Cost Management of Urban Green Space (Case Study: Tehran)

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Abstract: Urban green space is one of the most important components in city management and cities' development given its social and environmental functions and financial and economic aspects. Different species of plants including trees, shrubs, cover crops and flowers or seasonal plants have specific features in terms of climate-compatible of Tehran and water demand. They also have different roles in meeting expected functions of urban green space, particularly prettification and reducing air pollution by producing oxygen. Thus, this paper tries to study selection criteria, assess plant species, and determine appropriate criterion for Tehran green space. Then, it determines relative weight of each one by surveying 35 experts' view in the form of group analytical hierarchy process (GAHP) method. The obtained weights are instruments for valuation of 60 Tehran's main plant species done by simple valuation (linear) and TOPSIS methods. The results indicated that evergreen oak, elm, and silver cypress are the most valuable species. Ranking of plant species were obtained by two mentioned methods in each of four groups that they were almost matched with each other. Using these ranks has increased at least 33 percent of productivity cost of urban green space in replanting project of municipality districts as well as increasing citizens' satisfaction and life of plant species that is in line with resistance economy.

Keywords: Analytical Hierarchy Process (AHP), urban green space, cost management, TOPSIS model
JEL Classification: C44, R15, M00, C54

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1- Introduction

Green spaces in cities are created for prettification, oxygenating, attracting aerosols (as a result reduction of air pollution), air-cooling, relaxing and eliminating stress, creating opportunity to strengthen social interactions, controlling floods, protecting wildlife habitats, anti-allergy, releasing fresh smell, reducing energy consumption (heating and cooling), covering unfavorable views including disproportionate objects such as telecommunications mast etc. Plant species of urban green space are divided into four groups including trees, shrubs, covering plants, flowers or seasonal plants. The unit of account of covering plants and flowers are square meter and flower pot respectively. According to different theories of researchers during 1985 to 2009, functions and services of urban green space include increase in physical activities, outdoor hobbies, health, social services, economic services, effective separator and reflector of insulation against short wave solar radiation, improvement of thermal energy, reducing internal temperature, heat saving, reducing air pollution, reducing poor air quality by absorbing gaseous pollutants (such as ozone and nitrogen dioxide), preventing aerosols (such as aerosols smaller than 10 microns including dust, ash and pollen), releasing oxygen, moderating local air temperature, reducing the number of conditions for the formation of ground-level ozone, reducing the risk of heat-related illnesses, stress reduction, reducing flood during storm, improving air and heating, storing rain and building dam, reducing the amount of flooding and delay in the initiation of peak water flow, reducing flood, washing emissions, getting pollution of rivers and lakes, increasing the attractiveness of communities, noise reduction, improving wildlife habitat and shelter, providing recreational opportunities, increasing neighborhood utility, air and water purification, wind and noise filtering, microclimate stabilization, psychological services, promoting aesthetic values, supporting biodiversity, creating a sense of peace and tranquility, rise in price of surrounding houses (Laghai & Bahmanpour, 2012).

City of Tehran has about 700 square kilometers area. Its height is about 900 to 1800 meters above sea level. Tehran average annual rainfall is 220 mm (www.tehran.ir). Tehran is the world 25th populated city and the largest metropolis in the Middle East. Currently, Tehran has about fixed population about 9 million people. Counting floating population of the guests, travelers and resident workers, it will be 14 million people. City of Tehran has 22 districts and 123 areas. In this research, districts' climatic conditions are considered equally. The cost of constructing and protecting green space, implantable area (passage trees, parks, urban afforestation, quarter and pieces of green space, and squares) of Tehran Municipality in 2015 for each district separately have been represented in table1.

Table1. The cost of green space (billion Tomans) and implantable area (hectare) of Tehran Municipality in 2015 for each district separately

District	Cost	Area	District	Cost	Area	District	Cost	Area	District	Cost	Area
1	65	825	7	9.5	125	13	12.9	285	19	34.45	654
2	32.4	1390	8	7.88	171	14	9.9	351	20	25.2	611
3	15.7	488	9	10.4	282	15	23	1018	21	24.2	647
4	36.2	1971	10	6.89	79	16	16.7	300	22	39	900
5	20.2	1235	11	10.9	135	17	11.3	88	Total	470	12559
6	12.1	305	12	18.3	141	18	27.85	556	Average	21.37	571

Reference: (www.tehran.ir)

There are different standards to determine the area of urban green space. According to the World Health Organization, there should be at least 20 square meters green space for each citizen in order to have healthy life. However, proposed standard by the US office of Public Health and Department of Housing is 18 square meters, and proposed standard by the United Nations' Environment sector is 30 square meters (Laghai & Bahmanpour, 2012).

This paper tries to investigate whether the main types of plant species of Tehran green spaces create different values or not and how valuation is done for species that affect urban green space cost management. The hypothesis is that the efficiency of urban green space can be increased by prioritizing plant species for planting and maintenance. In a way that, the highest efficiency and quality of the two main functions of green space (prettification, oxygenation and ecological efficiency such as air-cooling) is created with definite budget ceiling. Moreover, it reduces water consumption of green space. Totally, the compatibility of plant species is maximized with the whole city's climate leading to increase useful life of the species, and consequently, reduce the cost of green space cultivation.

Many definitions have been suggested for cost management. In a general concept, cost management is the process of planning and controlling the budget of a business. Attention to the cost productivity is of great importance in cost management. Cost productivity in each issue is the ratio of income (profit, value, satisfaction, etc.) to expenditures and consisting of effectiveness and efficiency. For managing and developing a city, municipalities are incurred a variety of current and development expenditures. They should be categorized in main issues including employee's salaries and benefits, energy carriers, asphalt, green space, cleaning in the flexible structure of cost.

The most common gaseous pollutants that plants play a major role in reducing them include carbon monoxide, nitrogen oxides, sulfur dioxide, ozone and particulate matter smaller than 10 microns (McPherson et al., 1997). According to the advisor to the minister of health in 2011, there were 4460 deaths caused by air pollution in Tehran. About 2318 deaths were related to particulate matter smaller than 2.5 microns and 2142 deaths were related to particulate matter smaller than 10 microns.

Severe air pollution in the capital and many metropolises, severe drought in the country and city of Tehran, and lack of green space per capita justify the importance and necessity of doing this research about productivity and cost management in urban green space. However, the large figure of urban green space budget confirms the importance and necessity as well.

2- Literature Review

a)Foreign Researches

Jiménez et. al (2014) in a study investigates the criteria of choosing plant species for development in green roof with thermal performance (heat exchange and cooling) in the metropolitan area Mexico City. 31 species representing at least 97 local species and 30 localized species were investigated. Survival criteria (evolving-revived), immigration status to the place (local, external or global), life cycle (constant, annual, or seasonal), water requirement, ability to grow in poor soil, attractiveness (beauty, color of flowers, flowering period) were considered. Finally, some proper species were detected for each criterion and four species were appropriate from all aspects for regional climate.

Li et.al. (2011) in a research presented methodology aspects of a proposed process to choose key tree species of Hefei street in China.

A selection was performed among available options of tree species by using Analytic Hierarchical Process (AHP) and experts' knowledge approach. The main criteria were resistance against challenges of urban environment, perspective features, ecological impacts, and economic factors. Then, combined assessment value was calculated for 68 tree species. Sorting them in descending order, 18 more valuable tree species were identified. The most valuable tree was a species of plantain (hybrid plantain or London plantain).

b) Iranian Researches

Azadi Nejat et.al., (2009) in a study used AHP in assessing urban afforestation in order to choose appropriate tree species in arid and semi-arid areas. The main criteria were 1. Aesthetics; including visible sub criteria in the forest, form and structure of the tree, leaf color variation 2. Ecological; including sub criteria of soil improvement (litter thickness, the ratio of carbon to nitrogen: C/N), herbaceous, persistency, compatibility (vitality, fecundity, survival) 3. Protective; including sub criteria of reducing soil erosion, reducing noise pollution, and reducing air pollution 4. Economical (without sub criteria). They believed that fuzzy AHP method could be used given the complexity of issues of choosing species and other decision-making issues in urban afforestation. Other decision-making methods including the function of the multi-criteria method, goal-programming method, and TOPSIS method can be used for prioritization and different choices. Comparing the results of decision-making methods, the best method can be identified and selected to solve the issue of choosing a species for afforestation in arid and semi-arid areas.

Mohammadi and Limaei (2014) in a research studied appropriate criteria of choosing a plant in urban green space and priority of planting locations compared to each other in terms of the mentioned criteria. This was done by designing and distributing 19 questionnaires among Isfahan Municipality experts, University of Isfahan, Department of Natural Resources of Isfahan, and completing them with interview, and then implementing AHP method with Expert choice software. The criteria were divided into four main categories including ecological (consisting of sub criteria of safety, reducing noise pollution, and wild life), economical (consisting of sub criteria of energy consumption, producing food and energy, and producing wood), social (consisting of sub criteria of recreational values and relaxation), and aesthetics (including sub criteria of perspective). Geometric mean of 19 expert's opinion was used. Finally, the weights of criteria and sub criteria are as follows: ecological: 0.623 (safety: 0.403, reducing noise pollution: 0.182, wild life: 0.050), economical: 0.082 (energy consumption: 0.031, producing food and energy: 0.053, producing wood: 0.024), social: 0.216 (recreational values: 0.066, relaxation: 0.140), and aesthetics (perspective: 0.051). Inconsistency rate for four main criteria is 0.07 and it is 0.08 for sub criteria. However, the weights of options (places of planting) are as follows: large parks: 0.302, rivers: 0.276, city center: 0.144, surrounding: 0.140, and streets 0.139. Inconsistency rate is 0.08 for the weight of options.

Asgarzadeh et.al., (2014) in a research studied the way of choosing plant for urban perspectives of semi-arid areas (case study: Tehran) and they presented a mathematical model for it. After grouping plants, selection parameters for each group of plants were defined. Then, plant species were ranked in a comparative way for each parameter and by a working group consisting of eight experts. AHP and hierarchical cluster analysis methods were used to find the most compatible plant species for the studied area according to the main selection parameters (tolerance limit, durability of the area, urban conditions, aesthetic aspect, maintenance, features of plant growth, and other specific factors). Many new plants were ranked higher in final tables indicating Tehran's urban perspective has high potential to enjoy more attractive green space perspective, less allergy, lower cost, and less water consumption.

3- Theoretical Principles

Criteria of selecting plant species in urban green space are main issues of this research. In an arid area, those plants are useful that need minimum watering and tolerate long drought periods. In areas with soils of high PH, those should be planted that are resistant to iron chlorides. Moreover, plants should be selected based on their resistance to local illnesses, insects and pest problems (Rupp & Libbey, 1996). Although aesthetics was traditionally the most important reason for growing plants in towns and cities, there are several reports regarding the impacts of trees on quality of life in urban areas in recent decades. However, providing mentioned aesthetics, social, and climate functions is achieved only with vital reserves of urban trees (Sjöman, 2012). Generally, criteria of choosing trees in streets are climate compatibility, resistance against illnesses, ability to grow and reproduce, aesthetics features, social factors, root quality, growth form and potential, resistance against wind, resistance against draught, resistance against breaking branch, and air pollution tolerance. Moreover, there are particular criteria including attention to historical, cultural, and natural aspects of tree, shape branches and leaves, defoliation and fall off in the ever greenness, allergenic, falling leaves and fruits, damage to roads and sidewalks (Gul et al., 2012).

The process of choosing plant species for urban consumption can be facilitated through applying the model of choosing species that Miler presented in 1997. Important factors in this model contain local factors (including environmental and cultural restrictions), economic factors (including the costs of planting, maintenance and removal), and social factors (including neighborhood, social values, access, and functional facilities, aesthetics of species, public safety, and social negative costs). Environmental restrictions to insects, illnesses, climate, soil, and cultural limitation are related to physical restrictions caused by structure and human activity, but Miler did not prioritize these factors (Sæbø et al., 2003).

Sadeghian and Vardaniyan (2013) divided three criteria of choosing trees and shrubs in Isfahan's urban parks including 1. Basic features of trees i.e. compatibility with climate, tolerating illnesses and pests, ability to grow and reproduce 2. Tolerating challenges of urban locations 3. Criteria related to welfare values and functions of trees in urban areas.

Bahmanpoor and Salagegheh (2009) determined indicators of choosing species to identify plant species compatible with Tehran climate by Delphi method and referring to experts' opinion. They divided main criteria into two ecological and social-functional categories. Ecological sub criteria are habitat conditions (need requirement), ecological expectation, root status, resistance against atmospheric factors, resistance against illness and pest, light requirements, resistance against soil and water salinity, air and soil pollution, type of coverage (fall and ever greenness), the status of tree crown. Moreover, socio-functional sub criteria include shadow, stability against wind and storm, levels of pollen release and allergens, color (colorful species), reducing noise pollution, reducing air pollution, and annual growth.

Necessity and Minimum Diversity of Plant Species in City

It can be assumed that using wide variety of species leads to bigger aesthetics changes and healthier trees in urban areas. Increase in number of species leads to increase in aesthetics diversity and quality of urban forests and fostering a sense of identity and differentiation in cities (Sæbø et al., 2003). Some studies recommended increase in diversity of urban tree species.

Barker (1975) was one of the pioneers who suggested using a wide range of species and recommended that a given species should not more than 5 percent of tree population. Smiley et.al., (1986) and Miler & Miler (1991) recommended that the maximum ratio of each species should be less than 10 percent of total population. Grey and Deneke (1986) presented a similar perspective. For instance, one species should not be more than 10 to 15 percent of total population. Moll (1989) in a refined model recommended that no species should be more than 5 percent of city trees. Moreover, no category should be more than 20 percent, and no family should be more than 30 percent of total population (Sjöman, 2012). However, Miler (1997) proposed to ensure maximum protection against pest that urban forests should not include more than 10 percent of each single species, more than 20 percent of species in a bunch, and more than 30 percent of species in a family (Santamour Jr, 2004).

Analytical Hierarchy Process (AHP) method

AHP is one of the most important multiple-criteria decision-making (MCDM) models proposed by Saaty in 1980. This method is a theory of measurement via paired comparison emphasizing on experts' opinions to extract priority scales. The first step in AHP is to create a graphical representation of the problem in which purpose, criteria, and alternatives are represented. The way of making a hierarchy depends on the type of made decision (Qodsipoor, 2006).

Mau-Crimmins et.al., (2005) presented AHP stages considering to Saati theory as follows:

1- Creating a problem structure as hierarchy

2- Choosing options and judgment about decision-makers' relative priorities (with paired comparisons)

3- Using numbers to calculate priorities of each criterion and sub criterion in hierarchy and calculating compatibility and relative weights

4- Combining results (relative weights in different levels) to obtain final weight and determining the best option

If there is only one decision maker to evaluate criteria and options, typical AHP method will be used, and if there are some decision-makers, group AHP method will be used. In a group AHP method, geometric mean of numbers related experts' judgments is used for each criterion or option.

Aczel and Saati (1983) indicated that geometric mean is the best method to integrate judgments in a group AHP (Ghodsipoor, 2006) since the flexibility property of comparisons is kept in this mean (Asgharpoor, 2006).

Comparisons are made by using a scale of complete judgments that represents how much an element prevails over the other considering one property. Judgments can be inconsistent. To measure inconsistency and obtain a better consistency, judgments should be improved that is the concern of AHP method (Saaty, 2008).

Rahmani et.al., (2009) generalized least squares algorithm to calculate priority vector given the importance of consistency in the Analytical Hierarchy

Process and presented a simple method to detect inconsistency and fixing it in pair comparison matrix.

TOPSIS Method

One of the weaknesses in AHP is when number of paired comparisons goes up and makes the work difficult. In order to remove this weakness, TOPSIS method should be used. It is one of the most popular MCDM methods proposed by Hwang & Yoon in 1981 for the first time. The basis of TOPSIS is selecting the option that is closest to the positive ideal solution and has maximum distance from the negative ideal solution (Hwang & Yoon, 2012). TOPSIS algorithm includes the following steps:

1- Converting the existing decision-making matrix to a normalized matrix (by using Euclidean norm)

2- Creating a normalized balanced matrix (given the weight vector) as an input

3- Determining ideal solution (positive) and negative ideal solution

4- Calculating distance of options by ideal solutions (by using Euclidean method)

5- Calculating relative proximity of options to ideal solution

6- Ranking options in descending order of relative proximity

4- Research Methodology

In order to determine appropriate criteria and sub criteria for Tehran's green space, experts' opinions in the field of green space in Tehran Municipality were used as well as considering related literature, theoretical principles, and modeling given Tehran's specific climatic conditions. The results have been represented in diagram 2 with their hierarchy. Other criteria and sub criteria were not investigated in this research because of some reasons. For instance, some criteria are not applied in the city of Tehran or they have no importance (such as resistance against strong winds). Some others are used for a specific group and they are not applied in all groups (including shadow that is related to trees). The independence test of main criteria was used by Chi-square indicating that they are independent at the level of 10 percent.

In this research, first, descriptive-survey method was used. After defining the problem and the introduction of assumptions, criteria and sub criteria of choosing plant species in Tehran were determined by using previous studies and literature review and using expert's opinions. Then, 35 experts in the field of urban green space (including 25 administrative managers or experts in Tehran Municipality and 10 experts of green space with academic degree) were surveyed about the importance and relative weight of criteria and sub criteria with AHP method through designing and distributing form of data collection. However, non-random sampling method was used since the sample included managers and experts. The results can be reliable as they were 30 ones and central limit theorem. According to the Department of Parks and green spaces in Tehran, about 185 plant species have been planted in this city. In this research, 60 species (15 ones in each group) that are more widely used, and they can be planted in all districts according to experts, were examined as main species. Since these numbers are the most important plant species in Tehran, they were not compared in paired ones in terms of each criterion or sub criterion rather the value of each green space species was obtained in terms of each criterion and sub criterion based on 9-point Likert scale (1 to 9) with another form with same experts simultaneously (table2).

The mentioned forms were not questionnaire; therefore, their validity and reliability were not needed. Data collection tool was in form of tables. The necessary data were obtained based on 9-point Likert scale by justifying experts about the manner of inserting priority between two criteria or sub criteria.

Table2. 9-point Likert scale

Value	Same preferences	Intermediate	Little preferred	Intermediate	Better	Intermediate	Much better	Intermediate	Quietly better
Priority	1	2	3	4	5	6	7	8	9

Reference: (www.ariamodir.com)

The reason of using qualitative and judgment method instead of quantitative and objective method is that there were only a few quantitative studies have been done about some criteria including oxygenation (carbon capture and ecological efficiency), water requirement, and some sub criteria of inconsistency with climate. Moreover, there are few active laboratories in this field. Economically, it was not possible to order to provide a quantitative and accurate data and information of 60 plant species. However, very small inconsistency rates have been obtained in AHP indicating proximity of experts' opinions and their reliability. In this research, the output of AHP method was used as an input of TOPSIS method. In fact, prioritization of plant species in the city of Tehran was obtained by combining two mentioned methods.

5- Research Findings

Hierarchical structure of purpose, main criteria, and sub criteria of the issue have been defined as diagram2. Geometric average of theories' numbers for 35 experts about criteria and sub criteria was calculated. Then, the weight of each main criteria and sub criteria was calculated by using software. These weights have been represented in diagram 1.

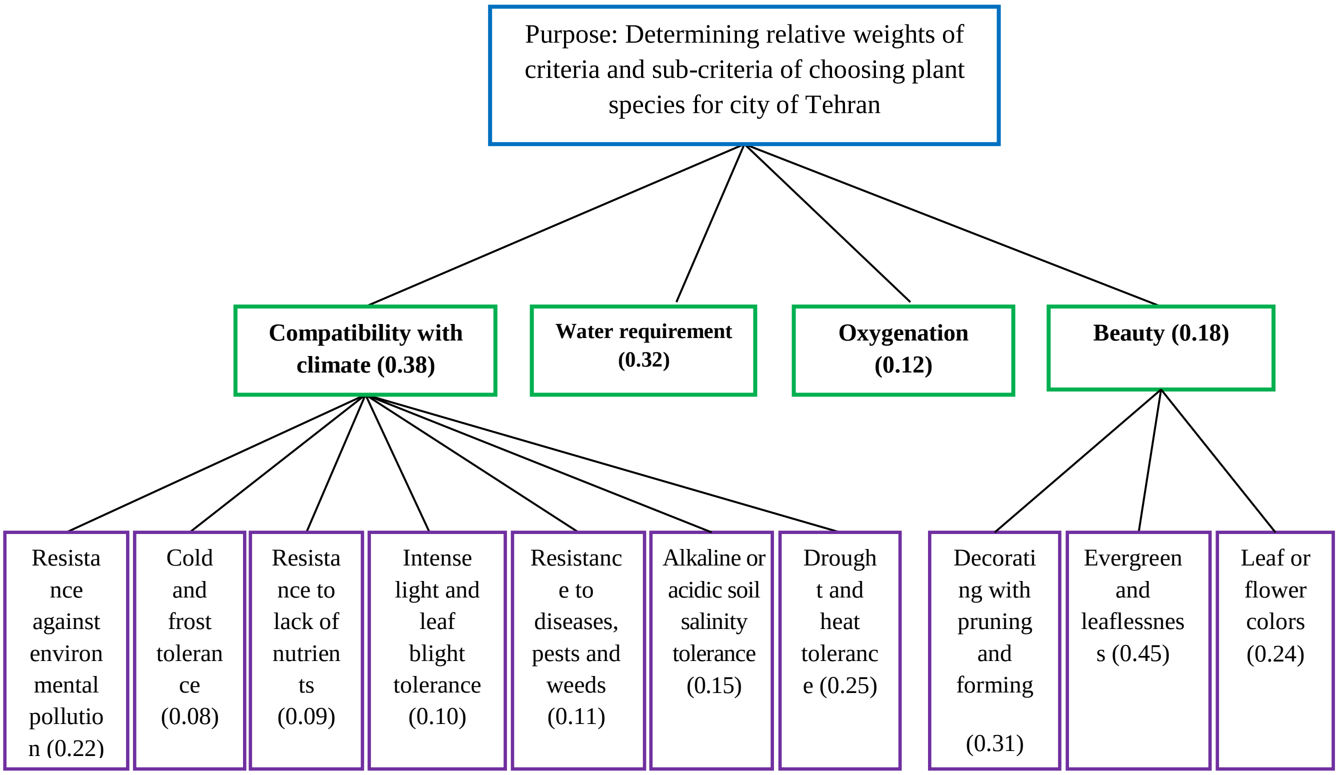

Diagram 1. Hierarchical structure and relative weights of criteria and sub criteria of the issue

Reference: (Researchers' findings)

Inconsistency rates for four main criteria and three sub criteria of beauty and seven sub criteria of climate-compatible were calculated 0.0003, 0.024, and 0.032 respectively. Since all three values are smaller than 0.1, the results are reliable. Applying the weights of criteria and sub criteria on the results of the second form for each plant species, a value score (between 1 to 9) was obtained. The results have been represented in table3.

Mathematical explanation of simple valuation method (linear) with W indices: weight, O: oxygenation, B: beauty, M: match with climate, L: Water requirement and C_i: the score of species value of i as follow:

$$W = W_O + W_B + W_M + W_L = 1$$

$$C_i = W_O * O_i + W_B * B_i + W_M * M_i + W_L * (9 - L_i)$$

Given that generally 9-ponit Likert scale is used in AHP method for paired comparisons, Likert scale is considered to score plant species in terms of each criterion or sub criterion in 9 points that is more accurate for changing a descriptive issue to quantitative one. The criterion of water-requirement has negative aspect; therefore, the result of subtracting the water requirements of 9 (maximum score) was used for each species.

In order to solve this issue with TOPSIS model, instead of calculating the weights of criteria with methods that are not based on experts' opinions (such as Shannon Entropy method), we use AHP method from obtained weights directly. The result (CL* or relative proximity to ideal solution for each of plant species and their ranking) have been represented in table4.

Table3. The score of main plant species value of Tehran's green space and their ranking with linear simple valuation method

Tree				Shrub				Cover Plant				Seasonal Flower			
Row	Species Name	Value	Score	Row	Species Name	Value	Score	Row	Species Name	Value	Score	Row	Species Name	Value	Score
1	Morus Alba	4.50	7	16	Pyross	4.44	5	31	Lawn	5.56	1	46	Violaceae	4.06	8
2	Pinus Eldarica	3.92	15	17	Cedrus	4.15	11	32	Sodomie	4.11	7	47	Petroselinum Crispum	4.20	2
3	Platanus	4.61	4	18	Theron	4.77	2	33	Rosmarinus Officinalis	4.05	8	48	Calendula Officinalis	4.02	11
4	Olive	4.08	12	19	Oleander	4.47	4	34	Atriplex Spp	4.13	6	49	Petunia Atkinsiana	3.65	15
5	Fraxinus Excelsior	4.23	10	20	Pyracantha	5.00	1	35	Franconie	3.37	15	50	Ornamental Cabbage	4.10	6
6	Ulmus	5.00	2	21	Viburnum Opulus L.Var Sterile	4.40	6	36	Phalaris	3.64	14	51	Chrysanthemums	4.16	4
7	Philadelphus Coronarius	3.96	14	22	Cotoneaster Frigidus	4.36	7	37	Silver Cloud	3.84	11	52	Matthiola Incana	3.82	13
8	Robinia	4.52	5	23	Berberis Thunbergii	4.36	8	38	Willisau Makya	4.21	4	53	Araucaria Araucana	4.06	9
9	Morus Alba	4.50	6	24	Sudagh	4.04	14	39	Festuca	4.19	5	54	Dahlia Mountain	4.23	1
10	Paulina	4.46	8	25	Haloxylon	3.91	15	40	Ivy	4.56	2	55	Achlantus	4.02	10
11	Cypress	4.92	3	26	Albizzia Lebbeck	4.27	10	41	Lavan	3.77	12	56	Cute Sun	4.01	12
12	Bitter Olive	4.44	9	27	Genisteae	4.07	13	42	Ajukka	4.01	10	57	Corpses	4.10	7
13	Holm Oak	5.07	1	28	Cercis Siliquastrum	4.12	12	43	Honeysuckle	4.35	3	58	Gaillardia	4.20	3
14	Hackberry	4.05	13	29	Yucca	4.53	3	44	Coquetry	3.66	13	59	Coastal Gazania	4.12	5
15	Typical Acacia	4.18	11	30	Japanese Quince	4.30	9	45	Sajyna	4.05	9	60	Amaranthus	3.70	14
Average		4.428		Average		4.346		Average		4.100		Average		4.029	

Reference: (Researcher's findings)

Table4. The value score of each main plant species of Tehran's green space and their ranking by using TOPSIS method

Row	Species Name	CL*	Rank	Row	Species Name	CL*	Rank	Row	Species Name	CL*	Rank	Row	Species Name	CL*	Rank
1	Morus Alba	0.292	8	16	Pyross	0.548	2	31	Lawn	0.968	1	46	Violaceae	0.368	4
2	Pinus Eldarica	0.090	13	17	Cedrus	0.238	8	32	Sodomie	0.472	4	47	Petroselinum Crispum	0.113	11
3	Platanus	0.250	10	18	Theron	0.528	4	33	Rosmarinus Officinalis	0.484	3	48	Calendula Officinalis	0.055	15
4	Olive	0.260	9	19	Oleander	0.537	3	34	Atriplex Spp	0.101	8	49	Petunia Atkinsiana	0.307	6
5	Fraxinus Excelsior	0.112	12	20	Pyracantha	0.906	1	35	Franconie	0.023	15	50	Ornamental Cabbage	0.157	9
6	Ulmus	0.815	2	21	Viburnum Opulus L.Var Sterile	0.220	10	36	Phalaris	0.026	13	51	Chrysanthemums	0.928	1
7	Philadelphus Coronarius	0.119	11	22	Cotoneaster Frigidus	0.438	6	37	Silver Cloud	0.035	12	52	Matthiola Incana	0.239	8
8	Robinia	0.312	7	23	Berberis Thunbergii	0.474	5	38	Willisau Makya	0.197	6	53	Araucaria Araucana	0.324	5
9	Morus Alba	0.348	6	24	Sudagh	0.083	14	39	Festuca	0.173	7	54	Dahlia Mountain	0.408	3
10	Paulina	0.352	4	25	Haloxylon	0.045	15	40	Ivy	0.672	2	55	Achlantus	0.089	13
11	Cypress	0.776	3	26	Albizzia Lebbeck	0.232	9	41	Lavan	0.061	10	56	Cute Sun	0.101	12
12	Bitter Olive	0.351	5	27	Genisteae	0.168	11	42	Ajukka	0.097	9	57	Corpses	0.278	7
13	Holm Oak	0.896	1	28	Cercis Siliquastrum	0.119	13	43	Honeysuckle	0.375	5	58	Gaillardia	0.124	10
14	Hackberry	0.064	15	29	Yucca	0.429	7	44	Coquetry	0.025	14	59	Coastal Gazania	0.460	2
15	Typical Acacia	0.088	14	30	Japanese Quince	0.159	12	45	Sajyna	0.049	11	60	Amaranthus	0.071	14
Average		0.342		Average		0.342		Average		0.251		Average		0.268	

Reference: (Researcher's findings)

If total ranks of each 60 plant species are considered based on two methods of simple valuation (linear) and TOPSIS according to tables 3 and 4, diagram 3 can be drawn. According to diagram3, the rankings of plant species that obtained by two simple valuation (linear) and TOPSIS methods are almost match with each other.

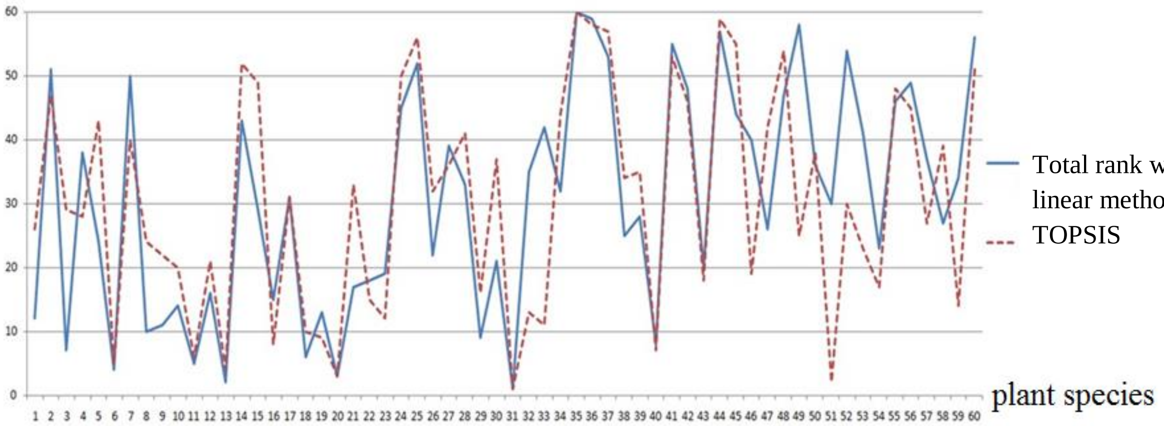

Diagram3. Comparison of total ranks of plant species with two simple valuation (linear) and TOPSIS methods

Reference: (Researchers' findings)

To prove the hypothesis, higher productivity of urban green space cost should be indicated with proposed method than status quo. About urban green space, cost productivity index is the ratio of the total value created in the total construction and maintenance cost. First, we consider the following simple model of linear planning:

i: plant species

j: district

C_i: the value of plant species of i

E_j: Annual budget of district's green space of j

a_i: required area of each unit of species of i

A_j: implantable area in the j district

X_{ij}: number of species of i that planted in j district

Z: the score of total created value in city by green space

$$\text{Max } Z=\sum_{i=1}^{15}\sum_{j=1}^{22} C_i X_{ij}$$

S.t.:

$$E_j=\sum_{i=1}^{15}\sum_{j=1}^{22} e_i X_{ij}$$

$$A_j=\sum_{i=1}^{15}\sum_{j=1}^{22} a_i X_{ij}$$

$$X_{ij} \geq 0$$

$$i=1, 2, ..., 60 \quad \& \quad j=1, 2, ..., 22$$

E_js and A_js are based on realities and according to table1. e_is and a_is were determined by experts. The dominant species in each region are clear, but there is no exact statistics of current species in each district. Thus, X_{ij}s have been estimated in calculations. Accordingly, the total score of created value in the city of Tehran by current green space has been estimated about 31 million (that is a normalized number i.e. without scale). Hypothetically, we fill implantable space of each district with species with their CL* priority according to table 4. This is done by considering the annual cost of planting and maintaining limits, required area for each species, and allocation of (X_{ij}) to the ratio of CL * of each species to total CL*s. Now, we can calculate the total created value. It is about 41.25 million that is more than 33 percent compared to current situation.

6- Conclusion

Recent news indicates attention to the cost of urban green space. For instance, Varamin Mayor announced municipality plan to develop green space and increase budget three times in this field in May 2015. In January, CEO of Department of Parks and green spaces of Tabriz municipality named that year "priority of green space and its visibility in the budget of areas." Expanding green space with the suggested method will increase at least 33 percent productivity price. For example, if total score of created value is 470 billion Tomans by green space (in terms of beautification, reducing air pollution, compatibility with climate and durability, water saving), the score of total mentioned value will be at least 1.33 times by implementing the suggested method with this budget indicating cost management. In fact, if suggested method is not used, we should spend more than 625 billion Tomans for Tehran's green space in order to obtain the total value of 1.33 times of current situation i.e. implementation of suggested method for Tehran will be followed by reducing more than 155 billion Tomans.

Briefly, the suggested method includes the following steps:

1. Determining criteria of choosing species for the intended city, classification, and determining their hierarchy
2. Surveying experts to determine implantable species and their score in terms of each criterion
3. Surveying experts to determine the weight of each selected criterion by using group AHP method
4. Valuation and ranking species with two simple valuation (linear) and TOPSIS methods (by indicating the relative weights of criteria from step 3 as a model input)
5. Determining optimal combination of species in districts and using the results of steps 3 and 4 in planting and cultivation programs of green space for intended city

Totally, trees create more value in a city than shrubs, covering plants, flowers, and seasonal plants. This research will be completed by research about appropriate arrangement of plant species in existing green space of the city in order to balance their number/amount in districts, areas, and neighborhoods given population, air pollution, and their green space per capita, and considering proper distribution of main function in line with social justice.

Thus, it is recommended to perform a comprehensive plan in different areas of Tehran according to the results and considering budget limits and implantable area (parks, urban afforestation, local green space, squares, etc.) in cultivation and planting steps of species based on their value-creation in the city (in terms of beauty, oxygenation, compatibility with climate, and less water requirement). In order to diversify, beautify and to ensure maximum protection of plant species against pests and diseases (avoid wasting a large proportion of plants in city in each group against pests and diseases of a special species), given to previous studies and Tehran's conditions, it is better to plant at least seven types of trees, seven types of shrubs, six types of covering plants, and eight types of seasonal flowers. In case of having accurate statistics of numbers and type of planted species in each of Tehran's districts and their remaining life, optimal answer can be achieved by modeling the problem in the form of linear planning and solving it with operational research soft wares in future researches. However, the output of this model will be not implemented immediately for the city of Tehran since it is obvious that removing and dismantling the current species that will not be matched with model output will not be economical. In fact, at this point, the model output for the city of Tehran just can specify replacement priority of species in different areas in cultivation stage (after finishing plant life). The authors believe that mathematical method of this paper can be applied to design green space of a new city close to the climate of Tehran. Moreover, it can be used in plants' cultivation of green space in current cities.

7- References

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