographical distribution pattern of the city's various functions, such as residential, industrial, commercial, retail, and spaces allocated for administrative use, institutions and social institutions, and leisure activities (Javad Shahidi, 2011).

* Land use emphasizes human activities in land and natural resources and land vegetation (Hajikhani, 1993).
* Land use refers to actual interactions occurring at a specific location whether people live, work, buy, teach, or enjoy, where they live.
* Land use is the type or kind of activity a land is used for, hence, some consider urbanization as a land use policy (McConnell, 1981).

2.2. Travel pattern

Most city travels take place on foot, bicycles, public transportation, and personal cars (Abolhasani, 2001: 86:

Ottawa & Ontario 2007: 28). Various variables can be counted as the travel pattern of citizens, such as travel time, travel means, travel length, the geographical range of travel, and destination of travel, each of which is a sum of various factors that can generally be classified into two main categories, travelers' characteristics and the urban structure pattern (Schwann et al., 2001: 178).

2.3. The relationship between land use and urban travel patterns

An examination of the interrelationship between land use and intra-city travel was first introduced in the United States and, after World War II, in Europe, and the hypothesis that "urban land use dispersion increases the volume of travel" was tested frequently (Boarnet and Sarmiento, 1998. 1154).
Research indicates that lands and trips are determined by each other, and therefore, the transportation and planning of land use must be in harmony with each other (Jahanshahlo and Amini, 2006: 4).
Considering the new perspectives on urban planning and transportation, theories and views have focused on policies of the demand side. Among the strategies of "travel demand management", attention has to be paid to determining the relationship between the two elements of land use and transport. With a smart and scientific approach, it is possible to locate the correct use of urban space as an important step in managing the flow of travel (Siyadat Mousavi and Sharif Mousavi, 2007: 1).
In the last two decades, the attention of urban planners has been drawn to those urban development patterns that can reduce the demand for travel by closing the centers of activity together. In other words, land use determines the location of the activity, and thus determines the opportunities for the origin and destination of the trip (Rodier, 2009: 2).
With this in mind, a reason for the high demand for travel is extra and excessive travel carried out to benefit from various urban services (Saifaddini et al., 2012: 66). As such, decisions about whether or not to travel are influenced to a large extent by the conditions of land use distribution (Soltani et al., 2012: 2). Today, the nature of land use clearly affects the reason of the journey and its nature, and, consequently, the process of production and distribution of travel; accordingly, several approaches have been used to predict land use (Gazis, 2002, 192). The main output of the transport and land use infrastructure is the travel patterns. As a result, the location of people's activities and their travel procedures determine the location where the transportation infrastructure meets at their origin and destination. On the other hand, land use is a function of transport performance. Since the new transport infrastructure changes the access to the land connected or unconnected to it, this subject influences the decisions made to develop and choose the place of residence and work. Developers, residents, and companies are choosing and developing a place where transport infrastructure is partly able to access other parts of the region. Due to this connection between transportation and land use, urban artifacts are partly the product of transport decision-making (Kumarkintala, 2005, 10). In fact, land use and transport can be considered two parts that are completely related to each other, and changing one of them creates reflections on the other. Increasing efficiency in one sector requires modification in the other (Boarnet and Handy, 2010, 3). The set of relationships is determined by the land use-transport feedback cycle, and each of these factors can be explored individually and in conjunction with the others:

- The distribution of land use, such as residential, industrial, and commercial areas, determines the location of human activities such as the place of residence, work, shopping, education, and recreation.
- The distribution of human activities in urban spaces requires spatial reactions (travel) in the transportation system to bridge the distance between activities.
- Infrastructure distribution in the transportation system creates an opportunity for a spatial response called "accessibility".
- The distribution of accessibilities in urban spaces is mutually determining land use and, consequently, making changes to the land use system (Jahanshahlo and Amini, 2006: 4).

Keeble emphasizes the fundamental role of land use in urban planning, and states that "urban planning is to predict the correct amount of land for every use in the right place and headquarters that are physically the appropriate body for each use." Land use is also one of the main factors in the production and attraction of traffic. Service types and service rates are not the same for all uses. Business centers, daily markets, industrial centers, and metropolitan and outbound terminals, entertainment centers, and offices have different roles in attracting travel. Some service utilities are used more than other services (Pouya Engineering Group of Designing and Strategy Consulting: 2012, 95).
Litman explicitly identifies land use factors effective on urban transport as nine major components, each of which contributes both individually and in conjunction.

2.4. Travel patterns in the central part of cities

A city center is not a fully-defined part of a city. The administrative and political boundaries do not identify the city center at least in terms of transport; the center may be older, more crowded, or poorer than its surroundings, but these differences may not be so dramatic and fast. In spite of all these facts, the city center is usually the city's historical part, and new developments are formed around it. This means that transportation facilities in urban centers are older and less expensive than other areas. This, combined with the density of work and population in the center, causes traffic congestion in urban centers (Jahanshahi, 2003: 113).
Urban centers also have features that can be considered to enhance sustainable transport. More denser and more compact land uses, which are typical of most urban

centers in the world, result in broader accessibility that can help reduce the length of travel and combine them for different purposes. On the other hand, the potential of sidewalks and the public transport network is wider in city centers. In many of these cases, the city center has a form of excellence in new urbanism, which seeks to reduce overall motor travel and reduce the use of personal transport in particular (Hensher et al 2004, Jahanshahi, 2003: 113).

What is happening today in the design of urban systems is the development of comprehensive urban plans aiming at maximizing the consistency between urban and land use policies on the one hand and optimal urban transportation systems on the other hand (Asgari Tafreshi, 2009: 12). The relationship between land use and transportation is taken into account in various paradigms that consider two economic/behavioral approaches, and mathematical programming and network equilibrium. The first approach is based on the principle of economic and maximum profits, and it is believed that land is allocated to different uses based on the price; in this approach, access is a side effect. In the second approach, mathematical models are optimized to allocate activities. The similarity of both approaches is in minimizing the costs (Giuliano, 1988, 4).

Table 2
Land use components affecting urban transport

Component	Definition	Effects on urban transport
Density	Population or occupation per unit of land	Increasing the density reduces travel by cars. Every 10% increase in density will reduce the use of cars by 2-3%.
Mixed-use	Combining residential, commercial, administrative, and other land uses together	Increasing mixed-use reduces travel by cars and increases the use of alternative models, especially walking. Neighborhood units with mixed-use reduce the use of cars by 5-15%.
Regional accessibility	Development of the City Center on a regional scale	Increasing access to the city center will reduce the use of cars. Neighborhood units in the central regions use between 10% and 30% less cars.
Management and design of routes	Scale, design, and management of streets	Increasing the design and management of multi-purpose streets increases their use. Traffic relaxation reduces the tendency to use cars and increases walking and cycling.
Walking and cycling status	The quantity and quality of the sidewalk, bicycle paths, and pedestrian pathway safety	Improving the pavement and bike paths reduces vehicle use.
Accessibility and quality of public transportation	The quality of public transportation services and the routes need public transportation	Improving public transportation services will increase the use of public transport and reduce vehicle use.
Parking management and supply	The number of parking spaces in each building and their management procedures	Reducing the supply of parking will increase the cost of parking and reduce the use of cars. An increase in the cost of parking will reduce the use of cars by 10-30 percent.
Site design	Design of parking buildings and facilities	The design of mixed-use sites reduces vehicle use. Especially if the site has public transportation.
Movement management	Different programs and strategies that include different models of using transportation.	Driving schedules and policies by specifying the purpose of the journey reduce vehicle use by 10% to 30%.

Source: (Litman, 2005, p. 4)

2.5. Spatial configuration and formation of travel patterns

This theory was founded by Hillier and Hanson (1984) in London and is based on research on the relationship between social and spatial forms (Rismanchian, Omid, and Simon Bell, 2010: 50).

The space configuration method analyzes the sequencing and configurational relationship of all spaces and presents the features of city spaces both graphically and in terms of mathematical parameters. According to the space configuration method, the order of positioning spaces alongside each other directly affects the use of spaces (Abbaszadegan, 2002, 64).

Hillier argues that, unlike spatial attraction theories, this is the spatial configuration of the pathway networks that form the intra-city movement. Although spatial configuration can affect spatial attraction and motion, it cannot be affected by them (Rismanchian, Omid, and Simon Bell, 1390.73).

Space syntax studies are trying to achieve solutions by considering artifact environments as an integrated spatial system by analyzing them regarding the disadvantages of space configuration and their relationship, as well as clarifying its foundations and structural patterns. (Hillier, 1998, 2) emphasizes that in the deep understanding of urban spaces, the role of each urban space individually and the individual characteristics of that space on a small scale is less important than its role in combination with other elements of the city and its macro-scale characteristics and the whole urban system (Rismanchian, Omid, and Simon Bell, 2010, 50). In fact, the founders of space configuration consider the constant factor "space" as lawful and use spatial laws to analyze and define the city (Alipour, Meysam, 2007, 2).

This theory believes that urban spaces are the product of social relationships and the relationship between urban spaces pursues social goals. Thus, understanding the relationship between urban spaces can help understand behavioral patterns and the quantitative analysis of qualitative-behavioral factors. This theory believes that spatial configuration and urban spatial composition are the main factors behind the distribution of socioeconomic activities, such as land use distribution, as well as the distribution pattern of movement in the city. For example, this theory states that spatial configuration and the relationship between urban spaces shape the pattern of movement in the city and cause the structural development of the city's space. By understanding this relationship, it is possible to identify the pattern of movement in the city quantitatively and use it to understand the spatial structure (Rismanchian, Omid, and Simon Bell, 2010, 50).

Accordingly, it can be deduced that the placement of urban land uses is in different pathways and, in the same way, travel patterns are distributed in it according to the communication network structure. This examines the configuration and distribution of land uses and the explanation of travel patterns through the communication network.

2.6. Theoretical framework of research

A review of the theoretical literature in land use planning, like intelligent growth, emphasizes mixed-use and its combination with public transportation, pedestrians, and bicycles. Based on this theory, increasing diversity in urban land use has a significant role in reducing travel generation, per capita traveled distance per day, travel time (distance), and per capita traffic. Radier also believes that the travel demand can be reduced by closing the activity focuses to each other. In other words, land use identifies the place of activity and, therefore, determines the opportunities for the origin and purpose of travel. In his book "Traffic Theory", Gazis also states that the nature of land use affects the reason and nature of the journey, and consequently the production and distribution process of travel; in this regard, several approaches have been used to predict land use. Therefore, Gazis stresses the integrated planning of these two categories (traffic and land use). In his book, "The Effects of Land Use on Transportation", Litman suggests the land use-transport feedback cycle and states the land use dispersion procedure, as well as the impacts of making transport planning decisions on land use development. Therefore, these two categories should be considered and planned in conjunction with each other. Similarly, Limonand and Nimir (2003) conclude in their paper that all types of travel are not equally affected by land use distribution. Hillier argues that, unlike spatial attraction theories, this is the spatial configuration of the pathway network that forms the intra-city movement. He claims that although spatial configuration can affect spatial attraction and motion, it cannot be affected by them. In fact, Hillier, who presented the theory of Space Syntax, believes that the placement of land uses and functions has an impact on these communication channels. In this section, the views and studies on the pattern of citizens' travel can be reviewed in several categories. Studies on socioeconomic parameters have influenced car ownership, personal, and family characteristics to choose the means of travel, travel time, and travel length, which could be useful for studies on the recognition of urban element effects on density, network communication, design, and travel behavior. In this section, we can refer to the studies of Cervero in England, Marshall's studies, and so on. In this study, the focus is on the role of land use, in line with the Litman, Kilimanjaro, and we seek to explain the problem by a new approach called Bill Hilier's Space Syntax. From the perspective of the spatial configuration elements, we seek research synergy.

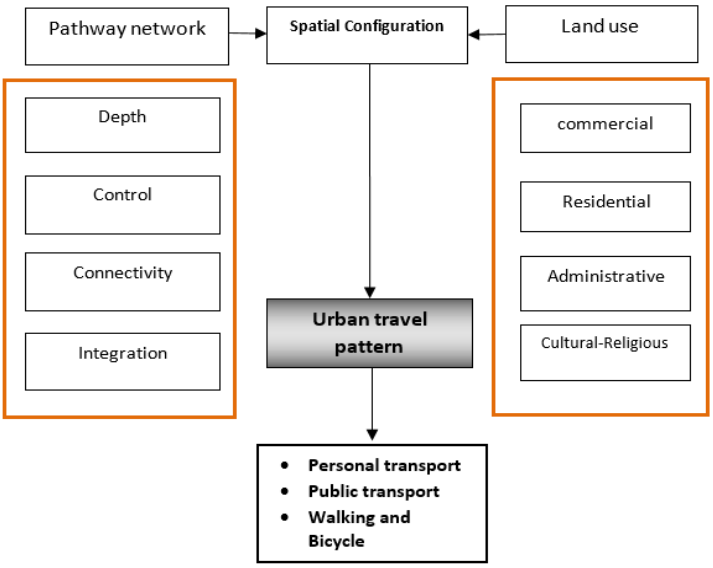

Fig. 3. The conceptual model of research

3. Research Findings

The findings of this study are presented in three main sections. In the first section, we examine the relationship between the spatial arrangement of the communication network in the space configuration theory with land use indexes to clarify the logic in determining the spatial configuration of land uses in the pathway network. We then examine the extent to which the patterns of travel in each of the selected categories are influenced by land use and, consequently, the spatial configuration, and its distribution.

3.1. Descriptive findings

This research is based on the basic assumption that the spatial configuration of land uses under the influence of the spatial configuration of the communication network influences the travel pattern. Accordingly, while this section focuses on the current state of land use, it provides the ground for analyzing the physical system of the region. In other words, it is considered to be a spatial configuration.

According to Table 3, the maximum area of land use in the area belongs to commercial utilities and urban services, and the lowest amount is related to industrial-workshop activities. The main streets of Qom City start from this area, and this link indicates that the streets in the area are among the main streets of the city, linking the main sections of the city. Moreover, the most important uses and activities are deployed there. According to Table 4 and in completing land use information, an important part of the land use of the area belongs to the communication network. The total land area of the pathway network is 890280 m^2, and the total area of the district is 8071783 m^2. The arterial routes of the region account for 11% of the area, and this share of the transport network shows the importance of the area, especially the communications between the spaces.

Table 3
Descriptive findings

Land use type	Number	Area (m^2)	Share (%)
Residential	11124	176939	28.6
Retail commercial	1536	229963	0.5
Wholesale commercial	42	72002	0.2
Business services	578	130194	2.8
City Services	401	2944446	6.4
Industrial-workshop	50	7425	0.2
Green space and garden	13	156039	3.4
Administrative	121	102543	2.2
Religious	285	224596	4.9
Open spaces and pathways	0	1360147	29.7
Facilities and Transportation	118	85642	1.9
Wastelands	815	210789	4.6
Total	15083	4578378	100.0

Source: Results from the comprehensive study of Qom City: Environmental Consulting Engineer 2011)

Table 4
The existing pathway network in terms of width, length, and area

Approximate area (m^2)	Length share (%)	Length (km)	Pathway Type/Width
Pedestrian routes up to 4 meters wide	47	40.9	141000
Accessibility up to 10 meters	43	37.5	344000
Collector up to 16 meters	5	4.4	70000
Main street up to 30 meters	12	10.5	288000
Arterial grade two up to 35 meters	3.1	2.7	99000
Arterial grade one up to 35 m	4.7	4.1	165000
Total	114.8	100	1107000

Source: Results from the comprehensive study of Qom City: Environmental Consulting Engineer 2011)

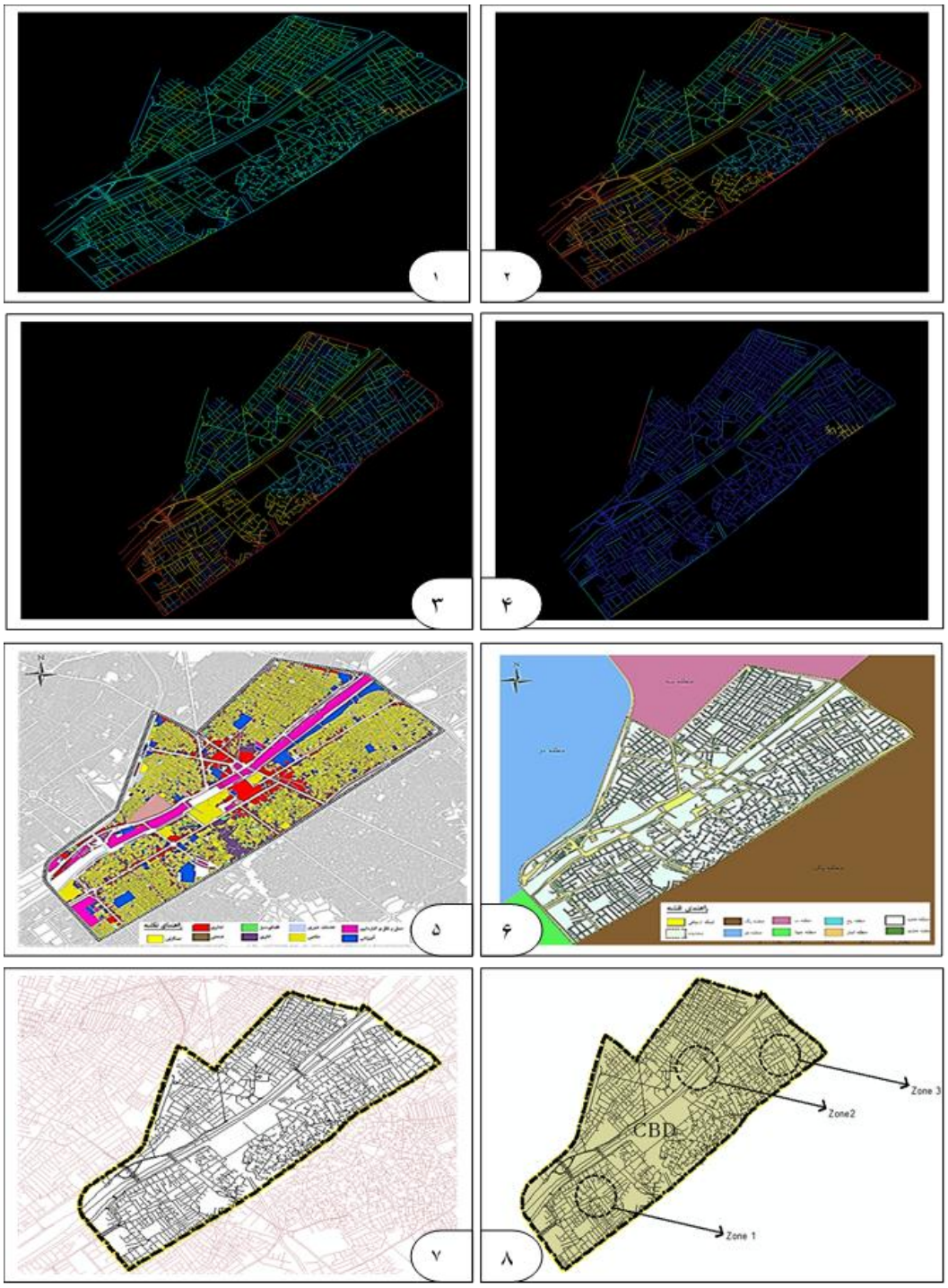

Fig.4. District 7 of Qom City

3.1.1. Spatial configuration of the communication network in district 7 of qom

The space syntax theory is modeled and analyzed in a configuration approach and by displaying branching connected graphs of discrete mathematics (how space is configured or how urban spaces are configured) alongside each other and their impacts on the activities and movements of citizens. On the other hand, the most prominent public space in cities is the street, on which the city is known and is in fact the most obvious characteristic of each city (Taherkhani, 13, 81, 89). Accordingly, to analyze the travel pattern in Qom City by the space syntax method in this research, the longest axis line of access and vision was first determined in the urban environment., followed by preparing its axis map. This "axis line" of the map consists of 1,761 lines for District 7 of Qom City, which was drawn in the Auto CAD environment and analyzed by Depthmap software. Several spatial values, namely depth, control, connectivity, and integration values, will be obtained from this analysis

according to the purpose of this research. The purpose of selecting these four indicators is to investigate the relationship between spatial configuration, travel patterns, and the location of land uses.
The variables such as control, depth, connectivity, and integration, were measured in the pathway network of the central section of the city using Depthmap software (space syntax).
Control: The value of this index indicates the probability of selecting a space in a city node (1).

$$Control = \sum_{i=1}^{n} \frac{1}{c(li)}$$

Depth: The separation of a specific space from the totality of the spatial configuration. For this purpose, spaces of greater depth separate themselves from the space configuration (2).

$$Mean - depth - of - node_k = \frac{\sum_{i=0}^{i=n} dik}{(n-1)}$$

Connectivity: This index indicates the extent to which a route is associated with another route and the higher the amount it represents, the higher the accessibility is (3).

$$C_i = k$$

K = the number of nodes connected to a space
C_i = the connection graph
Integrity: The greater the degree of integration, the greater the cohesion of the communication network elements (4).

$$RA = \frac{2(MD-1)}{K-2}$$

$$D_k = \frac{2(k(\log 1(\frac{k+2}{3}) - 1) + 1)}{(k-1)(k-2)}$$

$$Integration = \frac{Dk}{RA}$$

3.2. Analytical findings

At first glance, the perception of the relationship between land use and determining urban travel patterns is unlikely to be problematic. For some, the average travel distance between these activities and the origin of travel decreases and the possibility of traveling on foot or by bicycles increases when a large number of activities are available in a small area. Or, an increase in the volume of commercial land use in a range increases the possibility of vehicled travel attraction from surrounding areas. Nevertheless, the study of the difference in spatial conditions represents new facts in completing previous propositions. The analytic aspects of this research are based on theory testing. The relationship between the spatial configuration index in the network of pathways and the types of land uses is examined in the first section, and then the level of being effaceable of different travel patterns is tested in areas with different conditions; the second part covers the article's analysis. According to Table 6, there is a significant relationship between the variables associated with each of the four indexes of space configuration and the placement of land use types in proportion to the values belonging to these indexes.
This relationship is also effective in shaping travel patterns in the district (public transportation, personal transport, pedestrians, and bicycles) according to the table. For example, " increasing the degree of integrity of a range increases the concentration level of commercial land use in that range, and the cost of vehicle travel attractions increases in that range. While decreasing the values of the same index, the depth of a route increases, and this also affects the concentration level of residential land uses in a range, thereby increasing traveling on foot and by bicycles. The relationships in Table 2 are based on theoretical foundations, which are examined through a questionnaire on selected axes through correlation and regression tests in this section. The correspondence between components and indexes and its equivalence with land use and, in the same way dominant travel patterns in a district mean the effect and the potential of two-way relationships between them, and therefore, follows certain theoretical propositions to test this section.

3.2.1. The spatial configuration effect of networks on land use distribution in district 7

The correlation analysis is a statistical tool for determining the type and degree of the relationship of a quantitative variable with another quantitative variable. The correlation coefficient shows both the severity and the type of the relationship (direct or reverse). This coefficient is between 1 and -1 and is equal to zero in the absence of a relationship between two variables. The closer this ratio is to 1 and -1, the stronger this relationship is (Momeni, Qayumi, 111: 2007).
H0: $\rho = 0$, there is no significant correlation
H1: $\rho \neq 0$ has a significant correlation
To analyze the correlation of land use with travel patterns, they are divided into four categories: Commercial, Residential, Administrative, Service, and others. Subsequently, the location density of land uses in each route was investigated with each of the four indexes.

Calculation of the concentration percentage for each land use

$$= \frac{(\text{area of land use in one street})}{(\text{area of land use in the district})} \times 100$$

Table 3 shows the results of this analysis as follows:
There is a significant and direct relationship between the integrity value obtained from space configuration analysis in District 7 of Qom and the placement of land use. This relationship is stronger between commercial land use and integration in the arterial axis. Thus, the routes with a higher degree of integrity have more access, and, as a result, most commercial land use is concentrated on these routes. This fact confirms that the spatial structure and the combination of the pathway network is such that it

encourages travel by vehicle access from distant areas and pedestrian and bicycle access from nearby areas.
The depth index has the highest correlation with residential land use. Similarly, the results obtained in Table 7 indicate that the commercial, residential, administrative, and commercial variables are all influenced by the space configuration parameters, but this relationship can be interpreted as in pathways with more depth, in which the quantitative and qualitative situation of commercial land use collapses around it. The detailed results of the table illustrate these relationships more precisely.

Table 6
Calculation of Spatial Configuration indexes and Formation of Intra-Urban Travel Patterns

Method	Component	Indexes	Effects on land use placement	Equivalent to travel patterns
Space syntax	Connection	The importance of a street in the structure of a district	Commercial	Personal transport
			Administrative	Public transport
	Depth	The amount of isolated spaces and hidden corners in the range (The amount of isolated and untenable spaces)	Service	Pedestrian and bicycles
			Residential	Pedestrian and bicycles
		The quality of the vitality of the environment	Commercial	Personal transport
	Integrity	Local radius (Standards 3-5 radius indicate the number of shift directions)	Service	Pedestrians and bicycles
		The extent of the range of space hierarchy	Residential	Pedestrians and bicycles
		Number of pathways to each other (the number of stops)	Administrative	Public transport
		The degree of continuity of an axis with the whole range (The amount of space and distance needed to reach from one point to another)	Commercial	Personal transport
			Residential	Pedestrians and bicycles
	Control	The power of detecting routes from a street	Commercial	Personal transport
		Number of select options(route select)	Service	Public transport

Table 7
Correlations between values obtained from the space configuration indexes and land use configuration in the network

Main group	Main index	Type of the relationship	Depth	Control	Connection	Integrity
Residency	Residential	Pearson Correlation	.693	.672	.133	.613
Service	Sanitation		-.139	-.015	.110	-.011
	Medical		.109	-.060	.216	-.090
	Green space		.009	.103	.078	.056
	Sports		-.077	-.032	.206	-.045
	Tourism-Reception		.687	.714	.168	.739
	Sociocultural		-.021	-.016	.139	.032
	Religious		-.084	-.065	.274	-.003
Commercial	Commercial		.143	.108	.099	.106
Administrative	Administrative		-.045	-.033	.260	-.042
	Police		.826	.918	.739	.073
	Educational		.987	.860	.032	-.076
	Higher Education		.472	.917	-.003	.168

3.*2.2. The impact of land use distribution on the travel pattern in district 7*

Without precise knowledge of the spatial structure of the boundaries, the connections of the network components, and the configuration of urban pathways, one cannot understand the nature of phenomena such as intra-city travels (which are somehow affected by the spatial structure). Therefore, this is a tool for understanding the facts and predicting future procedures. For this purpose, we try to investigate their impact on the travel pattern in District 7 of Qom in this section. As discussed earlier, the second hypothesis of this study is that land use concentration in the pathway network as an independent variable influences the travel pattern, therefore, a regression model was used to prove this hypothesis. Thus,

the values of land use concentration in each route (10 selected routes) were analyzed by SPSS software to evaluate the relationship between these values and each of the travel patterns using the linear multivariable regression analysis.

The first output of the regression analysis is the summary table of the model. In this table, multiple correlation coefficients, coefficient of determination, adjusted coefficient of determination, and estimated criterion error are determined for each step of the regression analysis. The coefficient of determination is determined to study the changes in the dependent variable explained by independent variables. The summary table of the model shows the number of relevant models to obtain a desirable model for explaining the relationships. The regression rule table shows a good correlation between independent and dependent variables. The index of Square = 0.67 shows that 67% of the variation of the dependent variable (travel pattern) is affected by the independent variable (the land use configuration in the communication network).

The results in Table 9 illustrate the main details of the relationship.

Table 8

A summary of the Multivariate Linear Regression Analysis (Dependent Variable: Travel Pattern)

Model	R	R Square	Moderated R Square	Estimated standard error
Final	2.087	0.067	0.53	2.268

Reference: The authors' studies (2017)

According to the Linear Multivariate Regression Analysis model, commercial land use concentration directly affects the vehicle travel pattern, and the pedestrian travel pattern is mostly affected by the residential land use. Thus, it can be interpreted that the dominant land use of each route will have the highest effect on the dominant travel pattern along that route, which is related to the spatial configuration of that path in the network. Therefore, the findings of the linear regression model are shown in Table 9.

Table 9

Final coefficients (dependent variable: travel pattern)

Model	Non-standardized coefficients		Standardized coefficients	t	Sig.
	B	Std.Erorr	Beta		
Residential	.739	.168	.739	2.713	.000
Administrative	.032	.139	.032	5.002	.826
Commercial	-.003	.274	-.003	.222	.987
Service	.106	.099	.106	-.017	.472

3.3. Discussion

According to our analyses, commercial land use has a great influence on the vehicle-based traffic interaction (personal transport) in Qom, making the current situation difficult and unstable. Additionally, another factor affecting the personal vehicle travel pattern of District 7 in Qom is the service land use configuration, meaning that the most concentrated pathways are more likely to be picked up by people with a personal vehicle. This case of residential land use has different results and represents the dominant role of a route, suggesting that the understanding of travel purposes can influence the choice of the means of travel. This effect will occur according to the travel distance. Travels with shopping destinations in short distances are often done on foot. However, the travel means may change if the purpose is to shop and the distance is long, and public or private transportation may be chosen instead of walking and biking. In this respect, one prescription cannot be considered for all routes. In the process of land use management and planning, however, the capacity of a route or axis should be noted for establishing new land use, especially commercial land uses. If the purpose is the optimal distribution of travel patterns at the district level, it needs a series of comprehensive measures from the scale perspective. An important issue is to evaluate and accurately calculate the possible effects of establishing land use and a pattern of travel encouragement discussed in this article. Nonetheless, the communication network variable is also important. The demand for land use in different routes depends on the severity of traffic flows. Therefore, to adjust the demand (instead of a mere rent-seeking view over space), we should consider the capacity of a route for each travel pattern. Various parameters should be considered to measure the capacity of the communication network and land use, including the spatial configuration of the network, and at the same time, the most appropriate model for each route and the proportion of each travel pattern, including personal, public, and pedestrian tools, with a focus on urban land use, which should take place with the spatial configuration of the network of pathways. Therefore, the spatial structure is the mainstay of attention to land use and transportation issues in combination. An examination of the 7th network of routes shows that the highest concentration of commercial land use is at the main axis of the Eram-Safa'iyeh street, which includes district functions and absorbing the domain of these uses up to the city's total scale. Besides, this combined route has created a pattern of public and personal transportation

for the city. The second ring of routes, such as Arak streets, Amar Yasir Avenue, 15 Khordad Avenue, and Montazeri Street, are located next to this axis that is under control and is very different from the streets of the central part in terms of traffic volumes and the speed of traffic. In fact, Qom's urban management policies, which prohibit entry into the main core of the district, have driven back the traffic flow and created a huge stream of traffic in this part of the city. This policy, along with the role of the spatial structure, has intensified vehicle travel in the second ring, but with relatively reduced traffic in the main core.

4. Conclusion

Inappropriate land use distribution in the city leads to increased city travel, waste of time, increased costs, and, consequently, reduced urban productivity. The proper land use distribution and reallocation of facilities will create social justice and enable citizens to access more services and facilities. In this regard, due to the impact of land use on different patterns of travel, they have to be more careful in redistributing land use or possible effects of land use on the travel pattern in the range.

The effective relationships between land use distribution and travel patterns have so far been investigated in various studies using several factors to explain the reality. In this study, the space configuration technique, which is one of the most commonly used methods, can be used as a backup tool for urban planning and management.

The results of this research can be divided into two sections, the main objective and a focus on the research objectives:

4.1. The influence of spatial configuration of the network on the configuration of land use

The first goal of the study is to determine the role of the spatial configuration of pathways on the placement of land use and the extent to which each indicator influences the placement or percentage of land use density. This relationship could be tested through correlation analysis by collecting and preparing land use information in District 7 of Qom on the one hand and calculating the space placement indices on the other hand.

The results of examining each of the four space configuration indicators (connectivity, depth, control, and integration) and analyzing their individual values with the land use focus percentage in the checkpoints indicate that the four types of main residential, commercial, administrative, and service land uses have different orientations for deploying in areas with different structural features. Commercial land use, for example, tends to be located in areas with low pathway integrity, hence when the depth index is high, the tendency to commercial land use is lower. Residential use, on the other hand, reflects the reverse relationship of such a problem. When the integrity of the pathways is high, the tendency of residential land use is less. Similarly, according to land use deployment, different travel patterns are distributed in each direction in the same way, and the pattern of travel has been distributed according to land use deployment. Obviously, the more a pathway has connections with other pathways, it also has a better position, therefore, it is more likely to be selected. Accordingly, the uses and the degree of concentration of activities at the level of the axes are distributed according to the hierarchy of the network, and each travel flow in the district has its own share of the total.

4.2 Effects of land use concentration on travel patterns

In the second part, the goal was to determine the relationship between the percentage of land use concentration in the pathways and the dominant travel pattern in different axes. An analysis of land use surveys of these axes is that, for example, commercial land use exists on all routes, but when this concentration is more intense, the traffic volume of the cavalry is also higher. Therefore, the highest correlation between the pattern of travel, especially in the mode of personal transport, with severity The focus is on commercial land use, including Safa'iyeh Street, Dey 19th Street, and Tir 7th Street. On the other hand, pedestrian and bicycle speeds are higher (communicative pathways of residential neighborhoods) on the routes with the highest residential land use rates.

4.3. General suggestions

The main suggestion in this study is the importance and the way to calculate the impact of land use on the one side, as well as the position of passages in the spatial structure of the city on the pattern of travel in urban areas on the other side. The following suggestions are presented in this section:

- The hierarchy of service distribution is recommended - in the sense that the distribution of services is proportional to the hierarchy of physical division.
- Increasing equilibrium in the definition of the hierarchy of access will be paid attention to by planners and administrators. If the services provided in accordance with the principle of access are located at the level of neighborhood units, neighborhoods, and urban areas, the necessity of visiting residents to different parts of the city and the volume and congestion of intra-city trips will be reduced to some extent.
- Part of the traffic generated in the neighborhoods is due to the presence of land use with a transactional performance scale. By transferring these types of land use that encourage traveling, people can use the service complexes and industrial towns to decrease the traffic load of the neighborhood.
- The decentralization of travel-encouraging land use, as well as commercial, educational, and therapeutic uses, seems necessary. In addition, the occurrence of traffic congestion problems, especially in important activity nodes, is

inevitable because of the low appropriateness of the transport network levels with the type of operation and the change of land use at some points.

- The site of transportation studies and traffic in urban development plans requires revision, and there is a need to collect detailed information on high-precision and high-sensitivity traffic components.

4.4. Special offers for district 7 of qom City

The following research proposals can be used to orient Qom urban development programs in terms of land use, space configuration, and travel patterns:

First suggestion: attention to the methodology of the subject and calculating the impact of each land use on the travel pattern (based on the purpose, geography, time, means, and the distance of travel)

Second suggestion: The use of this method to evaluate the flow of travel after issuing land use building permits in the city and anticipating the possible impact of these permits on the pattern of travel.

Third suggestion: Focusing on the future impacts of land use (especially in relation to elevation development) and considering its traffic implications in land use planning and construction for traffic requirements.

Fourth suggestion: Investigating the role of each street in Qom in the pattern of travel, as well as identifying and suggesting new pathways to improve the status of the travel pattern in the configuration of the communication network (network ordering).

The fifth suggestion: the feasibility study of encouraging land use of traveling in a vehicle in District 7 of Qom (city center) to moderate the traffic.

Acknowledgments

The authors are grateful to Dr. Toghiyani (faculty member of the Department of Urbanism, Islamic Azad University, Najaf Abad Branch) for the guidance.

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