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**INVESTIGATION ON SOLUTIONS FOR SINGLE-CORE TO MULTI-CORE
CONVERSION OF SPATIAL STRUCTURE USING ANP MODEL- CASE STUDY:
HAMADAN CITY**

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ABSTRACT

Today, the newfound phenomenon of cities and multi-core and multi-central urban regions is conspicuous in most of metropolises in the world. Therefore, the phenomenon of multi-core cities in wide regions and metropolises requires exact practical investigations and studies. There is no doubt this newfound phenomenon is the urban form in 21st century. It is attempted in the present investigation to access some solutions for improving the efficiency of transport system in order to regulate the single-core structure into multi-core structure in Hamadan city. The present investigation proceeded to investigate on the solutions for single-core to multi-core conversion of spatial structure using descriptive-analytical method and in this regard, ANP model is used to analyze data and collected information. It is understood from the results of the investigation that the existing spatial distribution system of Hamadan metropolis is extremely inefficient and this structure is extremely single-core and in this regard, it is proceeded to present the multi-core organizing plan of city in order to solve the urban problems.

Keywords: Spatial Structure of city, Single-core pattern, Multi-core pattern, Hamadan

INTRODUCTION

One of the fundamental problems which is due to unsuitable spatial structure and modern urbanity is subjected to, is the irregular development of metropolises. At this time, many efforts which are carried out

to improve this situation and to conduct and control the changes in city form have remained futile. This lack of success is due to the problem that the change in city structure which is forming based on

interactive and complicated effect between market forces, public investments and criteria and regulations is not often investigated or followed up. Consequently, the major inefficiencies which are due to weakness of spatial structure are often unconsidered. The urbanization and urbanity process encountered various problems in critical and transitional conditions of society which among them is the unsuitable spatial structure (Soltani, 2001: 43). The physical structure of cities depends on various and interactive relations between all existing forces and factors. This spatial structure is one of the main reasons for inefficiency in modern metropolitan level which depends on numerous factors such as: market force, activities, urban infrastructures and various services, etc. this affair has achieved higher appearance especially in developing countries because of the weakness in service systems in metropolitan scale. In recent decades, the huge irregular and non-programmed invasion of rural population from villages to towns and from towns to moderate cities and from moderate cities to large cities and metropolises is one of the problems of urbanization in developing countries which has resulted in lack of succession in urban and regional planning in metropolitan areas of these countries (Ziari, Razaqi and Ziari, 2010). According to effects of city physical

environment on lives of citizens, it is necessary to proceed to the discussion of recognizing the pattern of city spatial structure and the factors affecting it in order to conduct the changes in a suitable direction (Hasanzadeh Ronizi, 2008). The inefficient spatial structure caused inappropriate distribution of uses. It also resulted in higher costs of exchanging because of the increase in distance between the origin and destination and this problem causes increase in the length of urban and capital expenditure infrastructures and its current infrastructure (Ziari et al, 2012).

With this introduction, Hamadan city is challenged because of being placed among historical cities and having national and hereditary esteems on one hand and also because of having urbanity problems. The present investigation follows several aims and attempts to achieve them; organizing the single-core structure of Hamadan to multi-cores using ANP and accessing some solutions in order to improve the efficiency of transport system. According to main factors of converting single-core spatial structure to multi-cores structure and based on the aims, the assumption of the investigation is that by changing the single-core structure of the city to multi-cores structure and by generating numerous focal points, future development and conduction of the city, distribution of uses and more

logical services may be generated in the city and also the out-of-place traffic may be reduced in the central core.

Various investigations have been conducted in this domain which among them, two following cases could be mentioned: Farhangi (2004) has proceeded to spatial investigation and analysis of Karaj city in order to present strategies for its future development. The studied subject is one of the new-aged subjects in area of urban planning discussions. Specifically, Alain Bertaud who is a prominent researcher and thinker has proceeded to investigate on this subject until now and this subject appears in his published works. Bertaud's reports is also published in two consequent volumes of human habitation periodicals for public use as the topic of "spatial structure of Tehran city, limitations and opportunities for future development" in the framework of cooperation with the ministry of roads and urban development and world bank about receiving bank loan for the program of "urban optimization and population modifications". The basic aims of Bertaud's reports are in order to improve the spatial structure of Tehran metropolis, reduce the pollution, improve the transport system and develop the cultural facilities.

Method of investigation

The type of research is "applicable-developmental" and its method of

investigation is "analytical-descriptive". The descriptive method includes: collecting the required information of the research through library studies (documents) and collecting the statistical data and also conclusions and it is comparative. In this investigation, the technique of data collection is used which includes documents, observations and documentation. In this regard, the method of network analysis process or ANP is used. The method of analyzing past documents and studies is investigated and discussed in historical change trend of Hamadan city structure. The aim of historical study of past events among studies is comparative studying of historical events and studying the causality of past events on current spatial structure (Nabavi, 2009, 125). Hence, the aim of this investigation is to plan and exactly locate other cores in order to make the city multi-cored and correlate the cores to each other in terms of occupation, economic, cultural-social, relational and informational currents which are correlated to each other through the roads and railroads, etc. the city would become a connected network in this pattern.

The studied sample

Hamadan is one of the western provinces of country with an area of 19445 km² and includes 1.19 percent of whole country. Its boundaries are limited to Hamadan province from north, Lorestan province from south,

Markazi province from east and Kermanshah and Kurdistan provinces from west. This province is a region that is mainly mountainous which is among the internal mountains of Pishkooch in Zagros (Qahramani Motlaq, 1996: 55). Hamadan metropolis is a city which has one core or central core with a population of 525729 people which is formed according to economic, physical factors and communicational infrastructures in city center. In this traditional model (single-core), all structures of activities are placed in central point of city which is the CBD of city and all laborers and residents were travelling from suburbs to trade center and center of city activities (Mori, 2008, 1).

Theoretical basics

Spatial structure

The spatial structure of city is the production of historical processes and metabolic economic-social and political conditions. The spatial structure of city includes physical structure of city. Spatial structure of city is a relatively stable way of elements form and city factors which their quality of establishment and the way of their communications are organized through a specific degree of discipline and operational capacity (M.M City and house, 2003, 10).

Recent vicissitudes which are carried out in economic and social level and have extremely influenced the spatial

development of cities, development of services part and also concentration of industries and factories in cities have caused to absorb many people from villages and towns to large cities. Rural migration to cities plays an important role in creating the concentration and excessive crowd in cities (Mashhadizadeh, Dehqani, 1968, 55).

The spatial structure of cities depends on various and interactive relations of all forces and factors existing in city. These factors may be including: market force, activities, urban infrastructures and various services which have been in a complicated relations between each other and sometimes this complexity is even an obstacle for achieving a suitable pattern of city development and construction in large scale and planning and regulation of urban policies in its scale. One of the fundamental problems of modern urbanity is irregular growth and development of metropolises and their urban region and the existing inefficiencies are mainly due to the industry of its spatial structure. The inefficient spatial structure causes inappropriate distribution of uses and also results in higher costs for exchanging because of increase in the distance between origin and destination and this problem causes increase in the length of urban infrastructures networks and investment costs and its current costs (Ziari, Razaqi and Ziari, 2010).

Multi-core pattern

The assumptions of this theory were at first investigated by Mackenzie in 1933. This theory denies figurative imaginations in two radial and concentric circles theories as well as spatial central trend and it introduces a variety of urban places that each one has its physical and social and economic characteristics (Ballchin et al, 1995). One of the reasons for urban core appearance is just the existence of given and professional activities in the region or some corners of city (Shokuyi, 1997, 164). The multi-core pattern appears in various spatial scales like urban or in-region scale or regional scale like Europe. The main characteristic of these centers is their different degrees of being multi-core that not only it determines "the space of the places" but also "the space of currents". Also the globalization of economy and the informationalization of cities i.e. change in construction and goods control towards advanced services production has a particular position in the process of multi-core and multi-center cities and metropolises (Hall, 2006, 3).

The city center is the best place to produce goods both in term of economizations due to aggregation and in term of advantages due to transporting the goods. However, this city center is not permanent. When the city grows, the transport cost increases either due to increase in city extent or due to the

costs which are resulted from the aggregation.

Also the economizations which are due to aggregation reduce in a given city size and replace with dissipations which are due to aggregation and "the economizations which are due to aggregation" become lower in main city center and "the costs which are due to aggregation" become higher. While the advantages of the main city center reduce the secondary city centers start to develop and absorb various economic activities and the urban structure becomes multi-center (Abedin Darkoosh, 2001, 66). The aim of multi-core model is to take the services towards people rather than taking people towards needs in order to create a stable pattern with an efficient structure which is accordant to people needs. Therefore it is necessary to evaluate a core in term of its abilities and potentials.

Identifying the spatial structure of metropolises: from single-core to multi-core

Since two centuries before, when industrial cities tended to develop and the crowded migration was formed to cities and transport communications were formed towards activity and industrial centers, many thinkers and theorists studied and opined about position determination and development of city and its surroundings and conducted many of these theories,

ideologies and urbanity-urban planning-urban transport schools (Papeli and Sanajerdi, 2003, 7).

The spatial structure of city has considerable effects on efficiency and urban environmental quality, the form of a city and the distribution pattern of population and assignment of uses and activities play considerable roles in air quality and as a result, other indicators of city. Today, the survival of cities depends on finding creative and rapid solutions for problems and issues (Sorur, 2008). The basis of theories about spatial structure of cities has its root in important local theories such as Von Thunen's economic theory, John Friedman's center-surrounding theory and Walter Christaller's central position theory.

In Alan Bertaud's view, the crowded single-core cities have higher housing costs and less land space usage than low crowded multi-core cities (Bertaud, 2002, 27).

According to Island Fled's (1997), Weglener's (1955) and Proudhem's (1996) theories, the "integrated work market" is the main reason for large cities to be single-core or multi-core. A single-core city may generate an integrated work market to provide the possibility to move simply along roads or railroads from surrounding to center (**Figure 1**). Therefore, travelling to CBD becomes shorter and price of land rises up. In this condition, the crowd follows

land price and therefore we would have negative slope for crowd from the center to surroundings (Bertaud, 2002, 5). The single-core model was suitable and appropriate for cities in 19th century. But since it resulted in a rapid lack of concentration on economic activities, new transport technologies encountered growth and instability and contained variety of travel patterns and a set of intersecting travels from suburb to city center it is not proportional for modern cities (Walter, 2008).

Identification of final indicators

In first step, the main criteria of choosing the best urban cores in Hamadan metropolis are identified in order to present solutions to convert single-core city to multi-core. The main criteria include: physical, economic and social, environmental, valuable and civil and legal. For each criterion, some indicators have been considered in a way that 19 sub-criteria have been selected. The criteria and sub-criteria of investigation are given in no.1. Also the criteria and sub-criteria of investigation are named as no.1 with a numerical index in order to be traceable and studied.

Investigation analysis

Determining the priority of model elements using ANP technique

In this investigation, ANP technique (network analysis technique) is used to determine the weight of criteria and model

indicators. At first, the main criteria are prioritized based on the aims. Then the inner relations are recognized among main criteria. In the third step, each one of sub-criteria are compared and prioritized in its related cluster. In fourth step, the inner relations between sub-criteria are specified. Finally, by calculating the initial super matrix, well-balanced super matrix and limit super matrix, the final priority of indicators is specified.

Determining the priority of main criteria based on target

To conduct hierarchical analysis, the main criteria are compared in pairs based on target. ANP technique is a ranking technique and the ranking is carried out based on pair comparisons. Pair comparison is very simple and all elements of each cluster should be compared in pairs. Hence, if n elements exist in a cluster, $\frac{n(n-1)}{2}$ comparisons would be carried out. For the reason that there are 5 criteria, therefore the numbers of conducted comparisons equal to:

$$\frac{n(n-1)}{2} = \frac{5(5-1)}{2} = 10$$

Therefore, 10 paired comparisons are carried out in view of a group of experts. The experts' view is aggregated using geometry mean technique and is used to calculate the final weight of criteria. The matrix of paired comparison is presented in

Table.2 which is resulted from aggregation of experts' view.

Comparison and determining the priority of sub-criteria

Determining the priority of physical sub-criteria

Here, the view of a group of experts is used. Experts' view has been collected in this theme. The geometry mean of experts' view is calculated. The carried out calculations for determining the priority of physical sub-criteria are presented in **Table 3**.

Based on the obtained eigenvector:

- The most priority is related to the possibility to found building with a weight of 0.289.
- The second priority is the sub-criterion of physical development of space with a normal weight of 0.269.
- The third priority is the existence sub-criterion or the possibility to provide the installations with a normal weight of 0.258.
- The fourth priority is the sub-criterion of suitable access to the network of passages with a normal weight of 0.183.

The rate of incompatibility of carried out comparisons are obtained 0.090 which is smaller than 0.1 and therefore the conducted comparisons may be reliable.

Determining the priority of Environmental sub-criteria

The environmental criterion is consisted of four sub-criteria: having the ability to

develop the green space, environmental pollutants and observing the neighborhood, air pollution and considering the direction of dominant wind, attention to keeping and stability of environment. The carried out calculations which are in order to determine the priority of environmental sub-criteria are presented in table.5.

Based on the obtained eigenvector, the sub-criterion of attention to keeping and stability of environment with a weight of 0.340 has a higher priority in comparison to other sub-criteria. Also the incompatibility rate of the conducted comparisons is obtained 0.076 which is smaller than 0.1 and therefore the conducted comparisons could be reliable.

Determining the priority of valuable sub-criteria

The valuable criterion is consisted of three sub-criteria: evaluation and security risk control, evaluation and controlling the environmental risk and evaluation and controlling the hygienic risk. Based on the obtained eigenvector, the highest priority is concerned to the sub-criterion of inexistence of visual pollutions with a normalized weight of 0.352. Also the compatibility coefficient of carried out comparisons is obtained as equal to 0.036 which is smaller than 0.1. Therefore, the results may be reliable.

Determining the priority of civil and legal sub-criteria

The civil and legal criterion is consisted of four sub-criteria. The carried out calculations which are in order to determine the priority of civil and legal sub-criteria are presented in table.6.

Based on the obtained eigenvector, the highest priority is concerned to the sub-criterion of optimized land use with a normalized weight of 0.321. Also the compatibility coefficient of carried out comparisons is obtained as equal to 0.064 which is smaller than 0.1. Therefore, the results may be reliable.

Based on the carried out calculations and limit super matrix and the output of Super Decision software, determination of final priority of criteria is available. The final priority of main criteria is illustrated in figure 4 adopted of limit super matrix.

Therefore, the indicator of possibility to found building (according to slope, topography and ease of access to materials) has the highest importance among all existing indicators with a normal weight of 0.076. The indicator of optimized land use has second priority with a weight of 0.071. The indicators of space physical developability and existence or possibility of providing the installations and infrastructures network have a high importance with similar weight. On the other hand, an indicator like existence of high visual variety and considering the

natural views has lower importance than other indicators in study.

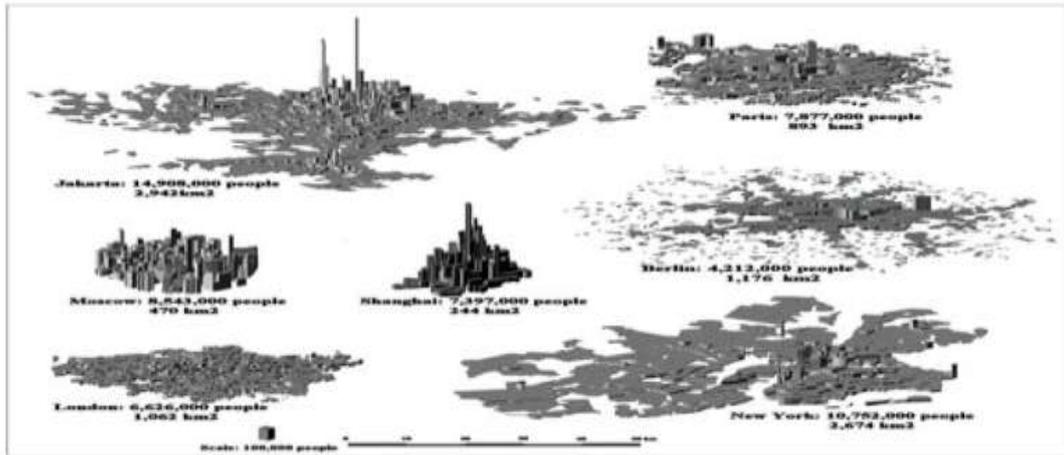


Figure 1: Patterns of spatial structure of cities [Bertaud, 2002]

Table 1: Main indicators and related sub-criteria

Symbol	Sub-criteria	Main criterion	Symbol
S11	Accessibility to neighbor cores and homes (suitable access to passage networks)	Physical criterion (Mir Moqtadaei, 2004)	C1
S12	Physical development of space		
S13	Possibility to found building (considering slope, topography and accessibility to materials)		
S14	Existence or possibility to provide installations and infrastructures networks, etc.		
S21	Variety of trade uses and development in the region	Economic and social criteria (Izadina and Rasaeen, 2010)	C2
S22	Variety of service uses and development in region		
S23	Accessibility to local markets and banks and economic institutions		
S31	development for green space	Environmental criteria (Noruzi, Bahman pour, 2013)	C3
S32	Environmental pollutants and observing neighborhood in locating with populated places		
S33	Air pollution and considering the dominant direction of wind		
S34	Attention to environment conservation		
S41	The city form and shape	Value criteria (Abafat yeganeh, 2008)	C4
S42	Existence of high visual variety and considering natural views		
S43	Inexistence of visual pollutions		
S44	Considering the identity of the region and consistency of development with natural appearance conditions		
S51	Optimized use of land	Legal civil criteria (Meshkini, 2013)	C5
S52	Adjustment of ownership rights		
S53	Using wastelands in public and services uses		
S54	Using the value of land in regard of public resources		

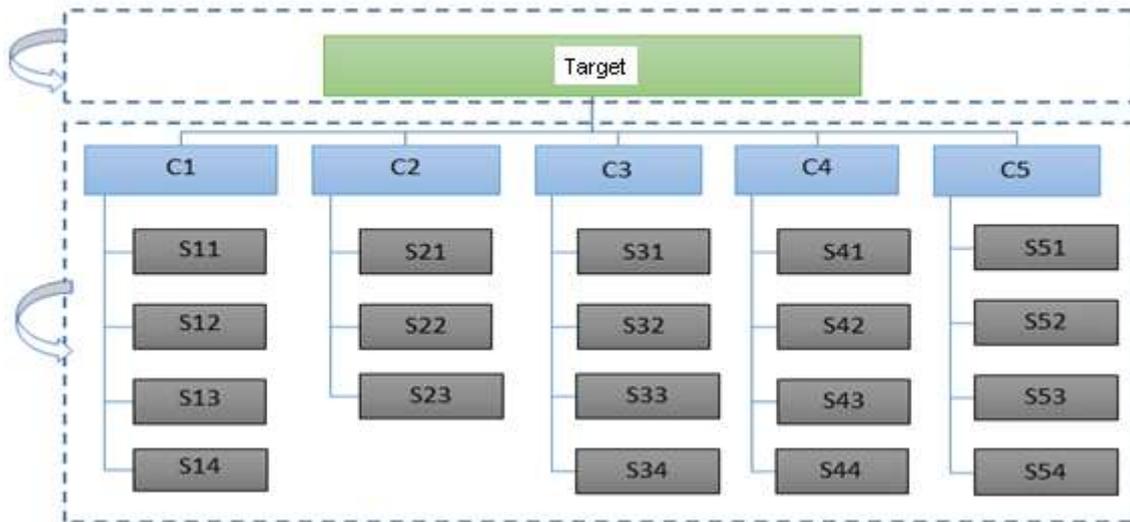


Figure 2: The pattern of communication network between studied variables

Table 2: Determination of main criteria priority

	Physical	Economic	Environmental	Valuable	Civil
Physical	1	5.911	1.097	2.125	1.175
Economic	0.169	1	0.967	0.394	0.851
Environmental	0.912	1.034	1	0.926	0.633
Valuable	0.471	2.537	1.080	1	1.345
Civil	0.851	1.175	1.580	0.743	1

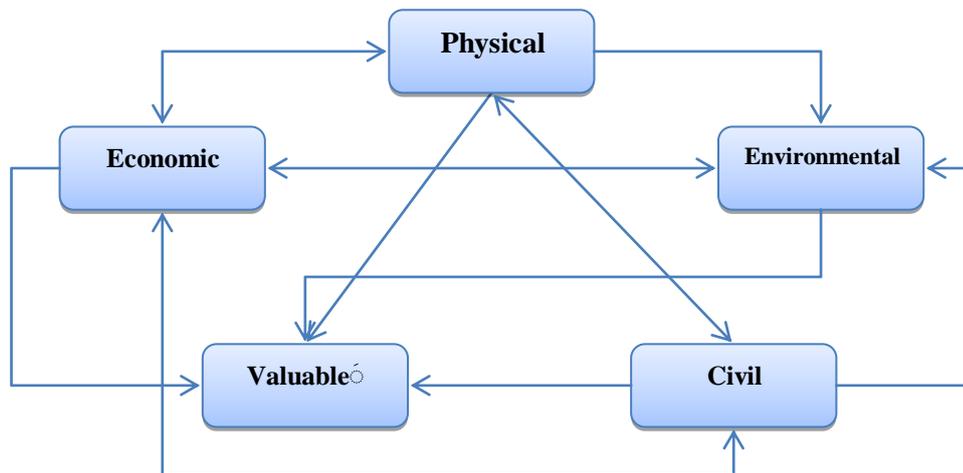


Figure 3: The pattern of inner relations between model main criteria

Table.3. determining the priority of physical sub-criteria

	Suitable access to network of passages	Physical development of space	Possibility to found building	Existence or possibility to provide installations and infrastructures	Geometry mean	Eigenvector
Suitable access to network of passages	1	0.942	0.455	0.717	0.744	0.183
Physical development of space	1.061	1	1.838	0.732	1.093	0.269
Possibility to found building	2.199	0.544	1	1.593	1.175	0.289
Existence or possibility to provide installations and infrastructures networks, etc.	1.395	1.365	0.628	1	1.046	0.258

Table.5. determining the priority of environmental sub-criteria

	development	Environmental pollutants	Air pollution	Attention to keep	Geometry mean	Eigenvector
Having the ability to develop the green space	1	2.036	0.935	0.920	1.150	0.278
Environmental pollutants and observing the neighborhood	0.491	1	2.601	0.471	0.881	0.213
Air pollution and considering the direction of dominant wind	1.070	0.384	1	0.592	0.702	0.170
Attention to keeping and stability of environment	1.087	2.125	1.689	1	1.405	0.340

Table.6. determining the priority of civil and legal sub-criteria

	Optimized use of land	Adjustment of ownership keeping	Using the wastelands	Using the value of land	Geometry mean	Eigenvector
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Optimized use of land	1	1.053	2.029	1.349	1.303	0.321
Adjustment of ownership keeping	0.950	1	0.712	1.607	1.021	0.251
Using the wastelands in public uses	0.493	1.405	1	0.631	0.813	0.200
Using the value of land in the direction of public resources	0.741	0.622	1.585	1	0.925	0.228

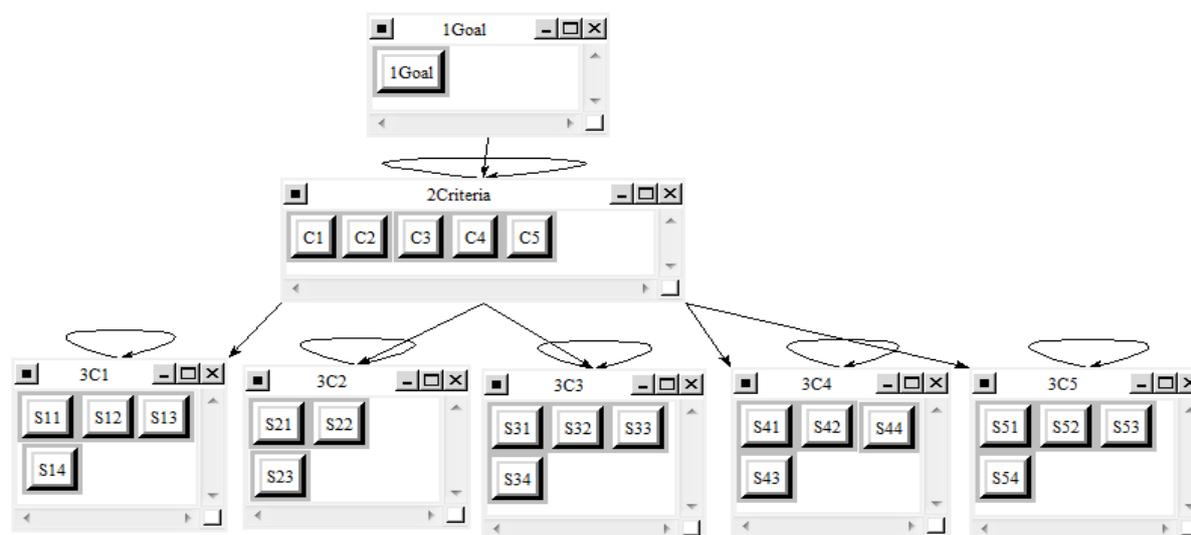


Fig.4. ANP chart of priority of indicators and choices in Super Decision software

Table.7. process of prioritizing to considered indicators

Symbol	Indicators	Total weight	Normal weight	Rank
S ₁₁	Accessibility to cores and neighbor houses	0.0241	0.0482	13
S ₁₂	Physical developability of space	0.0354	0.0708	3
S ₁₃	Possibility to found building (according to slope, topography and ease of access to materials)	0.038	0.0761	1
S ₁₄	Existence or possibility of providing the installations and infrastructures network	0.034	0.0679	4
S ₂₁	Variety of commercial uses and developability in region	0.0292	0.0583	7
S ₂₂	Variety of service uses and developability in region	0.0227	0.0453	14
S ₂₃	Accessibility to local markets and banks and economic institutions	0.0327	0.0654	5
S ₃₁	Ability to develop green space	0.0266	0.0532	10

S ₃₂	Environmental pollutants and observing the neighborhood in locating with residential areas	0.0204	0.0408	16
S ₃₃	Air pollution and considering the direction of dominant wind	0.0163	0.0325	17
S ₃₄	Attention to keeping and stability of environment	0.0325	0.0651	6
S ₄₁	Form and shape of city	0.0144	0.0287	18
S ₄₂	Existence of high visual variety and considering natural views	0.0102	0.0205	19
S ₄₃	Inexistence of visual pollutions	0.0269	0.0538	9
S ₄₄	Considering the identity of region and accordance of development to natural view conditions	0.0249	0.0498	12
S ₅₁	Optimized land use	0.0359	0.0718	2
S ₅₂	Adjustment of ownership keeping (ownership rights)	0.0281	0.0561	8
S ₅₃	Using wastelands in public and service uses	0.0224	0.0447	15
S ₅₄	Using the value of land in direction of public resources	0.0255	0.051	11

CONCLUSIONS

According to the statements mentioned in theoretical fundamentals of investigation and data analysis, it can be concluded that: the single-core pattern is observed in towns and moderate cities and it is coincident with the initial core of ancient cities historically. In this pattern, there are a lot of service dependences to city center from all points. On the other hand, the single-core cities are vulnerable to transport and traffic and rely on public transport system and they put pressure on this system and their outcomes are crowd and air pollution.

In this regard, single-core to multi-core conversion of spatial structure and conduction of future development of Hamadan metropolis has an influential step to develop in a way that it could create an easy access to services in new urban core and suitable relation to urban transport

network through developing the uses and generating new urban core.

Multi-core pattern or in other words, making Hamadan metropolis as bi-core is very closed to the concept of justice in urbanity and balanced transition in city level. Land use planning and distribution of urban travels are carried out more logically. Consequently the studies and investigations show that the existing system of spatial distribution in Hamadan metropolis is extremely and inefficiently unbalanced and this structure is extremely single-core.

Then according to the process of historical development of the city in past era and its current structure, it can be concluded that if the current process of city development continues, the distance between house place and work place or urban facilities would extremely increase and in this order, the volume of urban problems would be

increased permanently in this metropolis. Hence, it is attempted to present the multi-core city organizing plan by recognizing the existent potentials in various cores and analysis of cores and their interactive relations in order to solve the above problems.

"At first, concentration reduction in commercial and service activities, then generating commercial and service core in new core based on existing potentials and strengths and finally making the city as bi-core".

Therefore, it can be claimed that citizens would provide their services and needs in this pattern within best conditions. Communicational structure and traffic network also reduce the traffic volume in city cores especially in central core by reducing the volume of inter-sectoral relations between urban cores. Indeed, by reducing the concentration in service and commercial activities and then creating new cores of service and commerce in suburbs and making the urban system as multi-core, the logical distribution of urban travels, suitable distribution of transport in passages network and more suitable penetration of major services to numerous sections of city would all be harmonized automatically that have some outcomes like reduction in temporal and economic costs for city and

citizens and it can also result in balanced development of marginalized textures.

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