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Structural Analysis of Affecting Factors for Future Development of Green Spaces in Tabriz City

Raziyeh Teimouri[1] & Hamid Hodjati[1]

[1] Geography and Urban Planning, Tabriz University, Tabriz, Iran

Correspondence: Raziyeh Teimouri, Geography and Urban Planning from Tabriz University, Tabriz, Iran. Tel: 98-91-4913-9045. E-mail: Raziehteimouri@yahoo.com

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Abstract

This paper attempts to analyze factors involved in the development of urban green spaces with a systematic and structural approach and extract the most important factors for the optimal development of urban green spaces using relationships between these factors. This applied study was conducted using a descriptive analytical method, which attempted to present solutions to structural development of green spaces in Tabriz City as a case study. This study's findings can be generalized on cities with same condition. Thus, in order to achieve this goal, all factors involved in the development of green spaces have been initially extracted using Delphi method. Then, analysis of factors that have been extracted from MICMAC, relevance of factors involved in the development of green spaces in the city of Tabriz have been analyzed and finally key factors were determined. Eleven factors have identified as key factors that have important role in development of optimal green spaces in Tabriz city.

Keywords: Structural Analysis, Development, Green space, Tabriz City

1. Introduction

Urban green spaces are nature survivors in cities, which suffer from qualitative and quantitative changes as a result of improper urban developments. Moreover, these developments are associated with many ecological, economic and social effects (Jim, 2008). With the increasing city's depletion of the irreparable capital of natural elements as well as due to increasing destruction of green spaces and eventually quality degradation and natural performance of cities' ecosystems, ecologists have found that to solve real problems of today's world, it is essential to focus on perspectives of man dominance, which often include urban perspectives (Johnson and Hill, 2002). Presence of nature in the form of natural, open and green lands in cities should benefit from necessary physical relevance with spatial extent, composition and distribution and must be interwoven with city in such a way that they are inseparable from each other in optimal conditions, and in fact it covers cities (Tjallingi, 2003).

Importance of urban green spaces is widely recognized in all societies in social performance, biodiversity conservation and other ecological processes for eco-friendly development. Increasingly, former urban planning methods paid less insufficient attention to environment and environment surrounding cities, which led to much criticism (Gomez & Salvador, 2006). To confirm multiple roles of green spaces, a certain level of quality development and distribution of green spaces in urban areas should be considered, which is considered part of environmental sustainability agenda. Achieving this goal requires an integrated approach and a structure in relation to planning, monitoring, design and protecting urban green spaces to improve environmental sustainability in cities (Md & Haq, 2011). Today, green space planning has become a priority in urban planning and requires an integrated approach to achieving sustainable urban environment (Waldheim, 2006). In urbanization processes, natural features such as vegetation and natural soil are replaced with building materials for constructing residential areas, commercial buildings, roads and parking lots, to the extent that today , there is no optimal balance between green space area and open areas between urban networks and land natural patterns (Thaiutsa et al., 2008). Results of studies on land use changes from 1976 to 2006 in the city of Tabriz indicate that during 30 years, area of 6970.99 hectares has been allocated to construction, a total of 1542.57h of which was constructed on city's green spaces and orchards. Actually During this period, 26.07% of this use type was destroyed in the city of Tabriz and was turned into profitable uses (Rahimi, 2013). During this period, green space per capita of about 14 square meters reached to 7.5 square meters (Beheshti roy, 2012). Also, over a period of 10 years (from 2001 to 2011), green spaces and orchards with an area of 165 hectares, approved by Article 5

of intracity texture change have been repurposed to other land uses such as housing, roads, sports, etc (Rahimi, 2013). Process of dealing with urban green spaces from earlier times indicates that if this trend continues, destruction and use changes of green spaces, orchards and farmlands will lead to a terrible threat to sustainable development and thereby unbalancing ecological system in Tabriz (and perhaps at the regional level).

With regards to increasing population's demand for urban lands, some ecological and environmental functions move towards proportionating quality of life for human populations (Li, 2004). Therefore, in urbanization processes, natural features such as vegetation and natural soils will be replaced with building materials for construction of residential areas, commercial buildings, roads and parking lots, to the extent that today there is no optimal balance between green space surface and open areas between urban networks and natural patterns (Thaiutsa, 2008). Moreover, urban networks are dominating ecological networks, which in itself lead to a ground for loss of green spaces within the city and use change of such lands, which may lead to global environmental problems such as formation of urban heat islands.

In mean time, green spaces play a significant role in supporting urban social and ecological systems (Barbosa et al., 2007). Therefore, special attention must be paid to the promotion of ecological green spaces in order to improve their productivity, because within cities, valuable ecological elements are increasingly reduced (Zangiabadi & Rakhshani nasab, 2009). Accordingly**,** experts believe that one of the main ways to deal with urbanization problems is to strengthen relationship between urban people with nature (Shahivandi, 2006). Today, cities require particular attention in terms of restoration of urban nature. Because presence of nature in necessary and sufficient size, composition and distribution in cities is considered one of sustainable development requirements ,which is very important to improving quality of life in urban areas and makes these areas sustainable ecologically (Alizadeh & Salehifard, 2008). Based on structural and functional relationship principle, correlations between structural components and natural issues are modified when presence of components and relationship between main components has proper spatial structure in the context (Forman & Godron, 1986).

Structural analysis is one of the most used tools in futures studies. Structural analysis experienced since the middle of the 1980's an increasing number of application in various domains, within business as well as on society related topics (Arcade and et al., 2003). In long term view, decision makers need to justifiable anticipation for the major drivers that may effect on their domain key variables (Omran, Khorish, & Saleh, 2014). Therefore, this paper indicates the structural analysis for identifying the key factors in future development of Tabriz City's green spaces by answering to following question:

Which variables involved in development of green space of Tabriz city? And which of them has more influence on development of green space?

3. Methodology

Structural analysis seeks to identify key variables (overt and covert) in order to get feedbacks and encourage participants and beneficiaries on aspects and complex and unpredictable behavior of the system.

Structural analysis method is a tool for linking ideas and thoughts, which operates through correlation matrix of all system variables. This model is able to identify relationships between variables and eventually identify key variables affecting the system evolution. Structural analysis methods is among methods, which analyzes the relationships between variables and different components of a system and its output is effective in investigating relationships between variables and identifying their characteristics (Rabani, 2012). In this research, variables involved in the future development of green spaces in City of Tabriz are estimated using Delphi method. Then, structure of green spaces development in the city of Tabriz was analyzed using MICMAC software and key factors were extracted. It is worth mentioning that prediction method of "MICMAC" was invented by Michael Godet. He summarized the prediction method in the following steps:

Step 1: Evaluation of variables

The first phase includes a review of all variables detected within the intended system (internal and external variables); It should be noted that all variables are taken into account comprehensively. Use of experts' views helps expand set of variables and consider all potential actors in the intended system.

Step 2: Investigation of correlation between variables

In a structural analysis, there is possible of correlating between variables in a two-row table (direct correlation). Correlation degree of two variables is shown quantitatively. 0 means that there is no correlation between two variables and the amount of effect of variables can also be shown with corresponding numbers (0 = no correlation1 = poor correlation, 2 = moderate correlation, 3 = strong correlation). At this stage, we will face variable N and N × N questions (almost 5,000 questions for 70 variables), some of which will be discarded

without having systematic and comprehensive effect.

Step 3: Identification of key variables

This step includes identification of key variables, which is done using direct and indirect classifications.

Definition of direct classification: All relationships in a row reflect importance of a variable's effect on the whole system. Sum of a column represents affectability amount of a variable (level of direct affectability).

Definition of indirect classification: This program allows you to study effect expansion using path and feedback loops and eventually classify variables.

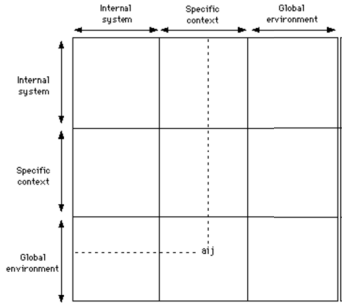

Figure (1). Structural analysis matrix

Source: Godet, 2012, 15

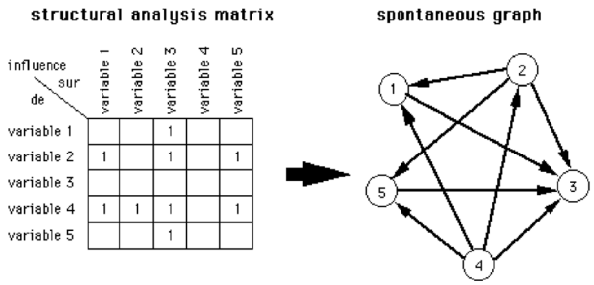

Figure (2). Structural analysis matrix and its diagram

Source: Godet, 2012, 15

4. Introduction of the Study Area

Tabriz city is the northwest hub in Iran in terms of population, industry, education and health. According to 2011 population and housing census, city of Tabriz has a population of 1,494,998 people.

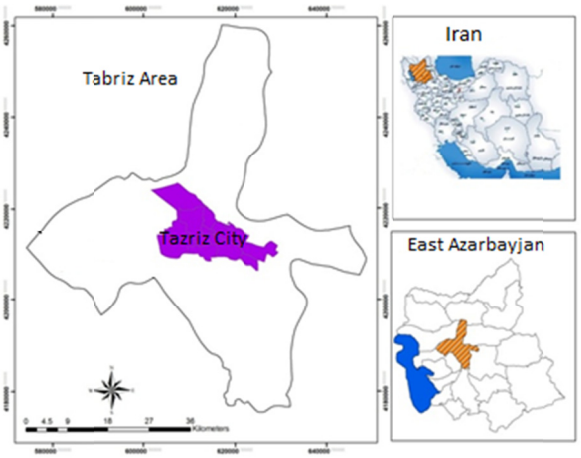

Figure (3). Geographic locating of Tabriz City

Source: compiled by author

Physical development of Tabriz metropolitan always leads to disappearance of orchards and urban green spaces. Tabriz city, which was once surrounded in midst of orchards and enjoyed rich agricultural lands in the city outskirt, has lost majority of them in favor of urban and often unnecessary construction by wrong government decisions in the form of urban development planning. Results of investigations in the last three decades indicate that rapid population growth and dominance of economic perspective to lands was associated with further expansion of metropolitan area of Tabriz in non-prone lands and destruction of agricultural and horticultural lands (Mahmoodzadeh, 2014: 175). Overall, parks and green spaces area in the city of Tabriz is 1333.88 hectares, which are dispersed across the city in an unbalanced and mostly peripheral ways.

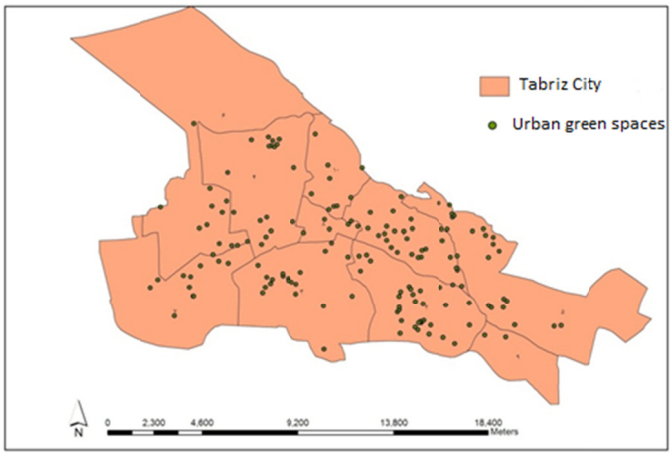

Figure (4). Dispersion of green spaces in Tabriz

Source: compiled by author

5. Results and Discussion

5.1 Opinion Polling Experts Using Delphi Method

In this study, to identify primary variables affecting future development of green spaces in the city of Tabriz, Delphi method is used as follows: First, experts and executives involved in the studied field were identified and selected. In this study, all specialists and experts in the green spaces development field, including university professors and parks staff as well as green space staff of ten municipality districts in Tabriz were surveyed (50 persons responded). After participants were selected, their views on future development of green spaces in city of Tabriz were surveyed and extracted. Finally, after monitoring variables, a total of 51 variables under six general factors (natural, socio - cultural, physical, environmental, economic and urban landscape) were selected as primary variables affecting the future development of green spaces in Tabriz.

Table (1). Factors affecting structural development of urban green spaces

Variable name	Class	Variable name	Class
Average annual precipitation	Natural Factors	Allocating specific budget on behalf of urban management	Economical
Available water resources		Use of appropriate agricultural land for economic savings in the long run	
Soil texture and depth		Acquisition and purchase of land in different places of the city	
Vegetation natural density		Mutual planning for green spaces in the outskirt area	
Average annual temperature		Investment in the development and protection of green spaces	
Prevailing wind speed		Provision of infrastructure for green spaces construction by the urban management	
Prevailing wind direction		Increase the economic efficiency of green spaces and in different parts of city centers and outskirts	
Humidity percentage		Temporal variety in using green spaces, especially in cold seasons	
Earth's tilt			
area of natural green spaces			
Construction and development of green promenade	So	Adequate and balanced distribution across the city	Ph

Green spaces maintenance and protection		Forestry development within and outside the city limits	
Equipping green spaces with recreational function		Construction of the green belt in suburbs	
Continuous use of green spaces		Design and implementation of water supply networks	
Proper for access to all citizens		Development of street green spaces (refuge, lawn and flower planting ...)	
Training and Strengthening public awareness in order to protect green space development		Construction of mountainous parks	
		Diversification of green spaces functions	
The use of appropriate genetic technologies on Plants for adaptation to climate		Proper location for the ecological development of green spaces	
Public participation in conservation and development of green spaces			
Natural and man-made attraction of green spaces			
Provision of security, equipment and facilities in public green spaces			
Managerial and institutional factors			
Organization of ecological networks (river, stream, watercourse, ...)	Environmental	Continuity of green spots	City s vision
Sustainable water resources (rivers, springs, water treatment plants, etc.)		Presence large spots of green spaces in four corners of the city	
Biodiversity (using native species compatible with Tabriz environment, providing green spaces suitable for native animals)		Observing the structure of green spots (linear, point wise and polygon)	
Appropriate locating with regard to prevailing wind		Planting of various plant species	
Appropriate locating with regard to the reduction of environmental pollution		Beautification and design of green spaces	
Dense planting of vegetation		Vertical green spaces (green roofs, green walls)	
Using trees instead of grasses and drought-resistant species		Attaching importance to green scenery in and around the city	

Source: compiled by author

5.2 General Analysis of System Environment

According to Delphi method mentioned above, a total of 51 variables in 6 areas were identified as factors affecting future development of ecological green space of Tabriz metropolitan and were studied and analyzed using cross-impact and structural analysis by MICMAC Software to extract main factors affecting future status of green spaces. Based on number of variables, a matrix with dimensions of 51 x 51 is used. By placing these factors in a 51x51 matrix, effect of each of these factors on each other was identified by weighting factors (from 0 to 3). All factors involved in planning of urban green spaces are considered as a system with intertwined elements and in the form of one structure and the relationship between these factors is measured so as to extract superior factors with higher effects. The number of repeated interaction between variables was considered two times and the matrix filling degree was 35.60 %, which shows dispersion of variables affecting development of ecological green spaces in Tabriz.

From a total of 890 evaluable relationships in this matrix, 1610 relationships are zero, 444 relationships are 1, 194 relationships are 2 and 252 relationships are 3. Also, the matrix had utility and optimization of 100% based on statistical indicators with two-time data rotations, which indicated a high validity of the questionnaire and its responses. In the following section, to analyze overall system environment and finally to identify key factors, affectability plans of variables as well as rating and displacement degree of variables are investigated.

Table (2). Initial data analysis of cross-impact matrix

Indicator	Value
Matrix size	51
number of interactions	2
number of zeros	1610
number of ones	444
number of twos	194
number of threes	252
Total	890
fillrate	35.6%

Source: compiled by author

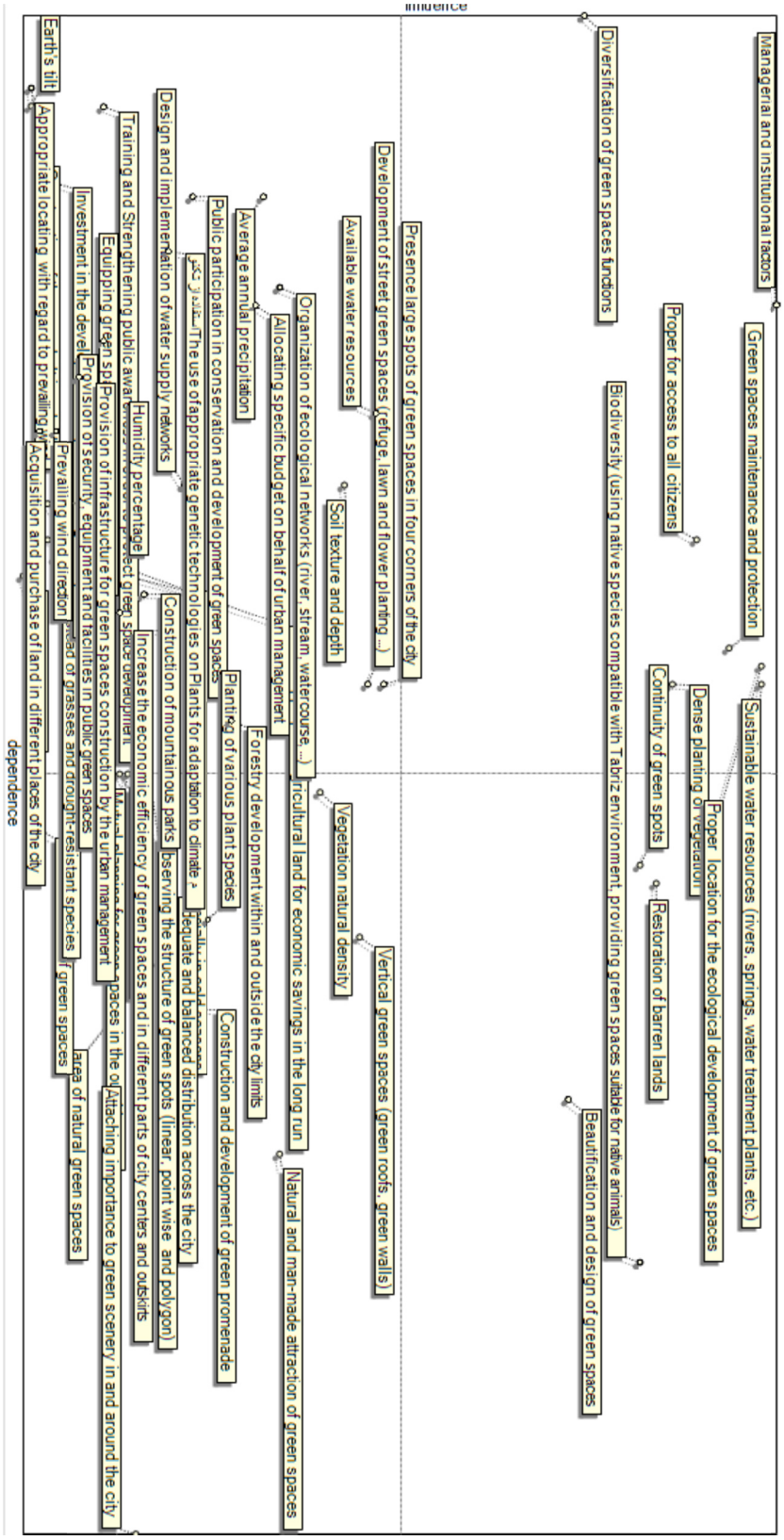

Figure (5). Dispersion of variables based on direct changes

Source: compiled by author

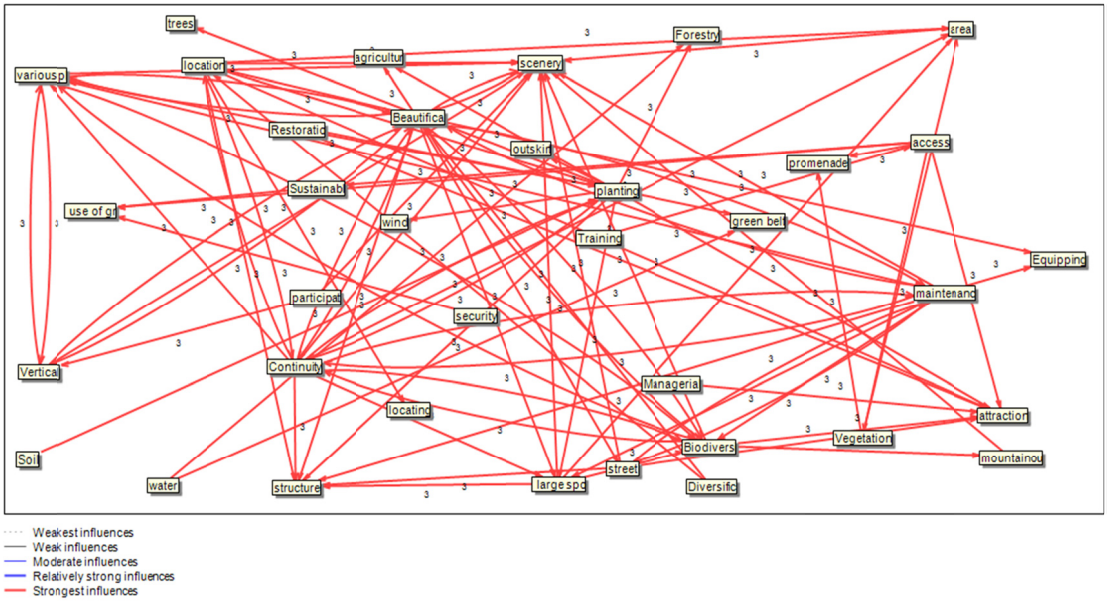

Figure (6). Direct relationships between variables (very weak to very strong effects

Source: compiled by author

The above diagram shows relationship between variables in "MICMAC" software.

5.3 Rating of Direct and Indirect Effects of Variables

According to the questionnaires that are completed in the form of a matrix, the software calculates the relationship between them and finally considers a numerical rating for each factor. Then, based on this rating, it ranks factors based on impact and affectability directly or indirectly, which in this case and on the basis of factors' rating, their impact and affectability rates changes. In the following table, green space development factors in Tabriz are ranked based on direct and indirect impact and affectability.

Table (3). Rating of direct and indirect effects of all envolved variables in green space development on each other

Rank	Label	Direct influence	Label	Direct dépendance	Label	Indirect influence	Label	Indirect dependence
1	Managerial factors	572	scenery	506	Managerial factors	605	scenery	513
2	Sustainable water Resources	560	Biodiversity	415	Proper locating	521	Biodiversity	417
3	Proper locating	560	Attraction increasing	379	Sustainable water Resources	516	Attraction increasing	414
4	maintenance	536	Beautification	361	Proper access	506	Beautification	377
5	Proper access	512	promenade	331	Continuity	501	promenade	324
6	Dense planting	494		307	maintenance	499	Balanced distribution	301
7	Restoration of barren lands	482	Vertical GS	307	Restoration of barren lands	481	Restoration of barren lands	298
8	Biodiversity	470	various specious	301	Diversification of GS applications	434	Vertical GS	296
9	Green space continuity	470	Restoration of barren lands	289	Beautification	432	various specious	289
10	Diversification of GS applications	427	Balanced distribution	289	Biodiversity	421	Continuous use	288
11	Beautification	415	Continuity of green space	283	Dense planting	406	Continuity of green space	283
12	Large patches of GS	277	Continuous use	271	Water resources	299	area of natural GS	274
13	Water resources	271	Naturally covered	259	Vertical GS	298	the structure of green spots (linear,	258

							point ,polygon)	
14	street GS	265	The average of annual temperature	253	Texture and depth of soil	278	The average of annual temperature	244
15	Vertical GS	259	Mutual GS planning in surrounding areas	253	street GS	277	Mutual GS planning in surrounding areas	244
16	Texture and depth of soil	247	the structure of green spots (linear, point ,polygon)	241	Large patches of GS	236	Proper locating	237
17	Naturally covered	229	Forestry development	235	Naturally covered	235	Naturally covered	236
18	Attraction increasing	198	Sustainable water Resources	223	Attraction increasing	231	Large patches of GS	232
19	Organization of ecological networks	198	Dense planting	223	Organization of ecological networks	223	maintenance	229
20	Average annual precipitation	186	street GS	223	Allocating specific budget	186	street GS	227
21	Allocating specific budget	180	Large patches of GS	223	Average annual precipitation	176	Dense planting	221
22	Forestry development	162	Proper locating	216	various specious	173	Equipping green spaces	220
23	various specious	144	maintenance	210	Forestry development	157	Increase the economic efficiency	219
24	development of green promenade	138	Increase the economic efficiency	204	Balanced distribution	152	Forestry development	219
25	Public participation in conservation and development of GS	132	Equipping green spaces	198	development of green promenade	150	Sustainable water Resources	219
26	Design of water supply networks	126	Construction of mountainous parks	192	Public participation in conservation and development of GS	138	Construction of mountainous parks	197
27	area of natural GS	120	Prevailing wind speed	186	the structure of green spots (linear, point ,polygon)	131	Temporal variety in using GS	193
28	The use of appropriate genetic technologies on Plants	114	Humidity percentage	180	The use of appropriate genetic technologies on Plants	123	Prevailing wind speed	177
29	Increase the economic efficiency	114	Temporal variety in using GS	180	scenery	119	Use of appropriate agricultural land for economic savings	169
30	Balanced distribution	114	Proper access	174	Design of water supply networks	118	Humidity percentage	168
31	Construction of mountainous parks	96	Use of appropriate agricultural land for economic savings	174	area of natural GS	110	Proper access	166
32	the structure of green spots (linear, point ,polygon)	96	Using trees instead of grasses	162	Increase the economic efficiency	91	Texture and depth of soil	157
33	scenery	90	Construction of the green belt in suburbs	162	Construction of mountainous parks	87	Construction of the green belt in suburbs	154
34	Mutual GS planning in surrounding areas	84	Texture and depth of soil	156	The average of annual temperature	78	Acquisition and purchase of land in different places of the city	153

35	The average of annual temperature	78	Design of water supply networks	156	Training public awareness in order to protect GS	72	Using trees instead of grasses	151
36	Equipping green spaces	78	Appropriate locating with regard to prevailing wind	138	Equipping green spaces	72	Prevailing wind direction	138
37	Humidity percentage	72	Acquisition and purchase of land in different places of the city	138	Mutual GS planning in surrounding areas	67	Provision of infrastructure for GS construction	126
38	Training public awareness in order to protect GS	66	Water resources	132	Humidity percentage	59	Water resources	124
39	Provision of security, and in public GS	66	Provision of infrastructure for GS construction	120	Provision of security, and in public GS	58	Water resources	121
40	Provision of infrastructure for GS construction	48	Provision of security, and in public GS	108	Construction of the green belt in suburbs	48	Allocating specific budget	111
41	Construction of the green belt in suburbs	42	Managerial factors	96	Temporal variety in using GS	40	The use of appropriate genetic technologies on Plants	108
42	Acquisition and purchase of land in different places of the city	30	Allocating specific budget	96	Provision of infrastructure for GS construction	36	Provision of security, and in public GS	108
43	Temporal variety in using GS	30	Organization of ecological networks	90	Acquisition and purchase of land in different places of the city	28	Organization of ecological networks	92
44	Using trees instead of grasses	24	The use of appropriate genetic technologies on Plants	78	Use of appropriate agricultural land for economic savings	25	Managerial factors	73
45	Use of appropriate agricultural land for economic savings	24	Average annual precipitation	60	Continuous use	25	Average annual precipitation	55
46	Appropriate locating with regard to prevailing wind	18	Public participation in conservation and development of GS	60	Using trees instead of grasses	19	Public participation in conservation and development of GS	48
47	Continuous use	18	Investment in the development and protection	54	Investment in the development and protection	17	Investment in the development and protection	38
48	Investment in the development and protection	18	Earth's tilt	30	Earth's tilt	11	Earth's tilt	29
49	Earth's tilt	12	Training public awareness in order to protect GS	30	Appropriate locating with regard to prevailing wind	8	Appropriate locating with regard to prevailing wind	23
50	Appropriate locating with regard to prevailing wind	12	Appropriate locating with regard to prevailing wind	24	Prevailing wind speed	2	Training public awareness in order to protect GS	20

Source: compiled by author

5.4 Displacement Degree of Factors in Case of Direct and Indirect Effects of Variables

The following diagram shows displacement degree of factors in case of direct and indirect effects of variables. As the diagram shows, the displacement degree had not much impact on changing the position of factors.

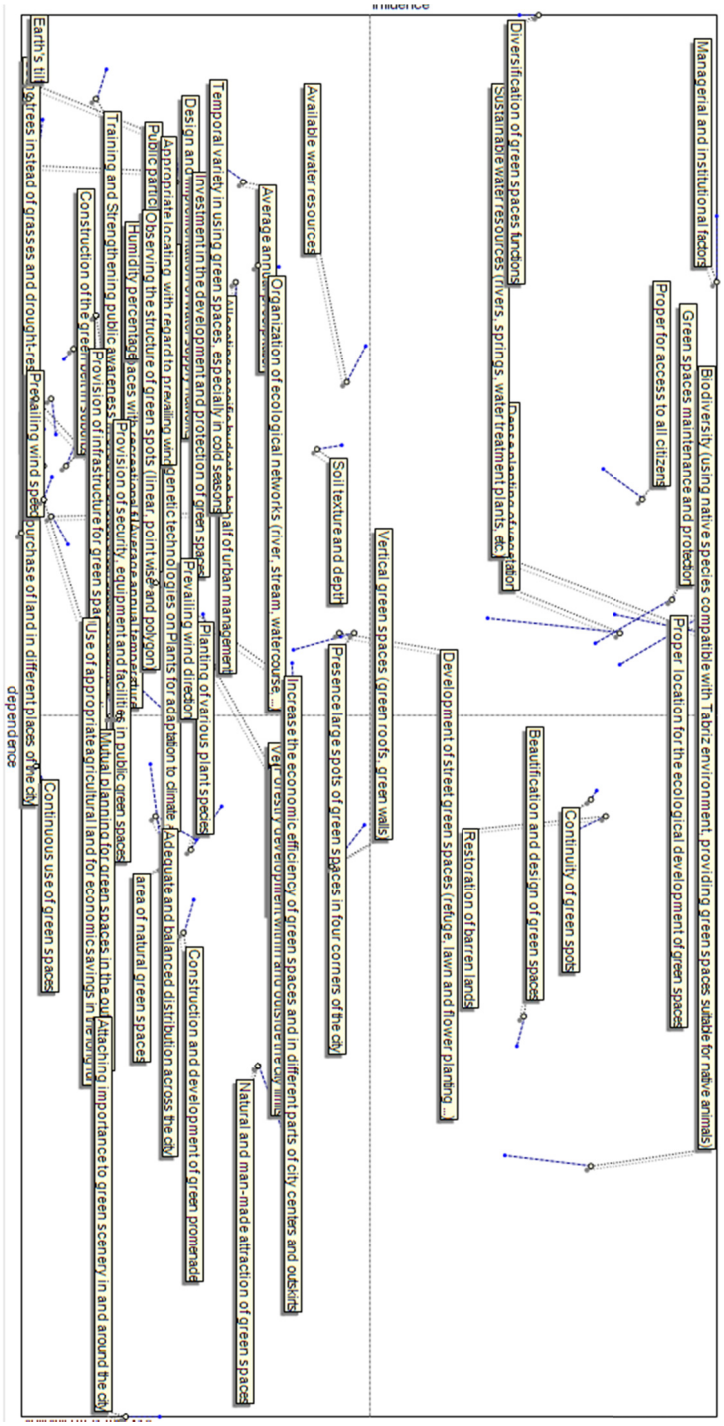

Figure (7). Displacement rate of direct and indirect effects
Source: compiled by author

5.5 Status of Green Spaces Future Development Factors in the City of Tabriz in MICMAC Diagram

In this section, we first investigated status of factors involved in the future development of green spaces in Tabriz metropolitan and analyzed overall status of the system. According to previous discussions, a total of 51 factors were identified, their effects on each other were measured and finally a total of 11 factors were extracted as key factors affecting the future development of green spaces in Tabriz metropolitan. All of these eleven factors were repeated in both direct and indirect methods.

Key factors, according to their weight are as follows:

Table (4). Key effective drivers (directly or indirectly)

Number	Variable	Direct effect	Variable	Indirect effect
1	Managerial and institutional factors	572	Managerial and institutional factors	605
2	Sustainable water Resources	521	Proper locating for ecological development	565
3	Proper locating for the ecological development	560	Sustainable Water Resources	520
4	Maintenance and protection	536	Proper access to all citizens	506
5	Proper access to all citizens	512	Green space continuity	501
6	Dense planting	494	Maintenance and protection	499
7	Restoration of barren lands	482	Restoration of barren lands	481
8	Biodiversity	470	Diversification of green space applications	434
9	Green space continuity	470	Beautification and design of green spaces	432
10	Diversification of green space applications	427	Biodiversity	421
11	Beautification and design of green spaces	415	Dense planting	406

Source: compiled by author

As the above table shows, all key drivers and factors affecting optimal planning of urban green spaces include following factors: managerial and institutional, proper locating for ecological development of green spaces, provision of sustainable water resources, maintenance and protection of green spaces, proper access for all citizens, Green space continuity, restoration of barren lands, dense planting, biodiversity, Beautification and design of green spaces.

Therefore, by taking into account these key factors in urban green spaces development scenarios, ecological development of green spaces and thus sustainable development in cities can be achieved.

The following diagram represents weight of key factors in the development of green spaces, which were effective directly and indirectly.

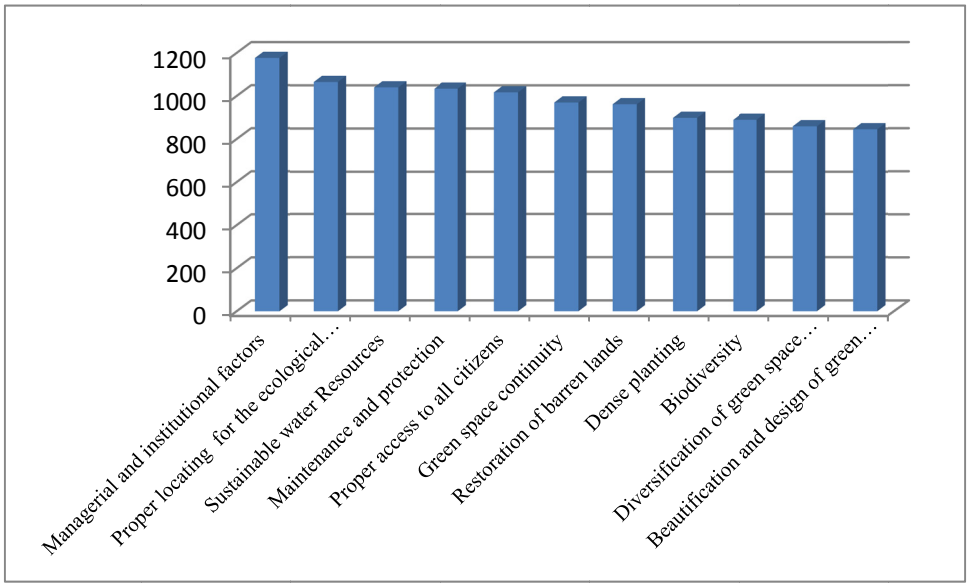

Figure (8). Factors with the highest impact rating with sum of weights of direct and indirect impact

Source: compiled by author

In both cases of direct and indirect effects, key factors have the highest weight compared with other factors, which is due to high importance of these factors in green spaces system of Tabriz metropolitan.

6. Conclusion

According to studies, following accelerating construction process in Tabriz metropolitan, especially in recent decades, the city suffered from severe damage in terms of ecologically important elements, particularly regarding green spaces and has lost these valuable spaces day by day to the benefit of economic gains(in terms of urban planning and urban physical development).

To resolve shortage of natural green spaces in cities, having a systematic and structured approach to the development of urban green spaces for present and future are necessary for proper planning for such spaces. Tabriz city with a high population density as well as having an increased density of housing and a variety of industrial and municipal facilities and equipment; requires a qualitative and quantitative improvement of urban green spaces in line with increasing ecological and social functions of these spaces.

In this study, using Delphi method after opinion polling relevant experts in the planning of urban green spaces, factors and variables involved in the development of green spaces were extracted and then driving and key factors for the future development of green spaces were specified after weighting, according to experts in MICMAC software.

Structural planning for the future development of urban green spaces, all factors involved in the planning of green spaces are considered like a system with intertwined elements and in the form of a structure. Moreover, associations between these factors are evaluated and factors with higher effect are extracted. These superior factors are used to plan the development of green areas so that ecological structure of urban green spaces bring sustainable development for the city in the best way. In order to achieve this goal, all components of natural, socio - cultural, ecological, economic, physical and urban landscape factors are involved as a system.

Finally, eleven factors; "managerial and institutional, proper locating for ecological development of green spaces, provision of sustainable water resources, maintenance and protection of green spaces, proper access for all citizens, Green space continuity, restoration of barren lands, dense planting, biodiversity, Beautification and design of green spaces" were determined among key factors for the future development of green spaces in Tabriz City and structural development of urban green spaces for present and future requires taking into account these key factors are in the planning process. If these key factors are coherently and systematically planned for the future development of green spaces in the city of Tabriz, they will help to creating perfect green spaces and substantially reduce environmental problems and consequently social and psychological problems in the city of Tabriz.

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