

Study of the sustainability of principles of design and degradation extent of Bardarash park in Duhok governorate

Avraz Murad Omar1

Dr. Yousif H. Hammo2

Agricultural Engineering - Duhok Municipalities Prof. - Hort. Dept. College of Agri. Sci.
-Univ. of Duhok

avrazmurad88@gmail.com

yousifhamm@uod.ac

Abstract

The experiment was conducted from August 2024 to June 2025 in Bardarash park/ Duhok Governorate/ Kurdistan Region of Iraq. The main objective was to evaluate the state of garden design principles, functional, aesthetic and agricultural services through a visitor questionnaire and assessed the extent of degradation by conducting field surveys. The best results include 61% of participates participate said that the principle of unity is achieved, 53% showed there is no balance, 45% showed that trees, shrubs and other elements are distributed appropriately throughout the park. Whereas 69% of participates said that the site or location for this park is good and appropriateness, 45% of said that the environmental and health functions is in good condition whereas 10% said that it is in bad condition. Only 32% of the participates said that the agricultural services are sufficient in this park. Only 21% said that the agricultural services appropriate with the number of workers in this park, whereas 40% said opposite (No. (

The highest weight of arithmetic means for unity principle (2.59), simplicity (2.35) whereas the highest weighted are 2.58 for the variable (park suitable or appropriate to the site) then 2.38 for the variable (the plants of park are sustainable within the region) and 2.35 for (park achieve the environmental and health functions). Relatively the number of seats is very few (29) only for this park. The surviving trees only 1191 with (60%) percentage while the dead trees were 795 with (40%), *Ligustrum japonicum*, *Thuja orientalis*, *Pinus brutia*, *Melia azedarach*, *Lagerstroemia indica* showed 100% survival, complete loss of *Cotoneaster salycifolia* (100%) and *Abelia grandiflora* (98%.(

Keywords: Bardarash, Landscape design, Principles of design, Aesthetic value, Functional value, Degradation of park .

Introduction

Bardarash District is located between latitude 36° 30' 03.65" N and longitude 43° 35' 04.998" E, at an elevation of 379 meter above sea level. It covers an area (961) km², with an estimated population of 173829 individuals according to Dohuk statistics directorate [8]. It's 90 kilometers from away Duhok Governorate. It has a big park are called

(Bardarash park) total area (36187) m² [2]. Bardarash district is located in Dohuk Governorate, Duhok City located in the northwestern part of the Iraqi Kurdistan between altitude 36° 51' 38.077" N, longitude 42° 52' 02.998" E and on elevation 565 meter above sea level with area about 76.06 km² [18]. Landscaping is the art of modifying or

enhancing the natural features of a piece of land to make it more aesthetically pleasing and functional. It involves a wide range of activities, from planting trees and shrubs to installing pathways, patios, and water features. Landscaping is a popular hobby for homeowners, as it allows them to create a beautiful outdoor environment that they can enjoy and share with others [1]. Parks is a natural, artificial or semi-natural public area set aside for ornamental or recreational purposes. Parks may consist of grassy regions, landscapes, rocky areas, trees, buildings, recreational centers, sports facilities, swimming pools, soccer pitches, dog-designated area, find monuments and fountains within parks. Parks are controlled by the relative authority or government body. Some parks can be large with thousands of square miles of natural areas, comprising mountains, rivers, wildlife, and vegetation. Urban green spaces play an important role and have a positive effect on the quality of life in cities [14,9]. The elements used in landscaping are described below, living elements, such as flora or fauna; or what is commonly referred to as gardening, the art and craft of growing plants with a goal of creating a beautiful environment within the landscape. Natural elements such as landforms, terrain shape and elevation, or bodies of water; human elements such as structures, buildings, fences or other material objects created and/or installed by humans; and abstract elements such as the weather and lighting conditions [19]. Greener growth is an important component of sustainable development as it protects the environment and allows economic growth [3]. It is fundamental for the people's needs and their rest and are a good indicator for the

progress and development of the country and ensure continued tourists attracting, investors, and improving the quality of life for its residents [21.]

principles of design

Design principles include unity, balance, transition, proportion, rhythm, focalization, repetition, simplicity and scale etc., are terms often associated with art. These terms are used to guide an artistic expression, and in landscape design, they are just as important as in other art forms. All effective landscape designs rely on basic principles. An understanding of these principles can keep you from creating a landscape beast instead of the beauty that you dream about [13.]

Functions and Values of Landscape Design

Landscape plants that include trees, shrubs, and turf remove smoke, dust, and other pollutants from the air so they improve air quality, one tree can remove 26 pounds of carbon dioxide from the atmosphere annually, equaling 11,000 miles of car emissions, a study showed that 1 acre of trees has the ability to remove 13 tons of particles and gases annually [7]. Estimated value of trees in U.S. Urban parks \$300 billion, air temperature reduction likely in the billions of dollars per year, air pollution removal \$500 million per year, grass provides the same function, one tree or a 2,500- square foot lawn each release enough oxygen each day to supply a family of four reduced ultraviolet radiations likely substantial [16]. Properly selected and placed plantings absorb sound waves, and can significantly reduce unwanted 'noise pollution' additionally, some plants make pleasant sounds of their own [20]. The visual

beauty and property can be enhanced through creative landscaping while undesirable features can be downplayed [15]. There is clear evidence that exposure to green space improves our mental well-being and reduces the need to treat mental health conditions, such as depression and anxiety [11,4,5]. Functional value landscaping offers a special functional value too. A little shade in the right place, a little sun in another, a place for the kids to play, a private patio, pool all add to the enjoyment of being outside. Also, according to a small park includes both trees and shrubs can trap up to 68 metric tons of dust per hectare annually [17]. Environmental value environmental benefits of a good landscape design can provide climate control and many other energy-saving measures. For example, trees and shrubs can influence wind, water, light, noise, and temperature around the home landscape. Water can be conserved and used more efficiently [6.]

The aims of this research were to studying the extent of application of garden design principles and their sustainability, functional, aesthetic condition and agricultural services which performed for Bardarash park in Duhok governorate by conducting a theoretical study (Questionnaire form) for the visitors of this park, and to evaluation of the degradation extent of this park by comparison between the condition of this park to day and at the beginning of construction.

Materials and Methods

The experiment was conducted from August 2024 to June 2025 in Bardarash park/ Bardarash District/ Duhok Governorate/ Kurdistan Region of Iraq. between latitude 36° 30' 03.65" N and longitude 43° 35' 04.998" E,

at an elevation of 379 meters above sea level. The main objective of study was to evaluate the application state of principles of landscape design, functional, aesthetic condition and agricultural services through a visitor questionnaire and assessed the extent of degradation by conducting field surveys.

The research was carried out by conducting the following points:

-1Getting the maps and the basic AutoCAD maps of park from the Duhok municipalities directorate [10], use Google Earth (a computer program that renders a 3D representation of earth based primarily on satellite imagery) for getting the park picture. Maps Me (a mapping application that users can access offline, it functions almost similar to Google Maps, only it can work without internet access). Geographical information system (GIS) that allows handling and analyzing geographic information [12 .]

-2Evaluation of this park by using number of questions, using the (questionnaire form) for 100 visitors to evaluate the extent of application of garden design principles, functional, aesthetic condition and agricultural services and their sustainability. Then analyze them to obtain its evaluation degree.

3-Field survey, to obtain the number and scientific name of all the plants that cultivated in this park, lawns state, the state of the irrigation system, pruning state of all plants that need pruning, walkways state and all the industrial facilities that it contains. To know the sustainability of its plants and the deterioration that occurred in all park elements then made a comparison with these elements at the beginning of construction since 2012 until mid-2025 to know the sustainability of

its plants and the degradation that occurred in all park elements.

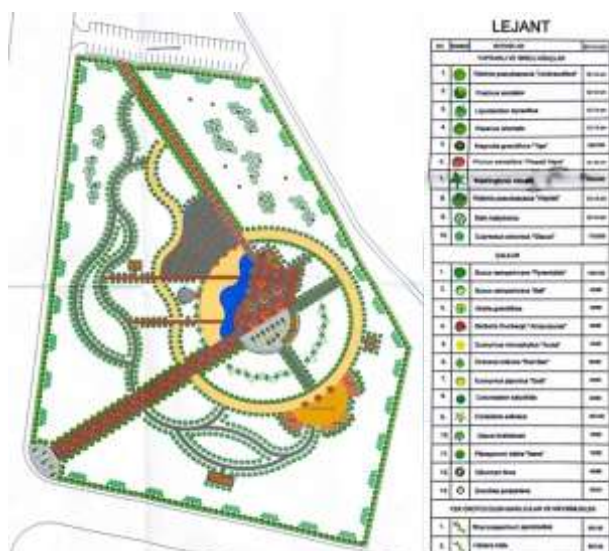


Fig 1: Design AutoCAD maps of park, Photo from Duhok Municipalities



Fig 2: Bardarash park map, Photo from Google earth

The research include

-1The first study. A study of the design principles, functional, aesthetic condition and agricultural services and their sustainability for Bardarash park from the visitors' perspective. This study includes two parts

First part. (personal and social variables of visitors.)

Second part. (includes two domain.)

First domain. (extent of application of landscape design principles and their sustainability) for Bardarash park. The scale includes three degrees (Yes=3, nearly=2, No=1.)

Second domain. (evaluation of the functional and aesthetic condition and agricultural

two study as follows:

services which performed for Bardarash park). (Good= 3, Medium= 2 and Bad= 1.)

-2Second study. Study of the degradation extent of Bardarash park for the period between 2012 and 2025 by use a survey procedure and compared between the two results of dates.

The measurement of these studies. number of respondents and their percentage, weighted arithmetic mean, and Pearson's correlation coefficient between factors and each variable, Duncan Multiple range test for the weighted arithmetic mean, number and name of the park components. All data were analysis by use SAS program and the means are compared by use Duncan Multiple range test at level 5%.

Results and Discussion

This research includes two studies :

First study: A study of the design principles, basic elements, functional, aesthetic condition and agricultural services and their sustainability for Bardarash park from the visitors' perspective .

This study includes two parts:

First part: (personal and social variables of visitors.(

The results in table (1) presents the demographic distribution of respondents in Bardarash park. The gender distribution indicates a higher proportion of male respondents (70%) compared to female (30%), suggesting either greater male presence in the park during the survey period or higher male participation willingness. Age distribution shows that the largest group of visitors is in the 18–25 age ranged (37%), followed closely by those aged 26–31 (33%), with visitors over

31 years comprising 30% of the sample. This pattern reflects a relatively young visitor population, possibly due to the park's recreational appeal to younger age groups. Regarding academic achievement, respondents are distributed across education levels, with college graduates representing the largest proportion (32%), followed by secondary education (29%), institute graduates (25%), and primary education (14%). This distribution suggests that the park attracts visitors from diverse educational backgrounds, with a slight dominance of higher-educated persons .

This table shows that the survey gathered opinions from a young and relatively educated sample, with a strong bias towards male respondents. While the age distribution is good, the gender and education imbalances are important limitations.

Table 1. Presents the individual characteristics of the respondent sample for Bardarash Park.

Individual characteristics	Categories	Frequency	Percentage
Gender	Male	70	70
	Female	30	30
	Total	100	100
Age (year)	18-25	37	37
	26-31	33	33
	More than 31	30	30
	Total	100	100
Academic achievement	Primary	14	14
	Secondary	29	29
	Institute	25	25
	College	32	32
	Total	100	100

Second part. (includes two domain : (

-1 Number of respondents and their percentage, weighted arithmetic mean, and Pearson's correlation coefficient between factors and each variable for first domain (extent of application of garden design principles and their sustainability) for Bardarash park. The scale includes three degrees (Yes=3, nearly=2, No=1.)

The results in table (2) indicated that 61% of participates participate in the questionnaire said that the principle of unity is achieved in this park, whereas 37% said that this principle are nearly achieved and 2% said no unity is achieved. Only 19% of participates in the questionnaire showed that there is balance between the different elements of the park where as 53% of the participates show that there is no balance are achieved among the park elements. 24% of participates participate in the questionnaire said that the principle of transition and gradation is correctly in this park, whereas 45% said that these principles are nearly correctly and 31% said no transition and gradation is incorrectly. 41% of the participates said that the proportionality among the park element is fulfilled, whereas 42% are said nearly fulfilled. Only 31% of the participates said that the rhythm among the park elements is achieved, whereas 55% said nearly achieved. 42% showed that the repetition is correct between the different element of park were as 22% showed the opposite. Only 17% of the participates said that the focalization is existing in this park whereas 49% showed the opposite. The simplicity is achieved as mentioned by

participates participate with 43% whereas 49% said it is achieved nearly. 37% of the participates showed that the scale among the elements of park is achieved where as 44% said that it achieved nearly. Only 34% of the participates said that the spaciousness among the park elements is achieved, whereas 45% said nearly achieved and 21% said no spaciousness is achieved. 38% presented that the accent is correct between the different element of park, whereas 22% showed the opposite and 40% are said nearly fulfilled. The time factor is taken in to consideration in the design and implementation of park elements in percentage (23, 51 and 26) % for (Yes, Nearly and No) levels respectively. 35% of the participates said that the light and shade are not taken in the consideration of the design and implement of the park versus to 26% which said yes. 45% of participates showed that tree, shrubs and other elements are distributed appropriately throughout the park versus 19% which said that the distribution is not wright. 30% of participates said that the park has variety and different elements where as 43% said that this principle is nearly achieved versus 27% which said that it is not good.

The highest weighted arithmetic means as shown in table (2) are 2.59 with (86.33%) from the highest degree (3) for the variable (No.1) (is the unity principle achieved in this park), then 2.35 with percentage reach 78.33% for the variable (No.8) (is there simplicity in park design) and 2.26 with percentage reach 75.33% for variable (No.14) (are the tree, shrubs and other elements distributed a properly throughout the park). This mean that the perform of these variables are in good

states compared with the highest degree for the scale (Yes=3). The lowest weighted arithmetic means as shown in the same table are 1.66 with percentage reach 55.33% from the highest degree (3) for the variable (No.2) (is the balance between the deferent elements of the park is achieved), then 1.68 with percentage reach 56% for the variable (No.7) (is the focalization being existent in the park). And 1.91 with percentage reach 63.66% for the variable (No.13) (are the light and shade taken the consideration in the design of the park) this mean that the perform of these variables are in acceptable states compared with the highest degree for the scale (Yes=3.)

It is clear from the table (2) that the negative significantly correlation was between gender

and variable (No.3) (is transition and gradation between the park elements done correctly) as in the equation ($r = -0.239^*$) females are more critical of how transitions and gradation between park elements are implemented than males. Positive significant correlation between age and variable (No.8) (is their simplicity in park design) as in the equation ($r = 0.205^*$) older respondents more satisfied with simplicity than younger visitors. Negative significantly correlation was between the academic level and the variable (No.9) (is there scale among the park element being fulfilled) as in the equation ($r = -0.255^*$) higher education linked to lower satisfaction with scale and vice versa .

Table 2. Description of the study variables (extent of application of garden design principles and their sustainability), number of respondents and their percentage, weighted arithmetic mean, and Pearson's correlation coefficient between gender, age, academic achievement and each variable for first domain (Bardarash park.)

NO	Variables	Levels						Total		Weighted means	Pearson Correlation between		
		Yes		Nearly		No					Var × Gender	Var × Age	Var × Academic
		Frequency	%	Frequency	%	Frequency	%	Frequency	%				
1	Is unity achieved in this park or does it appear as if it is multi-jointed?	61	61	37	37	2	2	100	100	2.59	0.095	-0.066	-0.076
2	Is the balance between the different elements of the park is achieved?	19	19	28	28	53	53	100	100	1.66	0.106	0.041	-0.116
3	Transition and gradation between the park elements is done correctly?	28	27	45	43	31	30	104	104	1.93	-2.39*	-0.091	-0.022
4	Is there proportionality among the park elements is fulfilled?	41	41	42	42	17	17	100	100	2.24	-0.144	-0.073	-0.112
5	Is the rhythm among the park elements achieved?	31	31	55	55	14	14	100	100	2.17	0.091	-0.147	-0.04
6	Is there a correct repetition between the different elements of the park?	42	42	36	36	22	22	100	100	2.20	-0.028	-0.166	0.024
7	Is the focalization being existent in the park?	17	17	34	34	49	49	100	100	1.68	-0.163	-0.02	0.051

8	Is there simplicity in park design?	43	43	49	49	8	8	100	100	2.35	0.053	0.205*	-0.064
9	Is there scale among the park elements being fulfilled?	37	37	44	44	19	19	100	100	2.18	-0.078	-0.08	-0.255*
10	Is there spaciousness in the park elements?	34	34	45	45	21	21	100	100	2.13	0.027	-0.018	0.081
11	Is there accent in the park elements?	38	38	40	40	22	22	100	100	2.16	0.023	0.10	0.037
12	Is the time factor taken into consideration in the design and implementation of park elements?	23	23	51	51	26	26	100	100	1.97	-0.184	0.136	0.112
13	Are light and shade taken into consideration in the design and implementation of park elements?	26	26	39	39	35	35	100	100	1.91	-0.047	0.005	0.009
14	Are the trees, shrubs and other elements distributed appropriately throughout the park?	45	45	36	36	19	19	100	100	2.26	-0.121	-0.10	0.069
15	Does the park have a variety of different elements, especially biological ones?	30	30	43	43	27	27	100	100	2.03	-0.003	-0.029	-0.103

Finally, the findings reveal that unity, simplicity, proportionality, and plant distribution are the main strengths of Bardarash park's design. However, balance, focalization, and light-shade are major weaknesses, reducing the park's ability to create a visually engaging and comfortable environment. While demographic factors had limited impact, age and education influenced perceptions of simplicity and scale, respectively.

Effect of gender, age and academic achievement on the weighted arithmetic mean of the variables (extent of application garden design principles and their sustainability) in the first domain of Bardarash park.

The results in table (3) show that the gender factor effected significantly on the weighted arithmetic mean of the variable (No.3) (transition and gradation between the park elements is done correctly) the female give 2.20 and morally superiority than male which gave (1.81) whereas the other variables are not affected significantly with this factor. In the other side the age factor has significant effect on the variable (No.1) (is unity achieved in this park) so the age (less than 26) year give highest significant weighted arithmetic mean reached 2.70 compared with the lest value for the age (26-31) year which give 2.42.

Table 3. Effect of studied factors of the respondents on the weighted arithmetic mean of the variables (extent of application garden design principles and their sustainability) in the first domain in Bardarash park.

No	Variables	Studied factor								
		Gender		Age (year)			Academic achievement			
		Male	Female	less than 26	26-31	More than 31	Primary	Secondary	Institute	College
1	Is unity achieved in this park or does it appear as if it is multi-jointed?	2.64a	2.53a	2.70a	2.42b	2.63ab	2.57a	2.72a	2.48a	2.56a
2	Is the balance between the different elements of the park is achieved?	1.71a	1.53a	1.59a	1.73a	1.66a	2.00a	1.55a	1.72a	1.56a
3	Transition and Gradation between the park elements is done correctly?	1.81b	2.20a	1.97a	2.00a	1.80a	1.85a	1.95a	2.04a	1.84a
4	Is there proportionality among the park elements is fulfilled?	2.17a	2.40a	2.24a	2.36a	2.10a	2.28a	2.28a	2.44a	2.03a
5	Is the Rhythm among the park elements achieved?	2.23a	2.10a	2.24a	2.24a	2.00a	2.14a	2.27a	2.08a	2.15a
6	Is there a correct repetition between the different elements?	2.19a	2.23a	2.43a	2.06a	2.13a	2.14a	2.21a	2.20a	2.21a
7	Is the Focalization being existent in the park?	1.60a	1.87a	1.65a	1.97a	1.60a	1.71a	1.51a	1.84a	1.68a
8	Is there simplicity in park design?	2.37a	2.30a	2.16a	2.45a	2.47a	2.50a	2.34a	2.28a	2.34a
9	Is there scale among the park elements being fulfilled?	2.14a	2.27a	2.32a	2.00a	2.20a	2.50a	2.27ab	2.20ab	1.94b
10	Is there Spaciousness in the park elements?	2.14a	2.10a	2.08a	2.27a	2.03a	2.07a	1.96a	2.16a	2.15a
11	Is there Accent in the park elements?	2.17a	2.13a	2.00a	2.33a	2.17a	2.07a	2.13a	2.24a	2.16a
12	Is the time factor taken into consideration in the design and implementation of park elements?	1.89a	2.17a	1.86a	1.97a	2.10a	1.92a	1.86a	1.96a	2.09a
13	Are light and shade taken into consideration in the design and implementation of park elements?	1.89a	1.97a	1.78b	2.18a	1.77b	1.85a	1.89a	2.00a	1.87a

14	Are the trees, shrubs and other elements distributed appropriately throughout the park?	2.20 a	2.40 a	2.32 a	2.30 a	2.13a	2.21 a	2.17a	2.32a	2.31 a
15	Does the park have a variety of different elements, especially biological ones?	2.02 a	2.03 a	2.05 a	2.03 a	2.00a	2.28 a	2.07a	1.84a	2.03 a

Means with same letter for each studied factor are not significantly different at 5% level based on Duncan's Multiple Rang Test.

Whereas significant effect on the variable (No.13) (are light and shade taken into consideration in the design and implementation of park elements) the age (26-31) year give the highest significant mean reach (2.18) compared with other age levels which give 1.78 and 1.77 for (less than 26) year and (more than 31) years respectively. The academic achievement effected significantly only on the variable (No.9) (is there scale among the park element being fulfilled) and the primary level significantly superiority than other academic achievement and give mean reach 2.50 compared with other levels secondary, institute, college which give 2.27, 2.20, and 1.94 respectively. Whereas the other variables are not affected significantly with the three factors.

The findings indicate that demographic factors had only limited influence on perceptions of garden design principles in Bardarash park. Unity, simplicity, proportionality, and plant distribution were generally viewed positively across groups, while balance, focalization, and light-shade remained weak points regardless of respondent characteristics.

-2 Number of respondents and their percentage, weighted arithmetic mean, and Pearson's correlation coefficient for the second domain (evaluation of the functional and aesthetic condition and agricultural services which performed for Bardarash park). The scale includes three degrees (Good=3, Medium=2, Bad=1.)

The results in table (4) indicated that 69% of participates participate in the questionnaire said that the site for this park is good and appropriateness, whereas 11% said the opposite. Regarding plant sustainability, 41% of participates indicated that the plants are well adapted and resistant, while the majority (56%) assessed the sustainability at a medium level. 45% of participates said that the environmental and health functions is in good condition whereas 10% said that it is in bad condition. 52% of the participates said that the originality or style of this park is good whereas 20% said bad. Design principles and elements employed are in medium situation as mention by 72% of the participates whereas 8% showed bad. The engineering facilities are suitability in to consideration in the design and implementation of park elements in percentage (31, 54 and 15) % for (Good, Medium and Bad) levels respectively. 31% of the

participates in the questionnaire showed that the plant materials among the elements of park is good whereas 50% said that it is nearly good. Only 32% of the participates said that the agricultural services are sufficient in this park whereas 32% showed the opposite. 21% of participates said that the agricultural services appropriate with the number of workers in this park, whereas 40% said opposite .

The highest weighted arithmetic means as shown in table (4) are 2.58 with percentage reach 86% from the highest degree (3) for the variable (No.1) (is park suitable or appropriate to the site), then 2.38 with percentage reach 79.33% for the variable (No.2) (the plants of park sustainable within the region) and 2.35 with percentage reach 78.33% for (No.3) (this park achieve the environmental and health functions for which it was established). This mean that the perform of these variables are in good states compared with the highest degree for the scale (good=3). The lowest weighted arithmetic means as shown in the same table are 1.82 with percentage reach 60.66% from the highest degree (3) for the variable (No.9) (are the agricultural services appropriate with the number of workers assigned to it), then

2.00 with percentage reach 66.66% for the variable (No.8) (are agricultural services irrigation, fertilization, pruning, mowing, etc. sufficient), and 2.12 with percentage reach 70.66% for (No.7) (did the plant materials are suitable to the purpose, site, design and appropriate to the region). This mean that the perform of these variables are acceptable states compared with the highest degree for the scale (good=3.(

It is clear from the table (4) that the negative significantly correlation was between the gender and the variable (No.7) (the plant materials are suitable to the purpose, site, design and appropriate to the region) as in the equation ($r = -0.200^*$) male tends to rate it less positive than female, incompatible with the site conditions between chosen species and design, purpose. Positive significant correlation between age and variable (No.1) (is this park suitable or appropriate to the site) as in the equation ($r = 0.289^*$) older respondents perceive the park site as more suitable. And other variables in the same table there are no significant affected .

Table 4. Description of the study variables (evaluation of the functional and aesthetic condition and agricultural services which performed for the garden), number of respondents and their percentage, weighted arithmetic mean, and Pearson's correlation coefficient between gender, age, academic achievement and each variable for the second domain (Bardarash park.)

N O	Variables	Levels						Total		Weighted means	Pearson Correlation between		
		Good		Medium		Bad					Var × Gender	Var × Age	Var × Academic
		Frequenc y	%	Frequenc y	%	Frequenc y	%	Frequenc y	%				
1	Is this park suitable or appropriate to the site?	69	69	20	20	11	11	100	100	2.58	-0.115	0.289*	0.016
2	Are the plants of park sustainable within the region?	41	41	56	56	3	3	100	100	2.38	-0.064	0.127	-0.043
3	Does this park achieve the environmental and health functions for which it was established?	45	45	45	45	10	10	100	100	2.35	-0.05	-0.066	0.036
4	Did this park show originality, distinction, style: distinguished for its superiority?	52	52	28	28	20	20	100	100	2.32	0.082	0.097	-0.036
5	Did the design principles and elements employed and applied successful?	20	20	72	72	8	8	100	100	2.12	0.025	0.138	-0.092
6	Did the engineering facilities contains suitable details; character/quality and suitable to purpose, site, and design?	31	31	54	54	15	15	100	100	2.16	-0.039	-0.034	0.001
7	Did the plant materials are suitable to the purpose, site, design and	31	31	50	50	19	19	100	100	2.12	-0.200*	0.085	0.054

	appropriate to the region?												
8	Are agricultural services (irrigation, fertilization, pruning, mowing, etc.) sufficient?	32	32	36	36	32	32	100	100	2.00	-0.109	0.061	-0.047
9	Are the agricultural services appropriate with the number of workers assigned to it?	21	21	40	40	39	39	100	100	1.82	-0.041	-0.069	-0.145

The findings reveal that site appropriateness is a strength, while agricultural services, manpower, and design principles are key weaknesses limiting the park's functionality and sustainability. The results suggest that improvements in maintenance staffing, plant selection, and application of design standards are necessary to enhance both aesthetic and functional performance.

Effect of gender, age and academic achievement on the weighted arithmetic mean of the variables (evaluation of the functional and aesthetic condition and agricultural services which performed for the garden) in second domain of Bardarash park.

The results in table (5) show that the gender factor effected significantly on the weighted arithmetic mean of the variable (No.7) (the plant materials are suitable to the purpose, site, design and appropriate to the region) the female give 2.33 and significantly superiority than male which gave (2.02) whereas the other variables are not affected significantly with this factor, but for most variables female respondents tend to give higher ratings than males. In the other hand the age factor has significant effect only on the variable (No.1) so the age (26-31) year give highest significant weighted arithmetic mean reached 2.84 compared with the lest value for the age (less than 26) year which give 2.24 .

Table 5. Effect of gender, age and academic achievement of the respondents on the weighted arithmetic mean of the variables (evaluation of the functional and aesthetic condition and agricultural services which performed for the garden) in the second domain (Bardarash park.(

No	Variables	Studied factor								
		Gender		Age (year)			Academic achievement			
		Male	Female	Less than 26	26-31	More than 31	Primary	Secondary	Institute	College
1	Is this park suitable or appropriate to the site?	2.53 a	2.70 a	2.24 b	2.84 a	2.70 a	2.78 a	2.48a	2.72a	2.65 a
2	Are the plants of park sustainable within the region?	2.36 a	2.43 a	2.30 a	2.39 a	2.47 a	2.64 a	2.40a b	2.36a b	2.24 b
3	Does this park achieve the environmental and health functions for which it was established?	2.33 a	2.40 a	2.35 a	2.45 a	2.23 a	2.42 a	2.27a	2.24a	2.43 a
4	Did this garden show originality, distinction, style: distinguished for its superiority?	2.37 a	2.23 a	2.29 a	2.18 a	2.50 a	2.42 a	2.38a	2.10a	2.37 a
5	Did the design principles and elements employed and applied successful?	2.13 a	2.10 a	2.00 a	2.21 a	2.17 a	2.35 a	2.03a	2.12a	2.09 a
6	Did the engineering facilities contains suitable details; character/quality and suitable to purpose, site, and design?	2.14 a	2.20 a	2.16 a	2.21 a	2.10 a	2.35 a	1.96a	2.28a	2.15 a
7	Did the plant materials are suitable to the purpose, site, design and appropriate to the region?	2.02 b	2.33 a	1.97 a	2.30 a	2.10 a	2.28 a	1.96a	2.04a	2.25 a
8	Are agricultural services (irrigation, fertilization, pruning, mowing, etc.) sufficient?	1.94 a	2.13 a	1.89 a	2.12 a	2.00 a	2.21 a	1.89a	1.04a	1.97 a
9	Are the agricultural services which required for the garden appropriate with the number of workers assigned to it?	1.18 a	1.87 a	1.81 a	1.97 a	1.66 a	2.07 a	1.72a b	2.08a	1.59 b

Means with same letter for each studied factor are not significantly different at 5% level based on Duncan's Multiple Rang Test.

Whereas the other variable is not affected significantly with this factor, but for most variables the age (26-31) year give highest ratings than other levels of age. The academic achievement factor significantly effected on the variable (No.2) (are the plants of park sustainable within the region) so the primary level gives highest significant weighted arithmetic mean reached 2.64 compared with the lest value for the academic achievement (college) which give 2.24. Whereas the academic achievement in (No.9) (Are the agricultural services which required for the garden appropriate with the number of workers assigned to it) so the institute level give the highest significantly effected mean reach (2.08) compared with other academic levels primary, secondary and college which give 2.07, 1.72 and 1.59 respectively .

Although some strengths (site suitability, originality for older visitors, and positive female perception of plant materials), the major weaknesses across all groups are insufficient agricultural services and worker support, which undermines the overall quality of the park.

Second study: Study of the degradation extent of Bardarash park for the period between 2012 and 2025 by use a survey procedure and compared between the two dates.

The results in table (6) from the field survey show that the park covers 36187m², of which 30043m² (83%) is green area, but health status of the green space is (24850 m²). The lawn type is mixed (cold season grasses) planted in sandy loam soil and irrigated with a sprinkler irrigation system, which provides good drainage. The number of seats is (29) for

visitors which are relatively few for the park's size.

A total of 1986 plants were initially planted in 2012. By the survey date in 2025 the surviving trees only 1191 with (60%) while the dead trees were 795 with (40%) when compared. 423 Evergreen trees planted in the beginning, only 368 is surviving. several species such as *Ligustrum japonicum*, *Thuja orientalis*, *Pinus brutia* achieved full survival, while *Cupressus arizonica* "Glauc", *Washingtonia robusta* had the highest losses (13%). 986 of deciduous trees are planted in the beginning with surviving trees reach 612 with percentage (62%). Some species such as (*Melia azedarach*, *Lagerstroemia indica*) showed 100% survival, moderate overall mortality was (38%), with high losses in *Robinia pseudoacacia* "Hispidia" (65%). *Platanus orientalist* and *Prunus cerasifera* had over (80%) mortality. 177 of Evergreen shrubs are planted only 78 are survived with percentage (44%) especially *Juniperus chinensis*, over half lost (56%), with complete loss of *Cotoneaster salycifolia* (100%) and near total loss of *Abelia grandiflora* (98%). 50 *Rosa* spp. planted only 11 are survival (22%). *Berberis thunbergii* "Atropurpurea" was completely lost. Groundcovers and climbing plants (*Rhyncospermum jasminoides*) reached 300 plantes, 122 are survival (41%), moderate-to-high mortality, high losses in *Hedera helix* (100%). Overall, the highest absolute loss occurred in deciduous trees and shrubs had the highest percentage loss. Several species suffered complete failure, suggesting possible issues with plant selection, climate suitability, irrigation efficiency, or maintenance practices .

Table 6. Field survey of park with green area, state of lawn, irrigation system, soil fertility, seats number, and plant types (including scientific names and numbers.)

Total area of park		36187.06 m²			
Total green area		30043.21 m²			
Health status of the green space		24850 m²			
Irrigation system		Sprinkler			
Lawon type		Mixed			
Soil type		Sandy loam			
Seat numbers		29			
N	Plant type	Initial planting in 2012	Additions	Dead	Remains
1	Evergreen trees				
1.1	<i>Cupressus arizonica</i> "Glauc" "	300	-	49	251
1.2	<i>Ligustrum japonicum</i> "Tige"	-	44	-	44
1.3	<i>Thuja occidentalist</i>	-	34	-	34
1.4	<i>Washingtonia robusta</i>	20	13	6	27
1.5	<i>Thuja orientalist</i>	-	5	-	5
1.6	<i>Cupressus arizonica</i> "Green"	-	5	-	5
1.7	<i>pinus brutia</i>	-	2	-	2
2	Deciduous trees				
2.1	<i>Melia azedarach</i>	-	246	-	246
2.2	<i>Fraxinus excelsior</i>	240	-	54	186
2.3	<i>Robinia pseudoacacia</i> "Hispid" "	300	-	195	105
2.4	<i>Lagerstroemia indica</i>	-	19	-	19
2.5	<i>Robinia pseudoacacia</i> "Umbraculifera"	58	-	41	17
2.6	<i>Fraxinus latifolia</i>	-	15	-	15
2.7	<i>Platanus orientalis</i>	49	-	41	8
2.8	<i>Prunus cerasifera</i> "Picardii Nigra"	50	-	43	7
2.9	<i>Gleditsia triacanthos</i>	-	3	-	3
2.10	<i>Populus tremula</i>	-	3	-	3
2.11	<i>Catalpa bignonioides</i>	-	2	-	2
3	Evergreen shrubs				
3.1	<i>Juniperus chinensis</i>	-	44	-	44
3.2	<i>Nerum olender</i>	-	15	-	15
3.3	<i>Myrtus communis</i>	-	10	-	10
3.4	<i>Juniperus horizontalis</i> "Silver Mist"	-	8	-	8
3.5	<i>Abelia grandiflora</i>	50	-	49	1

3.6	<i>Cotoneaster salicifolia</i>	50	-	50	0
4	Deciduous shrubs				
4.1	<i>Rosa spp.</i>	-	50	39	11
4.2	<i>Berberis thunbergii</i> "Atropurpurea"	50	-	50	0
5	Groundcovers and Climbing plants				
5.1	<i>Rhynchospermum jasminoides</i>	250	-	128	122
5.2	<i>Hedera helix</i>	50	-	50	0

Conclusion

The evaluation of Bardarash park revealed both strengths and weaknesses in its design, functionality, and ecological sustainability. Survey results showed that core design principles such as unity, simplicity, proportionality, and plant distribution were relatively well applied, while balance, focalization, and light-shade integration remained weak points. Functional assessment indicated that the park site is generally suitable and plants show partial sustainability, but agricultural services and manpower are insufficient, limiting long-term performance. Demographic factors such as gender, age, and education had only minor influence, with

younger and more educated respondents more critical of design quality.

The degradation survey between 2012 and 2025 highlighted significant ecological decline, with only 60% of trees surviving and many shrub and groundcover species experiencing very high mortality or complete loss. Species such as *Ligustrum japonicum*, *Thuja orientalis*, *Pinus brutia*, and *Melia azedarach* showed high resilience, while *Cotoneaster salicifolia*, *Abelia grandiflora*, *Berberis thunbergii*, and *Hedera helix* failed completely. These findings suggest problems in plant selection, climate adaptability, irrigation, and maintenance practices.

References

Akram Vatankhah (2023). The Benefits and Principles of Landscaping. Department of Horticulture, University of Tehran, Tehran, Iran; E-mail: Vatankhah1234@yahoo.com. J Hortic, Vol.10 Iss.4 No:1000342 (MRPFT. ([2]Ali Sindi, Ramanathan Balakrishnan and Gerard Waite (2021). "Kurdistan Region of Iraq: Demographic Survey". International Organization for Migration.

[1] [3]Belčáková, I, Świąder, M, Martyna-Zielinska, M., (2019). The green infrastructure in cities as a tool for climate change adaptation and mitigation: Slovakian and polish experiences. Atmosphere 10 (9), 552. [4]Bratman GN, Hamilton JP, Hahn KS, Daily GC, and Gross JJ (2015). Nature experience reduces rumination and subgenual prefrontal cortex activation. Proceedings of

the national academy of sciences, 112(28), 8567-8572. DOI: 10.1073/pnas.1510459112.

[5]Braubach M, Egorov A, Mudu P, Wolf TW Thompson C, and Martuzzi M (2017). Effects of urban green space on environmental health, equity and resilience. In Nature-based solutions to climate change adaptation in urban areas (pp. 187-205). Springer, Cham ;. DOI:10.1007/978-3-319-56091-5_11.

[6]Brzuszek R, Drackett P and Kelly L. (2021). Home Landscape Design. North Mississippi Research and Extension Center. Publication 2698 (POD-05-21.(

[7]Diane Relf, Extension Specialist, Environmental Horticulture, Virginia Tech (2022). "The Value of Landscaping" Virginia Cooperative Extension, Virginia Tech and Virginia State University. EXPERT REVIEWED 426-721. www.ext.vt.edu.

[8]Dohuk Statistics Directorate, (2022 .(

[9]Dou Y, Zhen L, De Groot R, Du B. Yu (2017). Assessing the importance of cultural ecosystem services in urban areas of Beijing municipality. Ecosystem. Serv. 24, 79–90. <https://doi.org/10.1016/j.ecoser.2017.02.011>.

[10]Duhok Municipalities Directorate, (2024.(

[11]Hartig T, Mitchell R, De Vries S, and Frumkin H (2014). Nature and health. Annual review of public health, 35, 207-228 ;.DOI: 10.1146/annurev-publhealth-032013-182443.

[12]Jamal A. Hassan. (2024). Remote sensing and GIS. Duhok University College of Agricultural Engineering Science.

[13]Kerry Smith (2019). Residential Landscape Design. The Alabama Cooperative Extension System (Alabama A&M University and Auburn University). www.aces.edu/directory.

[14]Kronenberg JA, Agata PK Anita Z and, Błażej Z (2016). "Wasting collaboration potential: A study in urban green space governance in a post-transition country, " Environmental Science and Policy, Elsevier, vol. 62(c), pages 69-78 DOI: 10.1016/j.envsci.2015.06.018.

[15]Mohd Ramzi Mohd Hussain, Izawati Tukiman and Ismawi Zen (2021). Landscape Design for Residential. Publication © Centre for Professional Development, International Islamic University Malaysia (IIUM). EISBN 978-967-19026-3-9.

www.iiu.edu.my/centre/cpd.

[16]Nowak DJ, and Heisler GM (2010). Air quality effects of urban trees and parks. <https://www.semanticscholar.org/paper/Air-quality-effects-of-urban-trees-and-parks-Nowa>.

[17]Rashmi Aradhya (2023). Benefits of urban green space for improving urban climate. (pp. 1-13). Springer, New York, <https://www.scribd.com>.

[18]Salah Sh. Mohammed (2023). Study of Green Space in Duhok City by Using Geotechnic. College of Agriculture Engineering Sciences. Duhok University.

[19]Sathyabama, (2021). "SAR1401-INTRODUCTION TO LANDSCAPE ARCHITECTURE", Institute of science and technology, <https://sist.sathyabama.ac.in> .

[20]Washington State Nursery and Landscape Association (2003). "Plants Benefits" <http://www.WSNLA.org/retail/news/benefits.html>.

[21]Yeang LD, Pike O, Durney M, and Zero G (2008). Urban Design Manual a best practice guide, a companion document to the Draft Planning Guidelines on Sustainable Residential Development in Urban Areas

Department of Environment, Heritage and
Local Government/ [http://www.
designforhomes.org/](http://www.designforhomes.org/)