Mohammadi, Mahmood; Shahivandi, Ahmad; Chadgani, Dariush Moradi et al.

Article

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Assessing the Impact of Competitiveness on Urban Network Transformation Using Social Network Analysis (Case: Isfahan City-Region)

Mahmood Mohammadi
Associate professor, Department of Urban Development, Faculty of Architecture and Urbanism, Art University of Isfahan, Isfahan, Iran
Ahmad Shahivandi
Assistant professor, Department of Urban Development, Faculty of Architecture and Urbanism, Art University of Isfahan, Isfahan, Iran
Dariush Moradi Chadgani
Assistant professor, Department of Urban Development, Faculty of Architecture and Urbanism, Art University of Isfahan, Isfahan, Iran
Niloofar Rastghalam*
Master of Urban Planning, Faculty of Architecture and Urbanism, Art University of Isfahan, Isfahan, Iran
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Abstract: The urban network is a collection of large and small cities, each of which, in terms of size and performance, affects the evolutionary process of the area. This study uses the two concepts of competitiveness and urban network to investigate the effective factors in the occurrence and intensification of inequalities in the urban network of Esfahan. In this regard, the changes and transformations of Esfahan urban network during three periods of 1375, 1385 and 1395 with regard to competitiveness indices and considering the distance between cities (based on flow analysis method) and creation of competitiveness matrix, using urban network mapping In the social network analysis (Gephi) software is measured. In this way, for each concept at any given time, a separate network is plotted and analyzed. The results indicate that in the mentioned periods distribution of competitive ability as a stream of capital, labor, and information in the city-region of Esfahan has been unfair. As far as the metropolis of Esfahan with much difference, the gap in the urban hierarchy of city-regions Based on the concept of competitiveness. The second place in comparison with this view belongs to Najafabad and the third place belongs to Falavarjan. In addition, except for a few exceptions, the process of changing cities' competitiveness has been consistent with the process of changing the hierarchy of cities in the same time frame. Therefore, it can be said that the urban hierarchy pattern in the Esfahan urban network follows a competitive ranking.

Keywords: Competitiveness, Urban Network, Esfahan City-Region, Social Network Analysis
JEL Classification: D41, N75, O18, P25

* Corresponding author: niloo.rgh@gmail.com

1- Introduction

From a long time ago, cities have been a platform for struggle, battle, and competition for power (Kamanroudi kajoori et al, 2010). This struggle and competition in the network of developed cities has been accompanied by an industrial revolution and, as a result, the expansion of urban-rural relations and the development of urban networks, in all economic, social, political, institutional and physical dimensions. While in the developing countries which predominantly have colonial past and still dominated by Western economic, political and cultural backgrounds. The process of imbalance in the urban network at the outset occurred under economic and political domination or with the absence and insignificant impact of industrial development and so hurried (Omidvar et al., 2009). This acceleration and imbalance in the urban networks has caused many problems in cities, like as the high density of populations in metropolitan, Marginalization, migration, fragmentation, and the emergence of dormant cities and the loss of urban network balance. One of the concepts that introduced to direct, manage urban growth and development is competitiveness. That has been described in the urban planning texts since the 1990s and has become a major objective in the agenda of the urban planning system (Bellu, et al. 2011). Competitiveness is directly linked to human capital, productivity, distribution of employment, the level of well-being and ultimately the quality of life of the people. In fact, the relationship between competitiveness and these concepts is a two-way communication, that is, competitive cities have a high level of concepts and the existence of these concepts also helps to make cities more competitive (Bristow, 2005). Accordingly, sources and incomes bases are hidden in the competitiveness of the cities. Competitiveness and facilities absorb population just like magnitude and caused an imbalance in the urban networks.

The purpose of this research is to trace the effects of the competitiveness on the Isfahan urban network transformation, consisting of 37 cities approved by Isfahan city-region plan. Therefore, by collecting the variables of competitiveness on the Isfahan urban network transformation and tracing these indices during the period of 1996, 2006 and 2016, and comparing them with the process of how the hierarchical changes of the Isfahan city network during these periods of time, the relationship between these two concepts is examined. The questions that this study seeks to answer are as follows:

- What are the effective competitiveness indices on Isfahan urban network transformation?

- What is the impact of competitiveness on the hierarchy of Isfahan urban network (during the period of 1996, 2006 and 2016)?

2- Literature Review

At the global level, especially in the Europe continent, many studies have been conducted on the concept of competitiveness. One of the most important of these studies is Martin (2012), which has been highlighted as one of the most important reports of competitiveness assessment in the European Union. In this research, the identification and evaluation of competitiveness indicators in Europe and the measurement of differences between countries in each indicator have been addressed and finally, a policy statement has been made to balance the region (Martin 2012).

In another study in 2014, the concept of competitiveness has been addressed with regard to regional economic growth

theory. The results of this study indicate that the economic dimension of competitiveness is considered as the main core of the ideas of economic development and endogenous development and plays a fundamental role in the economic changes of the region (Huggins, Izushi, et al., 2014).

Another study examines the competitiveness of Turkey compared to Brazil, Russia, India, China, South Korea, Malaysia, Colombia, Indonesia, Vietnam, Egypt and South Africa. In this research, according to national competitiveness indicators, using the IMD and WEF method, the studied countries are classified into three homogeneous groups. The results indicate a favorable situation of Turkey's competitiveness in comparison with other countries studied (Arsalan & Tatlıdil, 2012).

Research on urban network thinking can be cited in a study conducted in China in 2015, In this study the objectives include identifying urban networks in China, assessing the factors affecting the formation of urban networks, assessing the role of public services in the following urban networks , The results indicate that three factors of local productivity, flexibility in the supply of housing and urban facilities have been identified as effective factors in the separation of urban network (Glaeser, Ponzetto & Zou, 2015).

In addition, another study in China in 2015 explores how the urban network changes through population size, structure, dimensions, and size of physical space and area. In this research, by mapping the urban network in the 5-year period from 2000 to 2015, these changes have been detected (DIAPPI, 2015).

a) Iranian Researches

One of the studies on competitiveness is the "Regional Competitiveness Space Development Framework in Iran, case: 30 Provinces", which aims to answer two questions: "What is regional competitiveness" and "Why more area competitiveness than other regions" is set. In this research after identification of regional competitiveness factors from different perspectives in the documentary study method, finally, in a constructive manner, using a structural equation modeling model, an integrated model of graceful competitiveness of the provincial regions of Iran has been obtained (Sharifzadegan & Nedayitoosi, 2016).

In addition, another study titled "Measuring the Occupation of the elements of Regional Competitiveness Development in Iran", aims to identify the development frameworks for achieving the region's competitive position, the shortcomings of the common approaches to responding to this question, the extent of the identified impetus In reaching competitiveness, the role of interfering variables in the formulation of causal relationships, conventional models and identifying the specific drivers of the regions of the country as a fundamental and primary step in the development of the theoretical model in the spatial development of regional competitiveness of Iran, is in the agenda of this research with this aim, after examining different definitions of regional competitiveness (as a dependent variable) and identifying the proponents introduced from different theoretical perspectives (as independent variables) by documentary study, obvious variables or profiles are selected and by measuring the causal relationships by path analysis method, the coefficient of importance of the impacts of the propulsion in the context of Iran is determined. In addition, the necessity of providing the required data has made the level of research tied to

provincial areas (Sharifzadegan & Nedayitoosi, 2017).

In addition, other studies on competitiveness, we can mention the "Identification and Prioritization of Effective Root Factors in Promoting Regional Competitiveness of the Case Study: Kurdistan Province". This research, in the first step, developed the regional competitiveness assessment factors consisting of four main factors, 26 criteria and 62 sub-criteria, and in the next step, using these factors and the analytical model of MSA and Excel software, not only analyzing the data collected through the questionnaire but also identify and prioritize the factors affecting the competitiveness of Kurdistan province (Dadashpour & Dadehjani, 2015).

Studies related to the concept of the urban network, a research entitled "An analysis of the residential network with emphasis on population flows in Firouzkooh city" can be noted, which uses social network analysis to measure demographic changes in the urban network. According to the results of this research, the general pattern of Firouzkouh Township is a seasonal, regular and cyclic pattern of population flows that are presented in the form of summer and winter network patterns at the local and regional levels. This pattern is in line with the characteristics of the theory of growth poles and is far from the model of network theories (Azarbad et al., 2010). Another research entitled "Measurement of the Multidimensional Performance Index of the Urban Network in Mazandaran Province" has attempted to provide an indicator for assessing the multi-level functionalities of the area with simultaneous consideration of both functional and morphological aspects of the network. This index examines the potential and capacity for achieving a multicenter balanced structure in a city system. From a methodological point of view, this research is one of the most pragmatic and applied research. In this research, interactive methods and in particular social network analysis method have been used. Functional multidimensional index has been introduced as an indicator for determining the threshold of time and distance in urban networks for implementing a functional multi-level system. This indicator, in view of the intensity of relations between cities of a region and the distance between cities, examines the potential for the formation of a multi-centered system in practice (Mashfaghi & Rafie'an, 2016).

3- Theoretical Background

Competitiveness

Contrary to the many uses of competitiveness, both in academic and in policy-making, there is still no agreement on the meaning and indicators and on how to measure and achieve it. The United States was the first country in the 1990s to establishing a State Council for Competitiveness Policy-Making, takes step in the annual report on the competitiveness of the US economy. Since then, Europe has set up the European Competitiveness Council to produce EU regular competitions reports (Kitson et al., 2004) to bridge the gap with the United States and transform the union into the most dynamic competitive economy by 2010. Based on the definitions provided by the European Competitiveness Council, competitiveness is defined as a process and not a product, with the ultimate goal of increasing the welfare and quality of the inhabitants by increasing and sustaining the productivity

and distribution of wealth and improving the economic performance of the region (Lengyel, 2009), (Snapped & Bruneckien, 2009).

Urban Network

Urban network is a collection of cities and towns that forms the basis and context of urban settlements in a certain area (Shokouei, 2004), (Lotfi et al., 2012). In another definition, the urban network is referred to as a set of connecting points of villages and cities or interconnected rural-urban nodes, which illustrate the system of interconnections and interconnections between villages and cities (Castells, 2005) (Azarbad et al. 1389). In addition, these relations form the system of urban hierarchy relative to the quantitative and qualitative power and position of each element of the system. The first emphasis is on analyzing the urban hierarchy dispersion by the middle of the twentieth century, in which the first city (major city) was considered (Charkhlo et al., 2008). There are several models for measuring the urban hierarchy dispersion, including rank-size, coefficient of variation, entropy index, Lorenz curve, index of four cities of Keynesberg, etc. In this research, the entropy index was used to measure the distribution of urban hierarchy. The relation between the entropy index is as follows: (Asgharpour, 2006)

H = sum of abundance in non-linear logarithms

P = city population ratio to total urban population

Entropy is an unstable criterion for showing equilibrium in a distribution. In this model, unlike other models, the lower the index shows a greater concentration or an increase in concentration or imbalance in the distribution of the population among cities. In contrast, the more the index shows the distribution is moving towards equilibrium (Robbery & Goodarzi, 2009).

Social Network Analysis Method

The network analysis involves expressing the outer reality based on the layout of the points for the elements connected to the lines to the other elements, thus revealing how the elements are interconnected. In the pattern derived from the components of this method, the lines are similar to spider web or a kind of net and represent a real network (Combe, et al., 2010). The "network analysis method" at its simplest level indicates that an element or more has relationship (or interact) with other elements, which, in turn, are related to other elements. (Halgin & Borgatti, 2012), (Duke, 2006).

Network analysis is based on the theory of graphs in mathematics. In this theory, we deal with two sets: set of nodes and set of edges that together make a network. The nodes are the same elements of a network (such as individuals, organizations, molecules, and cells), and the edges are the same relations between elements (like friendship, bio-exchange, flows of capital, goods, energy, and population). Therefore, depending on the nature of the nodes and edges, different networks can be defined (Springer & Steiguer, 2011).

Matrices are the language of data entry to network analysis software, so rows are senders or selectors and columns are receivers or selectable. The analysis unit in the network analysis is "relationship," and hence the main difference between normal data and network data is revealed (Heaney, 2014).

Types of network can be divided into 6 categories including computer network,

bio-networks, artificial neural network, semantic network, fluid network and social network. The social network consists of nodes (which are generally individual or organizational) that are linked by one or more specific types of affiliation such as financial ideas and transactions, friends, kinship, web links, illnesses, and non-communicative links. Social network analysis addresses relationships with verbs and edges. The heads are individual actors in the networks, and the edges are the relations between these actors. A wide variety of edges can exist between the vertices. (Borgatti, 2009) (Butts, 2008) (Combe et al., 2010).

Social Networking Components

Points and Nodes: it includes the network of people, locations, cities or organizations, or indeed any element of the company or group that can be connected to any other elements. Generally, these units are conceptualized as points or nodes, and are typically marked with letters and numbers (Ruane & Koku, 2014).

Link and Connections: The lines between the nodes indicate that these points are connected with a special pattern. The nature of the link can be diverse: the flow of information, money, goods, services, influences, emotions, or any source (reason) that can connects actors (Scott & Carrington 2011).

Undirected relation (symmetric): In an undirected relation, the actor i relates to the actor j, and vice versa.

Directed relation (asymmetric): In a directed relation, the relation between the actor i and the actor j do not necessarily mean the relation between the actor j and the actor i (Ognyanova, 2010).

Social Network Analysis Indicators

Degree: The number of edges attached (connected) to each node is called the degree of that node. This measure indicates the social strength of the node based on the amount of its direct[1] connection in the network. Based on this measure, it is possible to identify the most powerful and influential network actor in such a way that many members of the network to communicate with other members need this member of the network.

In-Degree: Refers to number of edges (essentially directed relation) that enters to a node.

Out-Degree: Refers to number of edges (essentially directed relation) that exits from a node.

Weighted-In/Out-Degree: In networks with weighted edges (relations), the input/ output degree indexes of a node can be calculated by aggregating the weights of the input/output weights of the edges.

Modularity: The amount of this indicator reflects the network's desire to form different clusters in the network and indicates how clustering is networked (Duke, 2006).

Area of Research[2]

The city-region of Isfahan, according to the country divisions of 1996, has 28 urban areas (cites). This number increased to 37 urban areas by the changes that took place until 2003. Thus, the state of Borkharvameimeh includes the cities of Dolatabad, Dastgerd, Khorzuk, Habibabad, Komshecheh, Gaz and Shahinshahr; Isfahan state including Isfahan, Baharestan, Khorasgan and Segazi cities; KhomeiniShahr state

1- Here “direct” refers to “uncomplicated” or “not noncomplex”and does not mean "straight".

2- In this research urban network is considered as city-region.

includes Koshk, Dorcheh, Khomeini Shahr; Falavarjan state including Pirbakran, Baharan, Falavarjan, ImanShahr, Kelishad, Abrisham and Qahdrijan; Lenjan state includes the cities of Kharmayin, Baghbadaran, Zarinshahr, Foladshahr, Chamgardan, Zayanderrood, Varnamkhast, Lenjan; Mobarakeh state including Zibashahr, Talkhoncheh, Mobarakeh, Karkevand, Majlesi, Dizicheh; and Najafabad state including Najafabad, Kaharizang, and Goldashat.

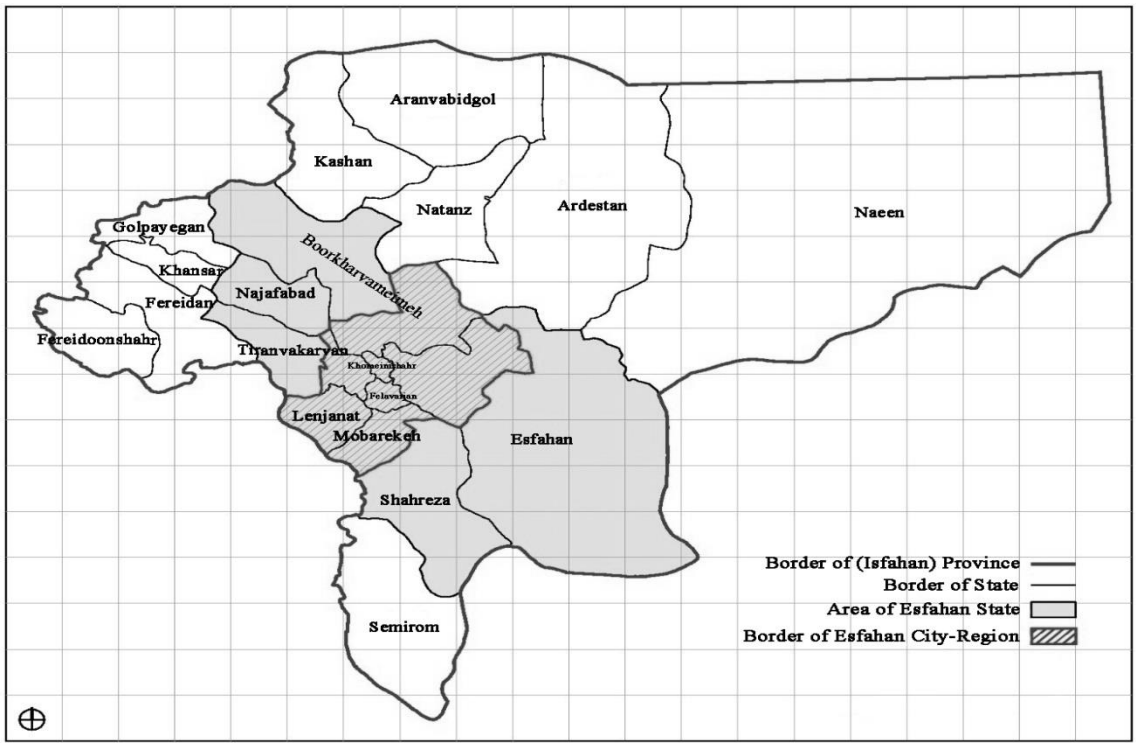

Fig.1. Area of Isfahan city-region in the Isfahan province
Source: (Isfahan City-Region Plan)

Table1. The area of states located in the city-region

State	Total area of state	Area located in city-region (m2)	Percent of located area in city-region (%)
Isfahan	1574.3	2639	16.7
Borkhrvameimeh	7705.1	2448	31.7
Najafabad	2279.8	636	27.9
Lenjanat	1111.2	1111.2	100
Mobarejeh	1020.4	1020.4	100
Felavarjan	315.9	315.9	100
Khomeinishahr	175.3	175.3	100
Total	28382	8345.8	29.4

Source: Authors based on Isfahan City-Region Plan

4- Research Methodology

This research is a descriptive-analytic (in terms of method) and an applied research (in terms of purpose). The statistical population of this research is 37 cities of Isfahan city-region Plan, approved in 2010. The method for collecting data and information in the descriptive phase (including theoretical fundamentals, background and data gathering to build competitiveness indicators) was a documentary study and a text review tool. The sources of data are reports of Isfahan City-region Plan, urban statistics maps &

reports, articles and statistical books of the provincial management and planning organization, results of census of population and housing in Isfahan towns and detailed (blue prints) plans of the studied cities. The method of data analysis in this research is also a social network analysis method (based on graph theory) and using the Gephi software. The basis for using this method in urban studies is the creation of virtual and purposeful networks that are appropriate to the research objectives and questions. Also, in this study, weighted –in-degree was used as the main criterion for comparison and investigation.

In the first step, the jury method (Delphi) and the questionnaire of experts have been used to refine and evaluate the indicators of competitiveness that can be applied in Isfahan. In order to determine the weight of the selected indicators, has been used the hierarchical analysis method and the binary comparison questionnaire completed by the panel (experts). It should be noted that the panel consists of 20 experts in the planning field of Isfahan Province, including experts from the Organization for Management and Planning of the Province (Deputy of Program Coordination and Budget) and professors of the Faculty of Economics of the University of Isfahan. In addition, in order to verifying the combinability of the dependent variable of competitiveness, was used a significant correlation test (Pearson coefficient) in SPSS software. The results of this test indicate that the 14 indicators derived from the Delphi technique have a sig of less than 0.05, and therefore they are fully correlated and combinable.

In the following, in order to prepare the data for entering the Gephi software and drawing the networks at the mentioned periods, different steps have been taken. First, the collected data derived from the Delphi technique for the 37 studied cities is normalized, and the eigenvector derived from the hierarchical analysis technique in the previous has been affected. In the next step, by using the sum of the normal weight of the competitiveness indices of each city, the numerical value of the combined competitiveness of each city was extracted during the years 1996, 2006 and 2016. The output of this stage is the numerical value of the competitiveness of each of the 37 cities studied, which is used as input numbers of the flow analysis method formula. Considering the nature of the flow of competitiveness between the two cities, the factor of distance has been applied as the determining and important factor in the degree of competitiveness between the two cities. In other words, in this research, competitiveness is considered as a stretch, attraction or stream of various indicators (capital, resources, labor, and information) between the two cities, which is inversely proportional to the distance between the two cities. Further, the numbers derived from the flow analysis formula are used as the input matrix for the Gephi software.

In order to evaluate the changes in the urban network, the population index is considered and the entropy index has been used to trace urban metropolis changes and analyze the urban hierarchy dispersion in the urban network of Isfahan during the research periods.

It is worthy of note, in this research, FoceAtlas algorithm is used in Gephi software. This algorithm provides a layout of nodes based on the intermediate forces of the nodes - the degree of repulsion and gravity. In this sense, in this algorithm, all nodes reside in tension equilibrium - like

the placement of stars in a system in space based on the mass and gravitational power of each star. The choice of this software from among the social network analysis software is also due to the existence of this algorithm and its compatibility with the nature of the distance-based competitiveness.

5- Results

Delphi technique has been used to investigate and identify the traceable and effective competitiveness indicators in Isfahan city-region. The results of the Delphi technique and the eigenvector (weight) of the indicators based on the hierarchical analysis method are also presented in Table 2.

Table2. Score and Weight of Final Indicators of Effective Competitiveness in Isfahan City-Region Derived from Delphi Technique

Indicator	Score	eigenvector
Population growth rate	0.882	0.0392
Economic Participation Rate	0.881	0.1498
Employment ratio	0.885	0.1479
The number of industrial workshops	0.881	0.0686
Municipality revenue	0.885	0.0303
The unemployment rate	0.886	0.0940
Literacy rate	0.889	0.0681
Water Access Rate	0.880	0.0153
Electricity Access Rate	0.880	0.0161
Gas Access Rate	0.882	0.0431
Telecommunications Access Rate	0.882	0.0476
Residential per capita	0.852	0.0235
The number of higher education institutions	0.911	0.1356
Number of out-of-town terminals	0.901	0.1209

In the next step, in order to prepare the data for entering the network analysis software and mapping the networks of competitiveness at different time periods, different steps have been taken. In the first step, according to the indicators derived from the Delphi technique, the needed data for these indicators were compiled for 37 cities approved by the Isfahan City-Region Plan for the years of 1996, 2006, and 2016. In the next step, the collected numbers are normalized for the competitiveness indices and the eigenvector derived from the hierarchical analysis technique in the previous step has been affected. Subsequently, by using the sum of the normal weight of the competitiveness indices of each city, the numerical value of the combined competitiveness of each city was extracted in time periods, 1996, 2006, and 2016. The output of this stage is the numerical value of competitiveness of each of the 37 cities studied at the time of research, which is used as input numbers of the flow analysis method formula. Further, the numbers derived from the flow analysis formula are used as the input matrix for the Gephi software.

First Network (1996)

In this research, four network indicators have been introduced to investigate the general characteristics of the competitiveness networks.

Table3. General Characteristics of The Mapped Networks of Isfahan city-region

Modularity	Density	Number of Edges	Number of Nodes
0.171	0.499	666	37

These networks with 37 nodes and 666 edges represent the urban network of the Isfahan city-region and the competitive relationship between each of the towns in the time series studied in the research. The networks' density refers to focus on the number of edges per node, which is 0.499 in these networks, which indicates the average network density and the correlation of competitive relations between cities of the Isfahan city-region. In other words, close to half of the competitive relationship is drawn between the cities of the city of Isfahan and has been neglected from the other half due to the similarity of the relationship. For example, the competitive relationship between Isfahan-Khorasgan and the competitive relationship between Khorasgan-Isfahan is considered the same. The networks' modularity or segmentation coefficient refers to, the amouth of separation of the network nodes relative to each other, which is a very small number due to the competitive relationship between the two cities and the absence of two cities without competitive relations in the urban network of Isfahan. Only the competitive relationship of each city with itself is ignored.

Weighted-in-degree Analysis of the First Network

After mapping the 1375 network, the hierarchical index of the weighted index of this network indicates that the cities of Isfahan, Najafabad and Falavarjan have the highest degree of weighted input in the urban network of Isfahan. Therefore, they are known as the most competitive cities of Isfahan city-region. In other words, it can be said that all network flows and the concentration of capital and facilities have moved towards the city of Isfahan. After the city of Isfahan, the city of Najafabad has been recognized as the most competitive city in the city-region and other members of the Isfahan city-region network have been defeated in the city (except Isfahan). The city of Varnamakhsh and Dizayesh are also known as the least competitive cities in the urban network of Isfahan with the lowest degree of entry.

Analysis of the Relationship between Entropy and Competitive Flow of the First Network

In order to identify the competitive hierarchy of Isfahan city-region in the 1996, this network is considered as the node between the two cities as the edges between the nodes, considering the cities of the research area. It should be noted that the competition stream used at this stage is the numbers derived from the matrix of competitive relationships between the two cities (derived from the previous stages of the research).

In addition, this view of network, the entropy of the population index for the time period of 1996 for each city of city-region on the network nodes is shown using the size and the color, thus Cities with more populations are shown as larger and more intense nodes, and cities are arranged according to the amount of interstitial competition (from low to high) to the clock. In the event of disaster and lack of competition, Isfahan, Najafabad and Falavarjan have the most competitiveness during the period of 1996.

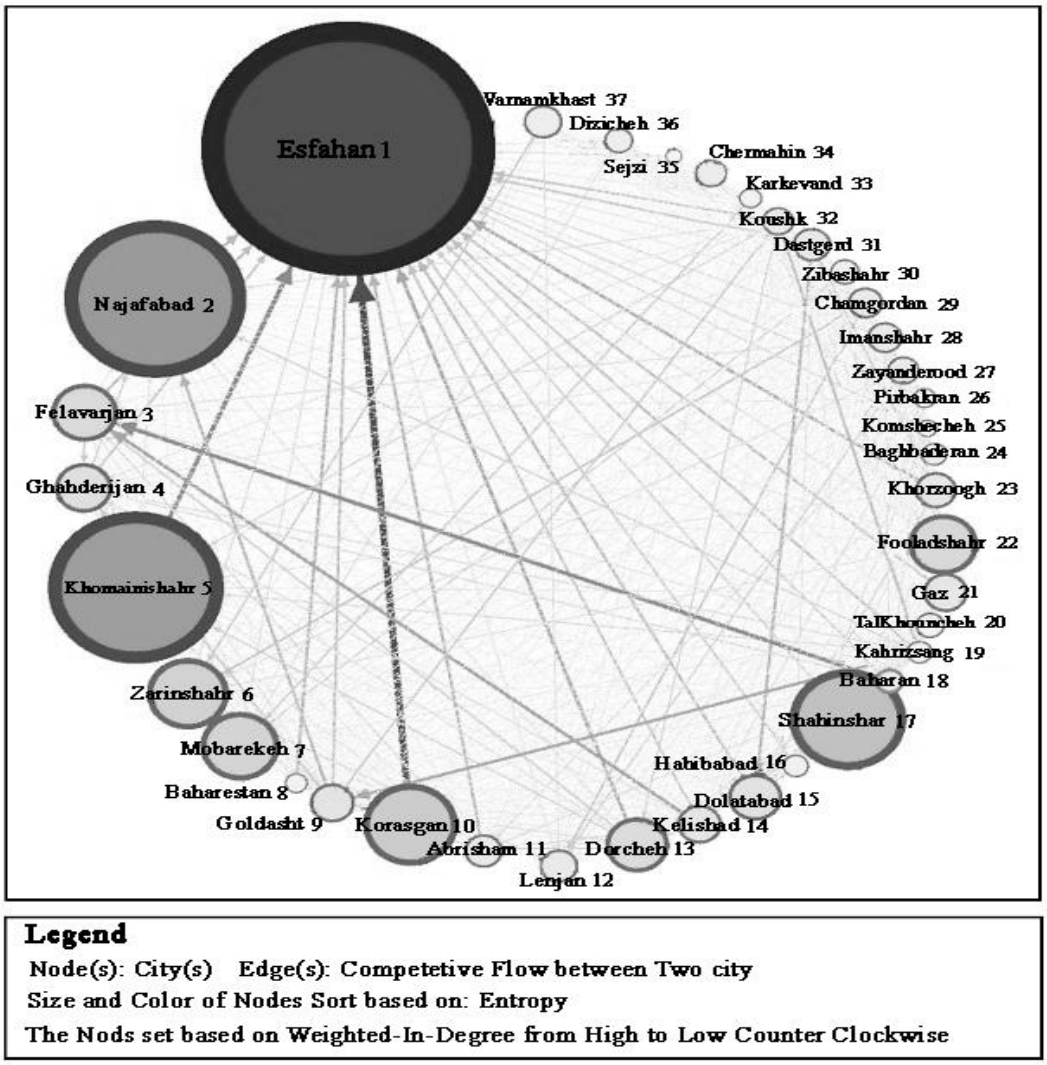

Fig2. The First Network (Relationship between Entropy and Competitive Flow)
Source: (Output of Gephi Software)

The results of the network indicate that there is a direct relationship between the urban hierarchies derived from the entropy index of most cities in the city-region with the competition between urban cities of Isfahan. In addition, the competitiveness and entropy index of several cities are not directly related to this, but these cities include:

- Shahinshahr and Khorasgan, which unlike the low competitiveness level in 1996, attracted a good population. The reason for this can be seen at the appropriate distance between these two cities by Isfahan and the possibility of residents to benefit from the facilities of the metropolis of Isfahan.

- Falavarjan and Ghadrijan, which, unlike the high competitiveness, failed to attract the right population. The reason for this can be attributed to the policy of preserving (freezeing) the arable and agricultural lands of these two cities.

Modularity Coefficient Analysis of the First Network

At this time, competitiveness at the area of the city-region is detectable in 4 cluster. The cluster consists of gathering cities that are connected to each other in exchanging capital flows, information, goods and facilities. The clusters usually

have a larger core and surrounding neighborhoods, meaning that several cities with a distinct city center are in the midst of competitive exchanges. In addition, clusters can affect many cities. The distinctive features of the use of the ForceAtlas algorithm are the adaptation of the obtained clusters and the location of the urban cities of Isfahan, so that the algorithm estimates the positioning of each node in relation to other nodes by establishing tensile relations between the nodes of each node. This research, based on the information entered into the gypsum software (the degree of competitiveness between the nodes), is shown in relative compliance with the location of urban cities of Isfahan.

At the time of 1996, Isfahan has become more concentrated in the cluster of western cities (such as Khomeini Shahr, Najafabad, Kooshk, Goldasht and Qahdrijan). In other words, in this period, the flow of capital and facilities was mostly influenced by the mentioned cities and, of course, towards Isfahan.

In addition, the southwest cluster (centered on the Zobahan highway) is formed around the cities of Mobarakeh, Zarinshahr and Lenjan, which shows the greater power of these cities in this area in terms of competitiveness.

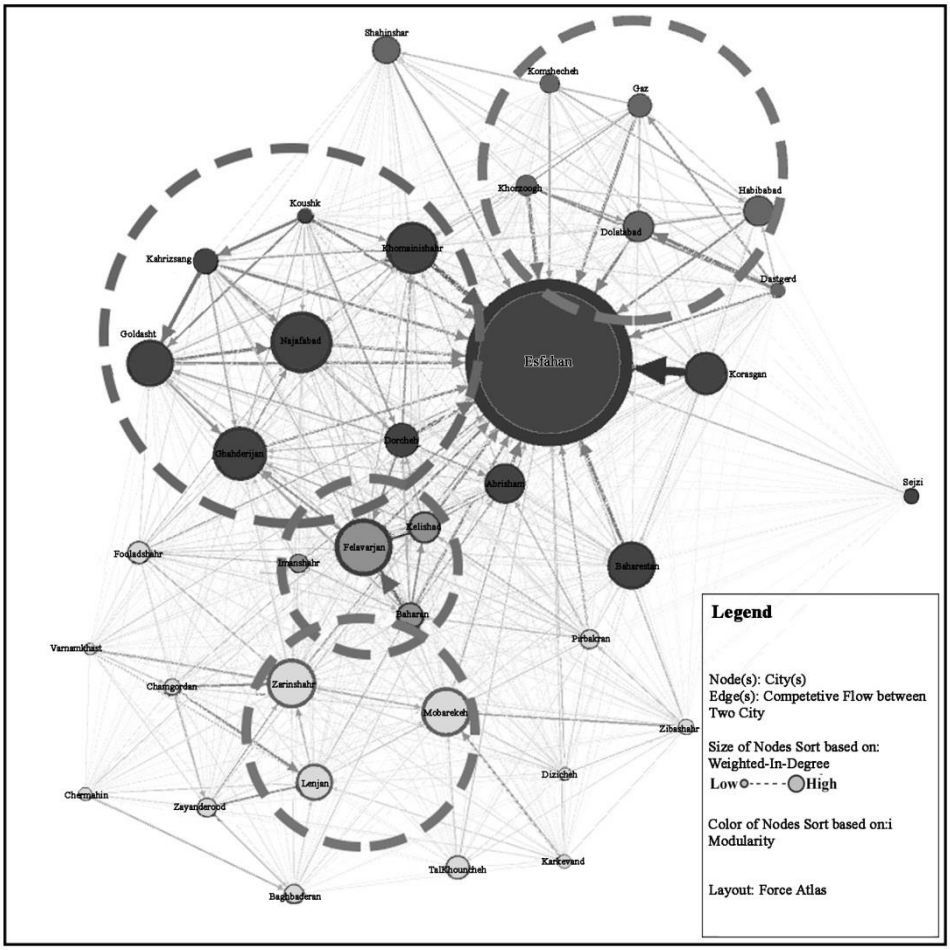

Fig3. The First Network (Distribution of Competitiveness Clusters)
Source: (Output of Gephi Software)

Second Network (2006)

Weighted-in-degree Analysis of the Second Network

In mapping the second network, cities as the nodes and competitive relationships between the cities of the Isfahan city-region (derived from the previous stages of the research) were mapped to the network's edges during the year 2006. The results of the analysis of the index of the weighted-in-degree of this network indicate that at the time of the year 2006, as in the time period of 1996, the highest amount of weighted-in-degree in the urban network of Isfahan was obtained for Isfahan, Najafabad and Falavarjan. Therefore, these three cities dominated the competition in 2006 and the metropolis of Isfahan is also known as the single most dominant urban network.

During 1996 and 2006, the city of Dastgert has had the highest rise in the rate of attraction of the competitive flows of Isfahan urban network. In addition, the city of Varnamakhsh and FouladShahr and Mobarakeh have also had significant rise.

Analysis of the Relationship between Entropy and Competitive Flow of the Second network

In the second network, after the influencing the population entropy index on the network nodes and the analysis of the hierarchy of this index and its comparison with the hierarchy of the competitiveness of city-region of Isfahan in the 2006, the results indicate that the urban hierarchy derived from the population entropy index has a direct relationship with the degree of competitiveness in this time. In addition, compared to 1996, this relationship has moved towards greater compatibility. In the network, the competitiveness and the entropy index of several cities are not directly related to this; these several cities are:

- Khorasgan, which is still (like the 1996), has attracted a good population, despite the low competitiveness level. The reason for this can be seen in the proper distance between the city and the possibility of residents to benefit from the facilities of the metropolis of Isfahan.

- Falavarjan and Ghadrijan and Gaz, which, unlike high competitiveness, failed to attract the right population. The reason for this, like the network of 1996, can be attributed to the preservation of these two cities for arable and agriculture, the results of this study indicate that these cities are ready to attract the surplus population of Isfahan.

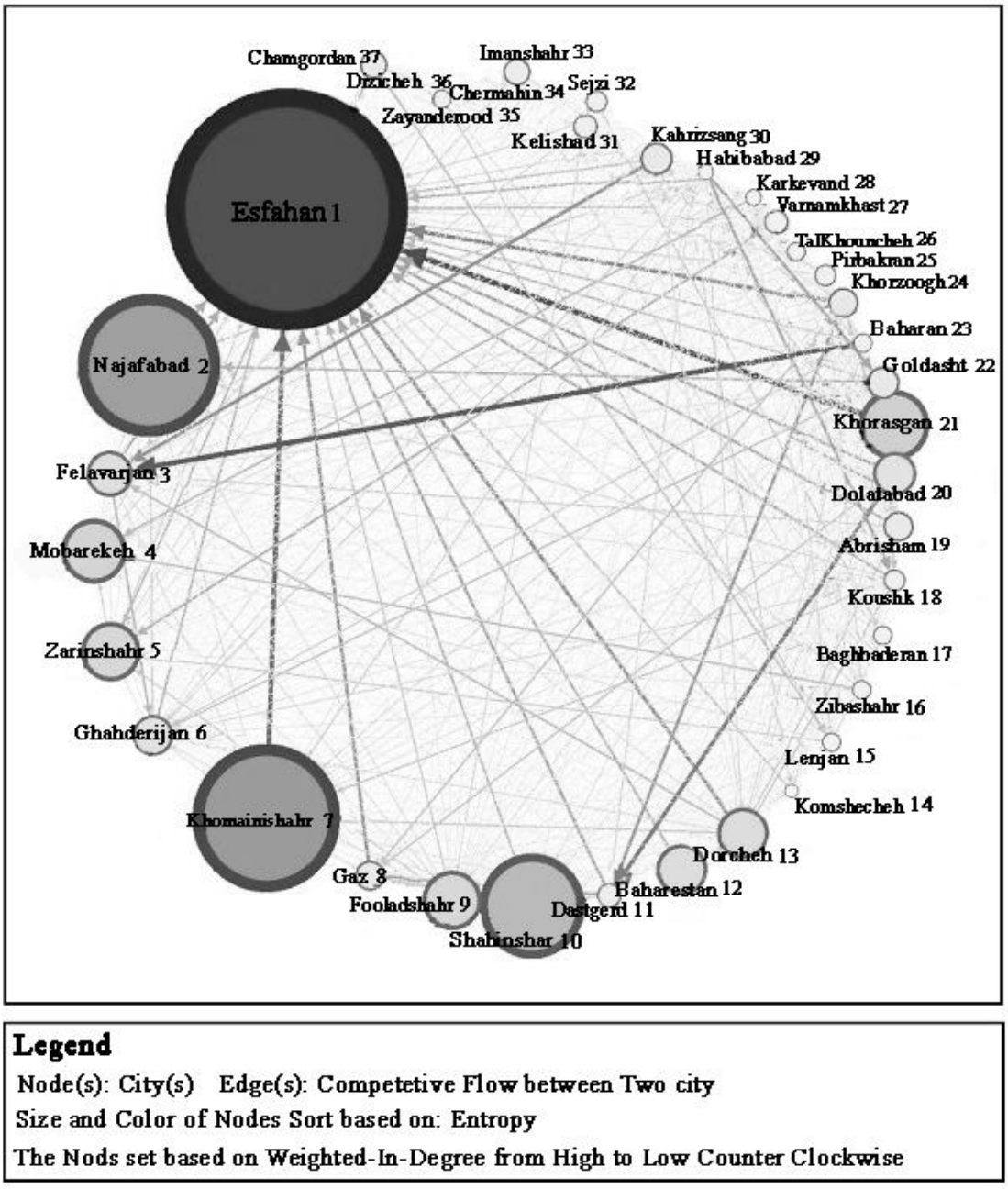

Fig4. The Second Network (Relationship between Entropy and Competitive Flow)
Sources: (Output of Gephi Software)

Modularity Coefficient Analysis of the Second Network

At the 2006, the towns of Isfahan city-region are detectable in three cluster. At this time, the number of clusters decreased compared to the 1996, which means that the concentration and homogeneity of Isfahan city-region is more competitive at this time. In this way, the cluster (Falavarjan-Baharan-Kilashad-ImanShahr)[1] has been destroyed and merged with two closely related clusters.

At this time (2006), the city of Isfahan is located in a cluster, most of which includes northeastern cities (such as Gaz, Khorzuk, Dolatabad, Komeshcheh, Dastgerd). This means that the flow of

1- This cluster is in 1996 network (Figure 3)

capital and facilities at this time is more from the said cities towards Isfahan. In other words, at this time, the competitiveness of the city-region of Isfahan is more focused on the northwest.

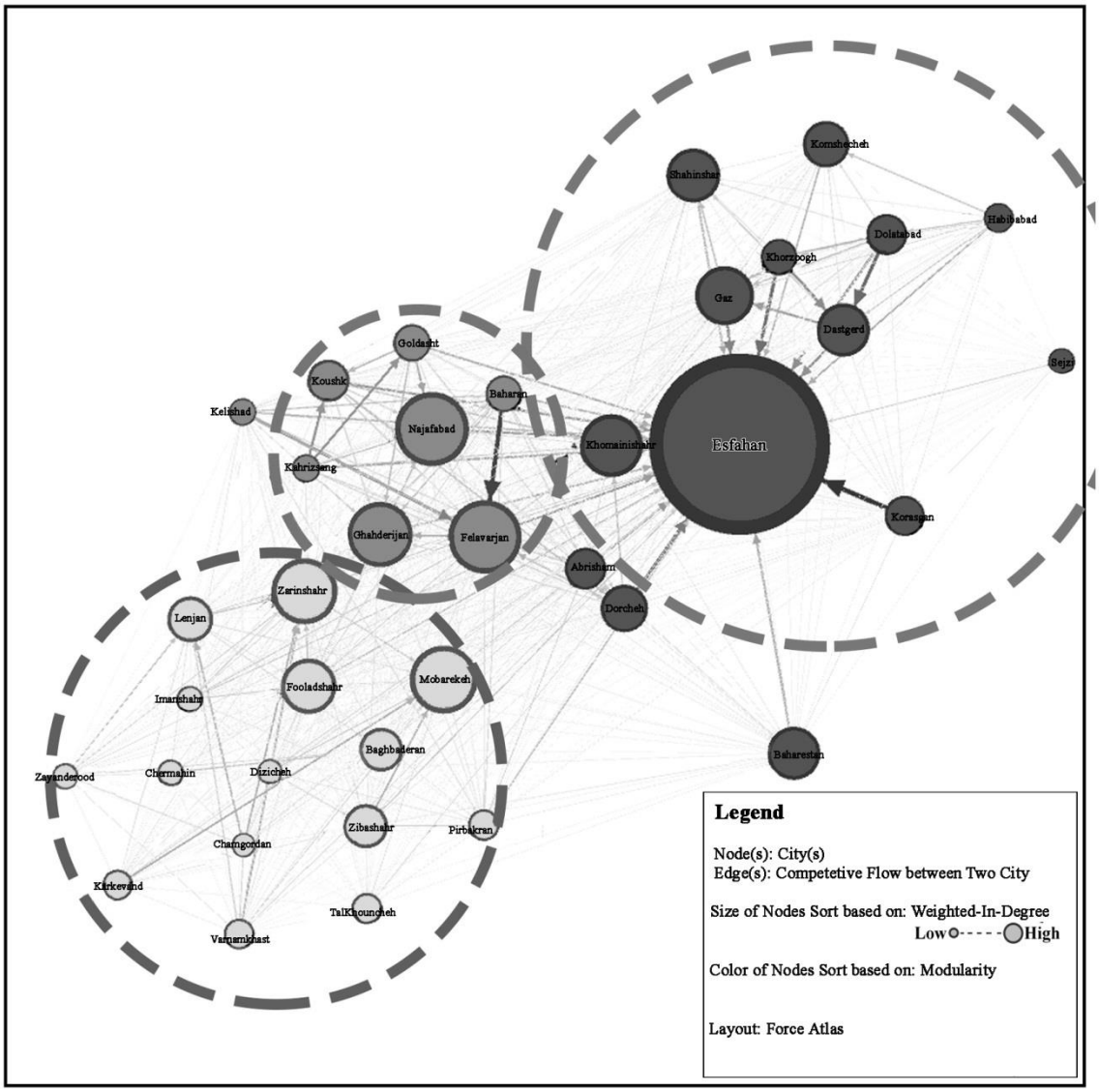

Fig5. The Second Network (Distribution of Competitiveness Clusters)

Sources: (Output of Gephi Software)

Third Network (2016)

Weighted-in-degree Analysis of the Third Network

In the third network same as the previous networks, cities of the city-region of Isfahan as nodes and competitive relationships between these cities at the time of 2016 were considered as edges, the results of the analysis of the weight index at this time, as in the previous periods, indicate that The cities of Isfahan, Najafabad and Falavarjan have the highest rates of weighed-in-dgree in the urban network of Isfahan. Repeating the first to third ranks in the three times[1] of the study indicates the stability of the competitive flows between urban cities towards these three cities.

1- 1996, 2006 and 2016

Analysis of the Relationship between Entropy and Competitive Flow of the Third network

The results of the influencing of the population entropy index on the network nodes of 2016 indicate that, as in previous periods, the Shahinshahr[1] has more than expected growth in proportion to the competitive flow of population. In addition, FouladShahr[2] has one of the most significant urban network rises during the studied time of this research. This is despite the fact that the new city of Baharestan did not have a significant Rise. It should be noted that the influence of the city of Khorasgan due to integration with the city of Isfahan in 2013 has been ignored in this network.

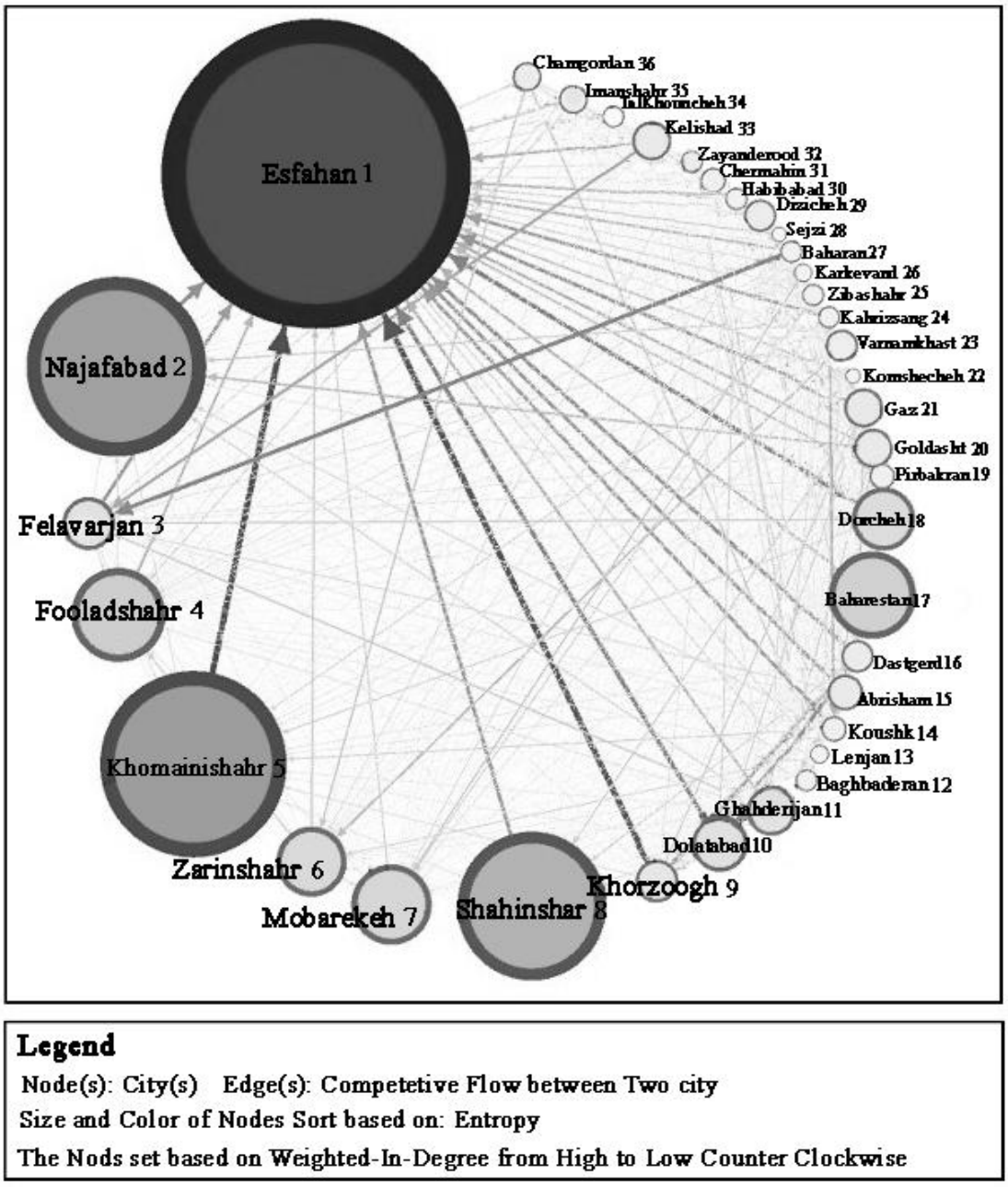

Fig6. The Third Network (Relationship between Entropy and Competitive Flow)
Source: (Output of Gephi Software)

1- This is a new city
2- This is a new city too

Modularity Coefficient Analysis of the Third Network

At the 2016, as in the 2006, competitiveness in the city-region of Isfahan can be traced in three clusters. At this time, the city of Isfahan is located in a cluster, most of which are northeastern cities of Isfahan. In other words, this means that the flow of capital and facilities at this time is more than that of the said cities towards Isfahan. In other words, at this time, the competitiveness of the city-region of Isfahan is more focused on the northwest. In addition, compared to the 2006, the northwest cluster has been in more exchange and attraction with Isfahan.

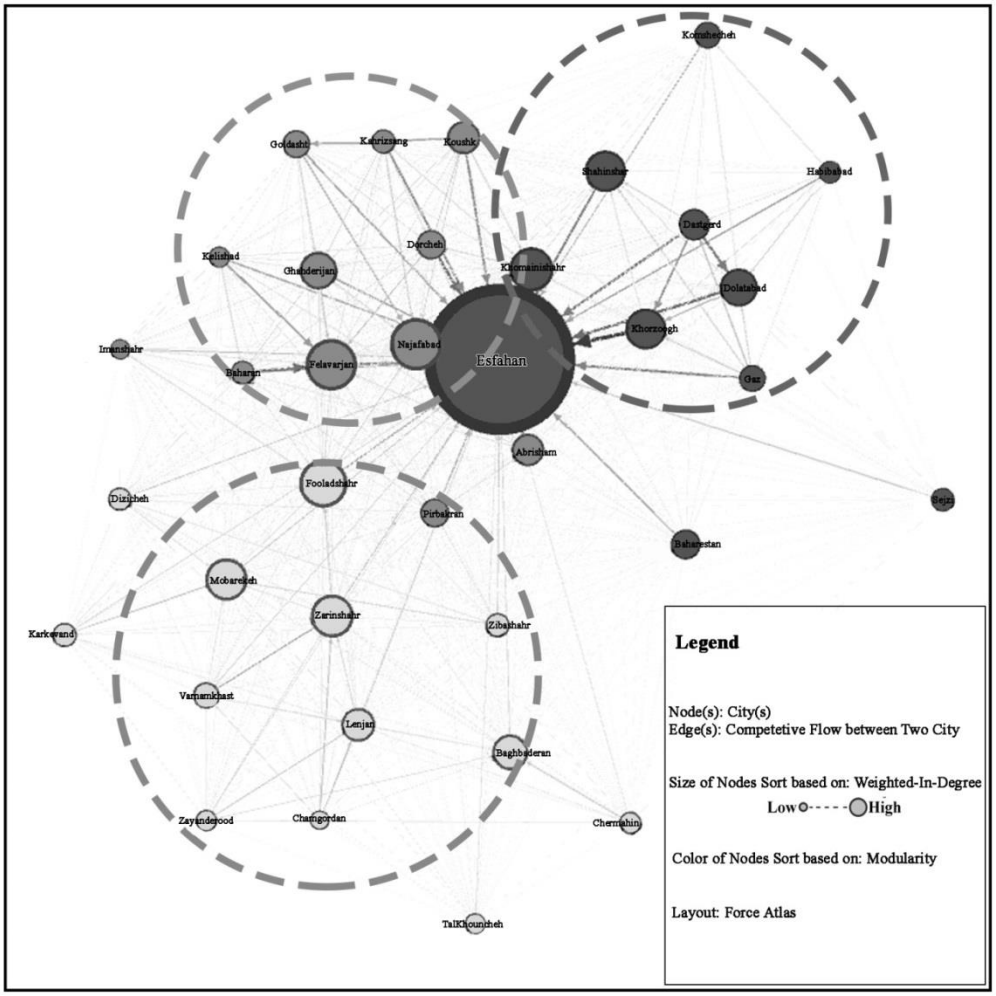

Fig7. The Third Network (Distribution of Competitiveness Clusters)

Source: (Output of Gephi Software)

In all three-research periods, the most competitive cities of the urban network are Isfahan, Najafabad and Falavarjan. In the interpretation of this result, we can focus on all the facilities of Isfahan and other cities of Isfahan Provenance in the metropolis of Isfahan. The city of Najafabad is also one of the most densely populated cities of Isfahan province as one of the conurbation cities of Isfahan. In the Falavarjan, as one of the most competitive cities, there is a population acceptance capacity and expansion of this city. However, due to the large urban policies that maintain the Lenjanat area[1] as the agricultural pole of Isfahan province, this region has survived the development and increase of population. . It should be

1- City of Falavarjan is located in the Lenjanat State (here "state" has smaller scale than Provinance)

noted that other towns in Isfahan city-region follow a direct relationship with the competitiveness variable.

The following diagram is illustrated in order to trace the competitiveness in the urban network of Isfahan:

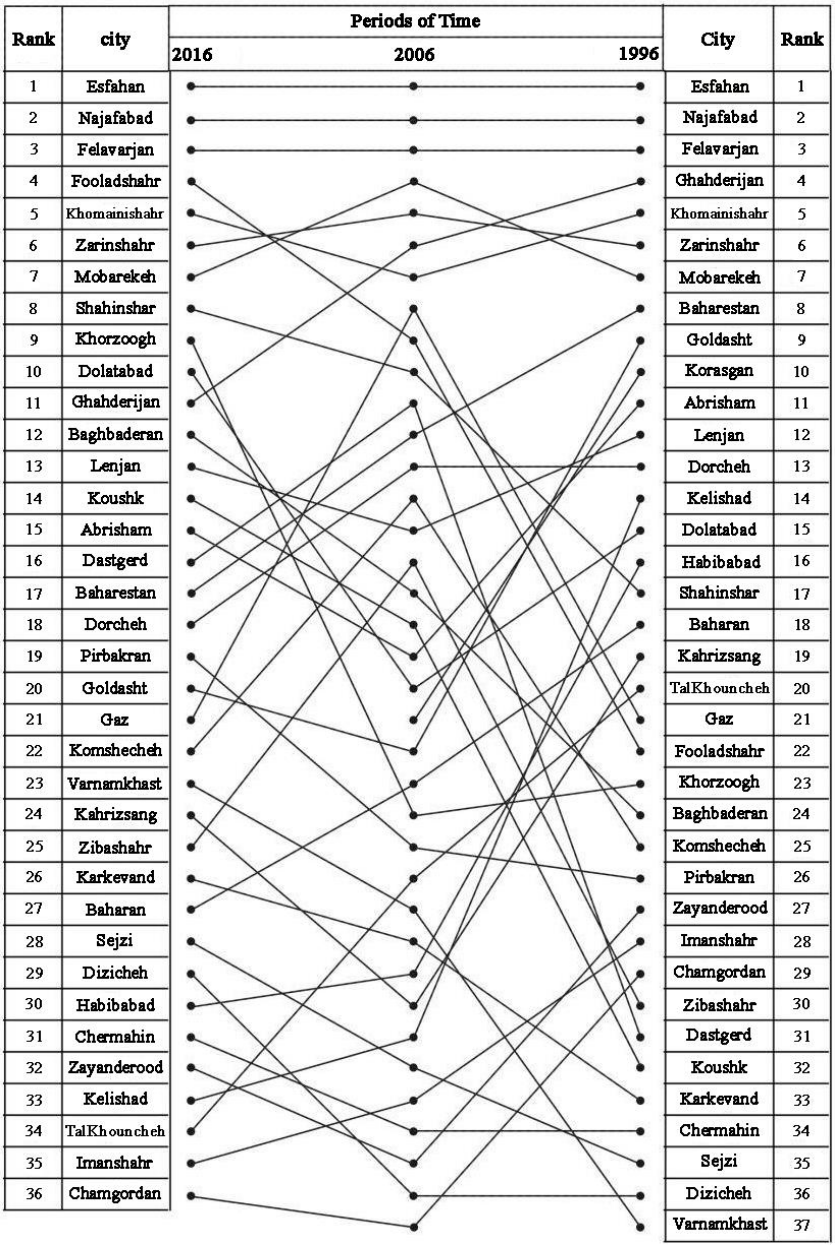

Fig8. The process of change in the competitiveness in 3 studied time of research

According to the Figure 8, the towns of Isfahan may be studied in the 7 following categories:

1- "Constant" trend of competition in research periods: Three cities of Isfahan, Najafabad and Falavarjan have had a steady trend between 1996 and 2016 and have always been in the first to third place in terms of the competitive flow of the network.

2- "Rise-Rise" trend of competition during research periods: Shahinshahr, FouladShahr, baghbaderan, Pirbakran, Koshk, Karkevand, Sejzai and Varnamkhast are among the cities that have been rising in the time periods of the research concerned.

3- "Constant-Rise" trend of competition during the research period: The two towns of Dizicheh and Chermahin have a

steady trend during the period of 1996-2006 and have Rised during 2006-2016.

4- "Descent-Descent" at times of research: Ghahdrajian, Baharestan, Kilashad, Habibabad, Baharan and Talekhoncheh cities in the two periods of the research period in terms of the amount of competitive flow with other cities have decreased.

5- "Constant-Descent" Trend in the time period of research: Dorcheh has a steady trend in the period from 1996-2006, after which it has decreased in the next period.

6- "Rise- Descent" trend at times of research: Mobarakeh, Zarinshahr, Gaz, Komshecheh, Zebashar and Dastgard cities in the time periods of research were first to rise and then to decline.

7- "Descent- Rise" trend during the research period: Cities like KhomeiniShahr, Goldasht, Abrisham, Lenjan, Dolatabad, Kahrizzang, Zayandehrud, Chamgradan and Khorzuk are the cities that have decreased in the first time and then Rise.

In addition to the above, during the period of 1996-2006, there have been major rises and Descents, including the high climbs that can be found in the ascents of the cities of Varnamakhsh, Kooshk, Dastgerd, Zebashr, Goghbadaran, Keshcheh, Gaz, and FouladShahr. Also, among the big Descents at this time, we can mention the descent of Habibabad, Kelishad, Goldasht, Kahrizzang and Khorasgan cities.

At the time of 2006-2016, one of the major rises can be mentioned Khorzuk, Dolatabad and Dizicheh.

The table 4 shows the numerical variations in the competitiveness of cities of in Isfahan urban network during the studied periods.

Table4. Amount of Competitiveness of the studied cities in the studied times

Rank	City	Competitiveness in 1996	Rank	City	Compet-itiveness in 2006	Rank	City	Competitiveness in 2016
1	Isfahan	72.7	**1**	Isfahan	77.1	**1**	Isfahan	123.6
2	Najafabad	23.2	**2**	Najafabad	24.6	**2**	Najafabad	30.7
3	Felavarjan	21.4	**3**	Felavarjan	24.3	**3**	Felavarjan	29.7
4	Ghahderijan	19.6	**4**	Mobarakeh	21.5	**4**	FooladShahr	26.7
5	Khomeinishahr	18.8	**5**	Zarinshahr	20.6	**5**	Khomeinishahr	22.8
6	Zarinshahr	17.6	**6**	Ghahderijan	20.0	**6**	Zarinshahr	21.8
7	Mobarakeh	17.5	**7**	Khomeinishahr	19.0	**7**	Mobarakeh	21.3
8	Baharestan	16.8	**8**	Gaz	17.1	**8**	ShahinShahr	20.2
9	Goldasht	16.4	**9**	FooladShahr	15.4	**9**	Khorzugh	19.9
10	Khorasgan	14.4	**10**	ShahinShahr	14.6	**10**	Dolatabad	17.1
11	Abrisham	13.2	**11**	Dastgerd	14.3	**11**	Ghahderijan	16.8
12	Lenjan	11.7	**12**	Baharestan	14.2	**12**	Baghbaderan	15.0
13	Dorcheh	10.5	**13**	Dorcheh	11.4	**13**	Lenjan	13.1
14	Kelishad	9.5	**14**	Komshecheh	11.0	**14**	Kooshk	12.6
15	Dolatabad	9.1	**15**	Lenjan	10.7	**15**	Abrisham	11.9
16	HabibAbad	8.8	**16**	ZibaShahr	9.8	**16**	Dastgerd	11.0
17	ShahinShahr	7.6	**17**	Baghbaderan	9.7	**17**	Baharestan	9.4
18	Baharan	7	**18**	Kooshk	8.8	**18**	Dorcheh	9.1
19	KahrizSang	6.4	**19**	Abrisham	8.6	**19**	Pirbackran	8.8
20	Talkhoncheh	5.7	**20**	Dolatabad	8.3	**20**	Goldasht	7.7
21	Gaz	5.7	**21**	Khorasgan	7.8	**21**	Gaz	6.6
22	FooladShahr	5.3	**22**	Goldasht	6.7	**22**	Komshecheh	6.5
23	Khorzugh	4.2	**23**	Baharan	6.2	**23**	Varnamkhast	6.2
24	Baghbaderan	4	**24**	Khorzugh	6.1	**24**	KahrizSang	4.3
25	Komshecheh	3.7	**25**	Pirbackran	3.6	**25**	ZibaShahr	4.2
26	Pirbackran	3.7	**26**	Talkhoncheh	3.4	**26**	Karkevand	4.2
27	Zayandehrod	3.6	**27**	Varnamkhast	3.3	**27**	Baharan	3.9
28	ImanShahr	3.4	**28**	Karkevand	3.2	**28**	Sejzi	3.7
29	Chamgordan	2.1	**29**	HabibAbad	3.0	**29**	Diziche	3.4
30	ZibaShahr	1.9	**30**	KahrizSang	2.1	**30**	HabibAbad	2.7
31	Dastgerd	1.3	**31**	Kelishad	1.7	**31**	Chermahin	2.4
32	Kooshk	1.3	**32**	Sejzi	1.4	**32**	Zayandehrod	1.6
33	Karkevand	0.78	**33**	ImanShahr	1.3	**33**	Kelishad	1.4
34	Chermahin	0.76	**34**	Chermahin	1.2	**34**	Talkhoncheh	1.1
35	Sejzi	0.56	**35**	Zayandehrod	1.0	**35**	ImanShahr	0.4
36	Diziche	0.36	**36**	Diziche	0.7	**36**	Chamgordan	0
37	Varnamkhast	0	**37**	Chamgordan	0	**37**	Khorasgan	-

6- Conclusion and Discussion

The urban network, from the perspective of its spatial dimension and how cities are deployed and distributed in terms of size, population and also its economic meaning, including the amount of exchange and trade between cities based on their basic functions, is both the result and the many causes Of the contemporary urbanization phenomena. The dynamics of any urban network depends on its internal or external relations and the amount and the way cities are relateed to each other within the network. Any action in the urban network will make extensive changes in other city of the network and will result in a balance or imbalance of the urban network.

The process of imbalance in the urban network is influenced by several factors, including industrialization, the concentration of facilities and welfare facilities, as well as inappropriate actions in the distribution of income sources. These factors, in addition, disrupt the order and balance of the urban network; cause other problems, such as migration, marginalization, dormitory of satellite towns, creating a gap and a sharp distance between metropolises and other small towns, etc.

The concept of competitiveness as an effective factor in attracting population, capital, facilities ... plays an effective role in balancing urban networks. Therefore, this research seeks to establish a link between the two meanings of the urban network and competitiveness and how these two perceptions are influenced by each other.

In this regard, the Isfahan City-region composed of 37 cities has been selected as the target area of research and has been traced to the changes in the concept of competitiveness as well as the hierarchical changes of the urban network. For this purpose, after collecting the theoretical, technical and practical frameworks, 52 indicators have been identified for competitiveness, and these indicators have been placed on the panel of experts with the aim of tracking the competitiveness transformation.

The results of this study indicate that 14 indicators play an important role in assessing competitiveness on urban network transformation. In the following, the values of these 14 indicators are collected for the 37 cities studied and normalized.

In the next step, the coefficients derived from Analytic Hierarchy Analysis (AHP) have been affected to these values and using the weight gain, the combined amount of competitiveness for the cities studied was obtained in three periods of 1375, 1385 and 1395. These numbers enter the formulas of the flow analysis method and the output of this formula has entered the 37 × 37 matrix into the gephi software. In the following three networks were mapped during the years 1375, 1385 and 1395, which in each network cities of Isfahan city-region as nodes and competitive relations between cities of Isfahan city-region is considered as the edges between cities.

Additionally, the hierarchy and the way cities are arranged based on the competitiveness of each city, and in order to better compare, the trend of changes in the entropy index of the nodes has been affected by size and color. The results of these three networks indicate that the cities of Isfahan, Najafabad and Falavarjan in each of the three periods have attracted the most amount of competition (including capital, information and facilities), and the difference between the three cities, the city of Isfahan, Separated from other

cities of Isfahan city network and created a significant gap in this network. Also, the process of changes in the population entropy index (except for some exceptions) is consistent with the hierarchical process of competitiveness in the urban network of Isfahan.

According to the results of the research on the existence of a significant gap in attracting competition through the metropolitan area of Isfahan in the urban network, we propose the following:

- Prevent the concentration of facilities and capital flow in the metropolis of Isfahan in order to distributing proportional population in the urban network of Isfahan
- Using the competitive potential of other cities in the Isfahan City-region such as Najafabad, Khomeini Shahr, Shahinshahr, Falavarjan and Ghahdrajn in order to attract the surplus population of Isfahan.
- Increasing competitiveness indices, especially economic indicators (including employment) in disadvantaged cities in attracting the competition in the urban network of Isfahan
- Increasing general amenities such as health services, higher education services, etc. in disadvantaged cities in attracting the competition in the urban network of Isfahan Strengthening the economic performance of the city of
- Falavarjan in the field of agriculture with the aim of increasing the attraction of the competition in the urban network of Isfahan as one of the economic indicators of competitiveness and also attracting the surplus of the metropolitan population of Isfahan.

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