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Article

Enhancing the visual landscape harmony in public open spaces: Sana'a city case study

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Abstract: Increasing the visual image quality of public spaces helps enhance the quality of people's lives. Although previous literature has discussed many of the principles and criteria of the visual design of open environments, architects, landscape architects, and urban designers still face difficulties in defining the most important visual design principles that enhance the Visual Landscape Harmony. This study examined the principles of the visual design of open spaces and their impact on creating a harmonious visual image and raising the quality of the visual landscape. The study mainly used the principles of visual design referred to by Bell. A visual survey analysis of four public spaces in Sana'a city in Yemen was carried out. The study also examined how the selected spaces meet the principles of visual design and their impact on raising the visual quality. Results indicated that the hierarchy, enclosure, figure and ground, diversity in elements, diversity in scales, homogeneous balance of 3D composition, and unique design of the space are the most contributing factors in creating visual harmony and enhancing the quality of the visual image. These principles can help architects, landscape architects, and urban designers and developers to make appropriate design decisions that can produce visual landscape images of open spaces, thus, enhancing the quality of the visual image and the efficiency of urban spaces and open areas.

Keywords: urban space; visual perception; management aspects; landscape quality; public squares; green parks; Sana'a city

1. Introduction

People's experiences in public open spaces begin with an initial visual view. Thus, their mental image is created, and the initial impression and preliminary evaluation of these spaces' quality start forming. Therefore, the visual aesthetic value is significant in the degree of preference for public open spaces.

Previous studies in urban, architectural, and landscape design have discussed many of the principles and criteria of the visual design of public spaces, due to the similarity, contradiction, and overlap of these criteria and principles, urban designers, architects and landscape designers still have difficulty selecting and defining the most important visual design principles that lead to producing the integrated and harmonious visual design of open spaces.

This study examined the most important criteria and principles of public open spaces' visual design. The study seeks to verify which are more influential in creating visual harmony, thus enhancing the quality of the visual landscape image. The study mainly dealt with the principles and foundations referred to by Bell [1] in his book Elements of Visual Design in the Landscape with so

me slight modifications to suit the practical aspects of the field study [1], and to

meet the objectives of this study. Bell referred to the principles of organization that are: axis, symmetry, hierarchy, transformation, and reference [1], while Ching [2] in his book, Architecture, Order, Mass and Pace added rhythm as one of the principles of the organization [2]. Based on Gestalt principles, Bell also developed principles for spatial connotations of elements and shapes like nearness, similarity, overlap, enclosure, continuity, form and background. He also addresses balance, intensity, rhythm, proportionality and scale as principles that create communication and visual coherence. Likewise, he discussed principles of unity, diversity, spirit and identity of space as objectives for the visual design of open space [1].

To address visual issues more objectively, comprehensively, and generally, the study identified four various open spaces in Sana'a city in Yemen.

Al-Tahrir Square, a public square located near the old city of Sana'a, the facades of the surrounding buildings are a mixture of traditional and modern styles. It represents an important cultural and political symbol of the country.

Al-Sha'ab Mosque Square, which derives its importance from its being the largest cultural and political building, was built in Yemen recently during the reign of the late President Ali Abdullah Saleh [3]. The mosque was called Al-Saleh Mosque before changing its name to the Al-Sha'ab Mosque recently.

Al-Sabean and Al-Thawra parks are the two most important public parks in Sana'a city, and despite their deteriorating condition, they still host many recreational and social activities [4]. Al-Thawra Park is the oldest urban park in Sana'a, which was built in 1974.

The study examined the extent to which these spaces achieve the principles of public spaces' visual design. Then, the study investigated the reflection of applying these design principles to the quality of the visual landscape. Through the results of Pearson Correlation Coefficients between the visual design principles and visual harmony, this study proposed the most important and influential principles in the quality of the visual landscape image. At the same time, the study aimed to assess the visual issues in the selected public spaces in Sana'a City by examining the achievement of those targeted spaces for the principles and criteria of the visual design of open spaces. Furthermore, the investigation of management issues in four selected spaces has not been neglected.

2. Literature review

2.1. Visual design of public spaces

Public Open spaces are present in people's minds through all civil activities and events, and they reflect the culture and lifestyle of people and their social and economic conditions. Therefore, people's interaction and connection with public spaces is a strong and influential one [5]. The effects of the outcome of technological life and developments cause anxiety, which grows day by day to the extent that those effects have changed people's lives to further isolation and privatization. Therefore, the role of public places in social life becomes more significant [6,7]. People's experiences of the place have produced the visual perception of urban open spaces. Variety in forms, structures, functions, details, colors and relationships, all participate in creating the place's self-ironing image [8]. The perceived image of the place in the

user's mind is significant because it is the prevailing impression of space and, therefore, understanding the principles and criteria for the visual design of open spaces and understanding their effects in enhancing landscape image quality.

Several literature studies have discussed the theoretical aspect of the visual design of public open spaces. Bell [1,9], in his book, Elements of Visual Design in the Landscape has divided the principles of the visual design of open spaces into four groups. The aim of design includes unity, diversity, and spirit and identity of space. Spatial singles include enclosure, nearness, interlock and overlap, similarity, figure and background, and continuity. Compatibility methods include balance, tension, rhythm and repeat, proportion, and human scale [1,9]. Ordering principles include axes, symmetry, hierarchy, transformation, and datum. Ching [2,10] in his book Architecture, Form, Space, Order pointed out the rhythm as one of the ordering principles. Smith [11] also referred to enhancing the visual aesthetic value through similarity, proximity, common ground and enclosure, orientation, closure and continuity. German psychologists developed a theory of visual perception called 'Gestalt' whose principles depend on the relationship between the element's location. They are: Proximity, Similarity, Common, Fate, Good Continuation, Closure, Area and Symmetry [12]. (Kaplan, Kaplan, and Ryan [13] developed four factors to determine the preference for a visual landscape image. They are cohesion, complexity, clarity legibility and ambiguity. In the same way, Tveit, Ode, and Fry [14] outlined nine visual concepts of different aspects of visual appearance quality: supervision, coherence, turbulence, historical, visual scale, imaginability, complexity, naturalness, and temporary events.

Recently, Liu and Nijhuis [15] used four visual design concepts to analyze and understand the visual-spatial characteristics of Vondel park in Amsterdam, namely sequencing, direction, continuity and complexity. They used six different quantitative and qualitative methods and traditional and advanced techniques. They are compartment analysis, three-dimensional landscapes, network cell analysis, sight analysis, metrics of landscape and eye-tracking.

Many studies have been published on the application and practical aspects of the visual quality of open space. Etaati [16] used some visual design principles to measure the visual quality of open spaces: ordering, correct scale, unity composition and harmony. Nasar [17] used five criteria to evaluate the visual quality: naturalness, maintenance and vitality, openness and defined space, historical significance and ordering. In his thesis, PUTRA [18] used a volumetric vision analysis called "View sphere" to assess open spaces' visual quality [18]. On the other hand, Sarradin, Siret, and Teller [19] evaluated the visual space by analyzing the shape of the sky. They proposed a computerized method for analyzing the perspective that points to the gradual change in the visual field. Crawford [20] used remote sensing to assess landscape visual quality in open spaces and demonstrated its feasibility by comparing it with a previous traditional study. Chen et al. [21] presented an evaluation of aesthetic quality by visual, auditory, tactile, and olfactory factors of urban open spaces. Also, Tang et al. [22] evaluated the street interface to understand the mechanism and the characteristics of the form.

Harmony is the suitable integration of different elements and parts together to form a coherent and harmonious composition [23,24]. The visual beauty is due to the

harmonious relations between the composite elements, perhaps more than the elements themselves [24]. Therefore, the study deals with visual harmony in public open spaces as a result of the principles and criteria of visual landscape design, which lead together to creating an integrated and harmonious three-dimensional image, consistent with the surrounding urban environment, and free of visual distortions.

To achieve the objective of this study, the principles of the visual design referred to by Bell [9] are investigated with some slight modifications because they are more practical and generalized. As mentioned above Bell has divided the principles of the visual design of open spaces into four groups. The first, ordering principles include axes, symmetry, hierarchy, transformation, and datum. The study also deals with rhythm as one of the ordering principles as pointed out by Ching [2,10]. The study deals with the second group as they are, which spatial singles include enclosure, nearness, interlock and overlap, similarity, figure and background, and continuity. The third group of Bell elements is the aim of design, which includes unity, diversity, and spirit and identity of space, and the fourth is compatibility methods which, include balance, tension, rhythm and repeat, proportion, and human scale. However, the study deals with diversity as a separate criterion because it has value from multiple aspects and different sub-criteria. It includes sub-criteria that influence the composition of the visual landscape, which are diversity in scale, elements, color, shape, and texture. These sub-criteria can have a different impact in shaping the visual image of the landscape. There is a need for diversity in visual design that provides stimulation and enrichment to the visual scene.

Likewise, the identity and spirit of the space were treated as a separate standard because it includes aspects that are relatively different from visual design standards, such as historical and cultural elements and symbols. Although the identity and spirit of a place are what distinguishes one location and landscape from another, this concept is almost abstract and intangible and tends more to be emotional and is more common in the subconscious. Unity, balance, and intensity are also integrated into the standard of homogeneous and unity of the two- and three-dimensional composition. The study deals with proportion and the human visual scale as separate standards due to their connection to each other. The study verifies the effect of other factors on the harmony of the visual landscape, such as the absence of visual distortions in the space and the level of maintenance and cleanliness.

Therefore, the study deals with principles of the visual design of urban open spaces such as ordering, spatial cues, diversity, scale and proportion, homogeneous and balance of composition, spirit and identity of space and other related scopes.

2.1.1. Ordering

The principles of organization or arrangement create visually coherent urban environments [25,26]. In most cases, many principles and criteria are used simultaneously although one principle may be more dominant [23].

An axis is a line formed by two points in space, in which the shapes and elements are arranged [2]. The axis is a formal and important principle for the design; it is often used in the design for a more robust display, and it is used to emphasize the importance of an element [1]. Symmetry is the arrangement of shapes, elements, and spaces evenly around the axis or centre [2]. Symmetrical designs tend to be very stable and formal.

Natural landscapes tend to be asymmetrical, and the use of symmetrical elements and shapes in them may lead to visual tension [27].

Hierarchy is a change in the shapes, sizes, and locations of elements and spaces to emphasize their importance [2]. Hierarchy creates a visual, dominating some design elements. It may be related to function and space as in architecture, or linked to function and environment as in natural patterns, and it may be in landscape elements scale to guide the design [27]. Rhythm is the repetition or alternation of elements or shapes at certain intervals, regularly or randomly. Rhythm is used to bring life to design and create vitality, contributing to the unity of composition [27]. Transformation means the change of the structural organization or spatial composition through a series of separate alterations in response to a specific context without losing identity [2]. This transformation may appear in landscapes over time, and if it is handled correctly, we can perceive it [1]. Datum is a line or a level which, through its regularity and continuity, gathers and organizes a pattern of elements, shapes, or spaces [2], and it can be real or implicit.

2.1.2. Spatial cues

Spatial signals are derived from Gestalt theory principles developed by German psychologists in the fifties for learning purposes. They are: Proximity, Similarity, Common, Fate, Good Continuation, Closure, and Area and Symmetry [12]. While Bell [9] developed them as principles to organize the visual elements in open spaces. They include enclosure, nearness, interlock and overlap, similarity, figure and background and continuity [9].

2.1.3. Diversity

Visual diversity is an essential need to provide stimulation and raise the quality of life. Variety in Landscape image can be through diversity in scales and elements, colors, shapes, and textures of the landscape elements. The balanced diversity can enhance visual harmony, but extremism in variety may create visual chaos [1]. Diversity is associated with a complexity that refers to the richness of the visual elements within the visual landscape image [15], but increasing the variety of elements requires a more organized composition to maintain balance and unity [1]. Also, the functional and visual diversity in design might be an attractive factor for people in built-outdoor environments [28].

2.1.4. Human scale and correct proportion

The human scale is the size of the elements and masses relative to the human size. The essential aspect of the human scale is how we perceive the environment around us to our size. In large blocks, we may reduce the scale through the gradient and pay attention to the details in the lowest level that is close to us, and it is better to the continuity of scale gradual by hierarchy [1].

Proportion is the ratio of the size of element to some of them or parts thereof. Many theories and ways help get the correct proportion, such as the Golden Section, Classical Orders, Renaissance Theories, Modular, Ken, and Anthropometry [2]. In unofficial landscapes, applying the golden section is impossible [1]. So the study can use the visual scale, which refers not to the real dimensions of objects but, rather, to how the body appears in relation to the dimensions of the other items surrounding it

[2].

2.1.5. Homogeneous and unity of composition

Unity is necessary to connect the design parts, to form a balanced, uniform whole. Several organizational factors are involved in achieving composition unity. The contrast of the design elements creates vitality for the design, but much contrast might create a visual confusion that reduces unity. The unity can be considered a synonym for visual coherence, which makes the feeling that all parts are connected and linked [9]. The unity of composition can be created through the balance of the visual forces, the proportions of the sizes of elements to each other, the achievement of the human visual scale in the parts of the space, and the creation of repetition and rhythm in the elements. The tension may help in creating a dynamic and harmonious composition [1].

2.1.6. Spirit and identity of space

It is a unique quality that is distinguished by one place from another. The spirit of the place is intangible but has a high value when used in designing the visual landscape, as it creates a feeling of space and belonging to it. The identity of space can be achieved through historical value or historical symbols within space [1]. Careful designing and creating solutions of public open spaces through innovative and expressive design vocabularies also make the identity and genius of the place [29].

2.1.7. Others related

Many factors may influence the harmony of visual landscape like the level of hygiene in the space, the maintenance level of spaces equipment, landscape elements, and hardscape elements and the elements of visual distortions. New interventions like maintenance and restoration work in open outdoor environments often lead to visual distortions if not studied very carefully [30]. Also, unauthorized advertising panels, exposed electrical installations, and neglected landscape elements represent visual distortion items that impair visual landscape quality [31].

3. Materials and methods

3.1. Study area: Sana'a City

Sana'a city is the political capital of the Republic of Yemen. It is the most important cultural center in the country. It was named the Arab World's Capital of Culture in 2004 [32,33]. The city is located 21–15 north of the Equator and 12.44 East of Greenwich, at an altitude of 2150 m above the sea level. Two mountains (Aiban to the west and Nukum to the east) surround it [34]. It includes the old city of Sana'a, which has been registered as one of the World Heritage sites in 1993. It has been inhabited for 2500 years. In the 7th and 8th centuries, the city was an important Islamic cultural center. This religious and political heritage can be recognized by the 103 mosques, 14 hammams, and more than 6000 houses built before the 11th century [35]. The old city also has a distinctive architectural and urban heritage [32], which can be considered as a record expressing the real story of the human civilization and development in Yemen [36]. The political and administrative situation in Sana'a has a long history of urbanization and its rapid growth. Multifaceted transformations took

place in the city through social, cultural, economic and historical factors that caused changes in people's lifestyles [37].

The urban areas of Sana'a city have developed over the years. Development started from the then urban old city, to its outskirts outside its wall, which includes the largest part of the urban block area of the new town, then signs of development decreases towards the slums, just increase once again towards the city suburbs [38]. Sana'a city's urban areas includes several types of urban open spaces such as natural spaces, paths and streets, green areas and recreational parks, public squares, sports stadiums, spaces between buildings, and empty open spaces, (see **Figure 1**).

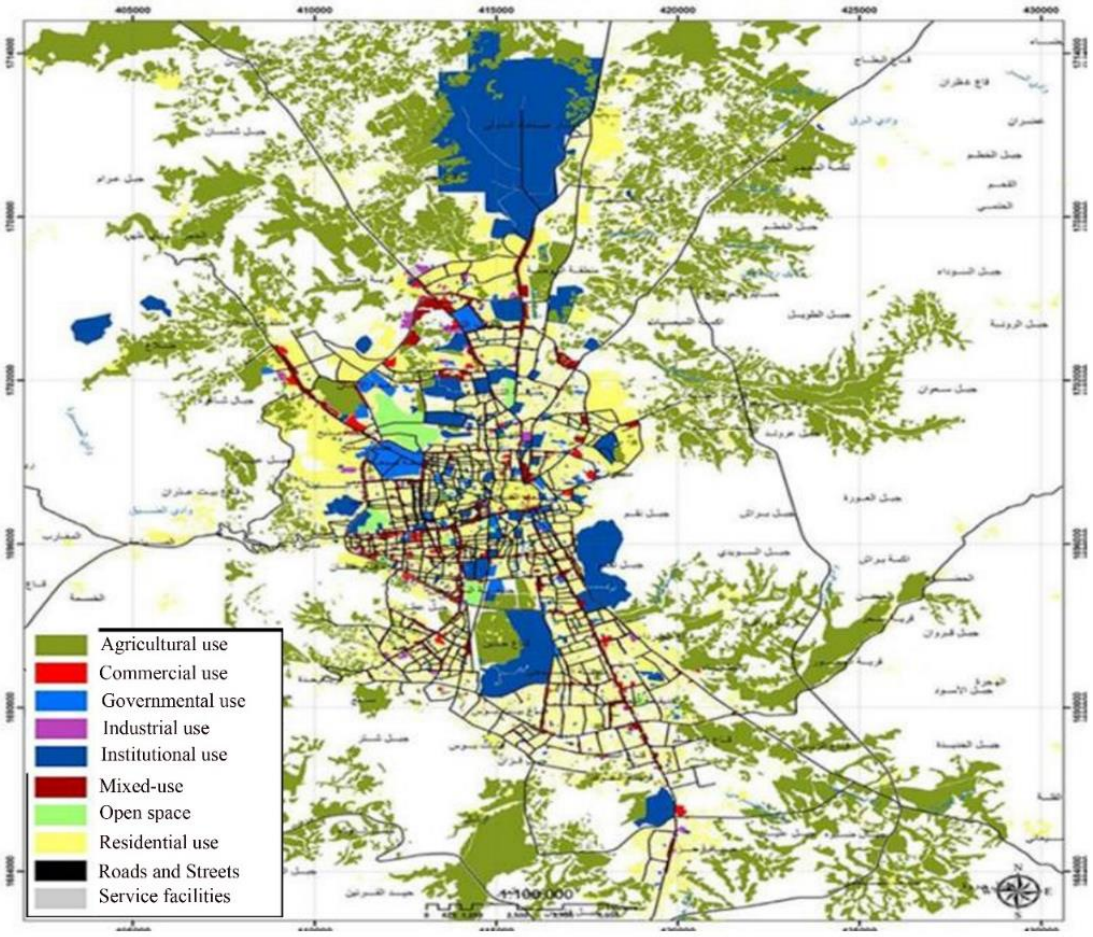

Figure 1. Shows overall structure, land uses, and the open spaces in Sana'a city [39].

The study identified two types of public open spaces, public squares, and public parks, the most frequented public spaces in Sana'a city. The four most important public spaces in the city were selected as a case study: Al-Tahrir Square, Al-Sabean park, Al-Shaab Mosque Square, and Al-Thawra Park, (see **Figure 2**).

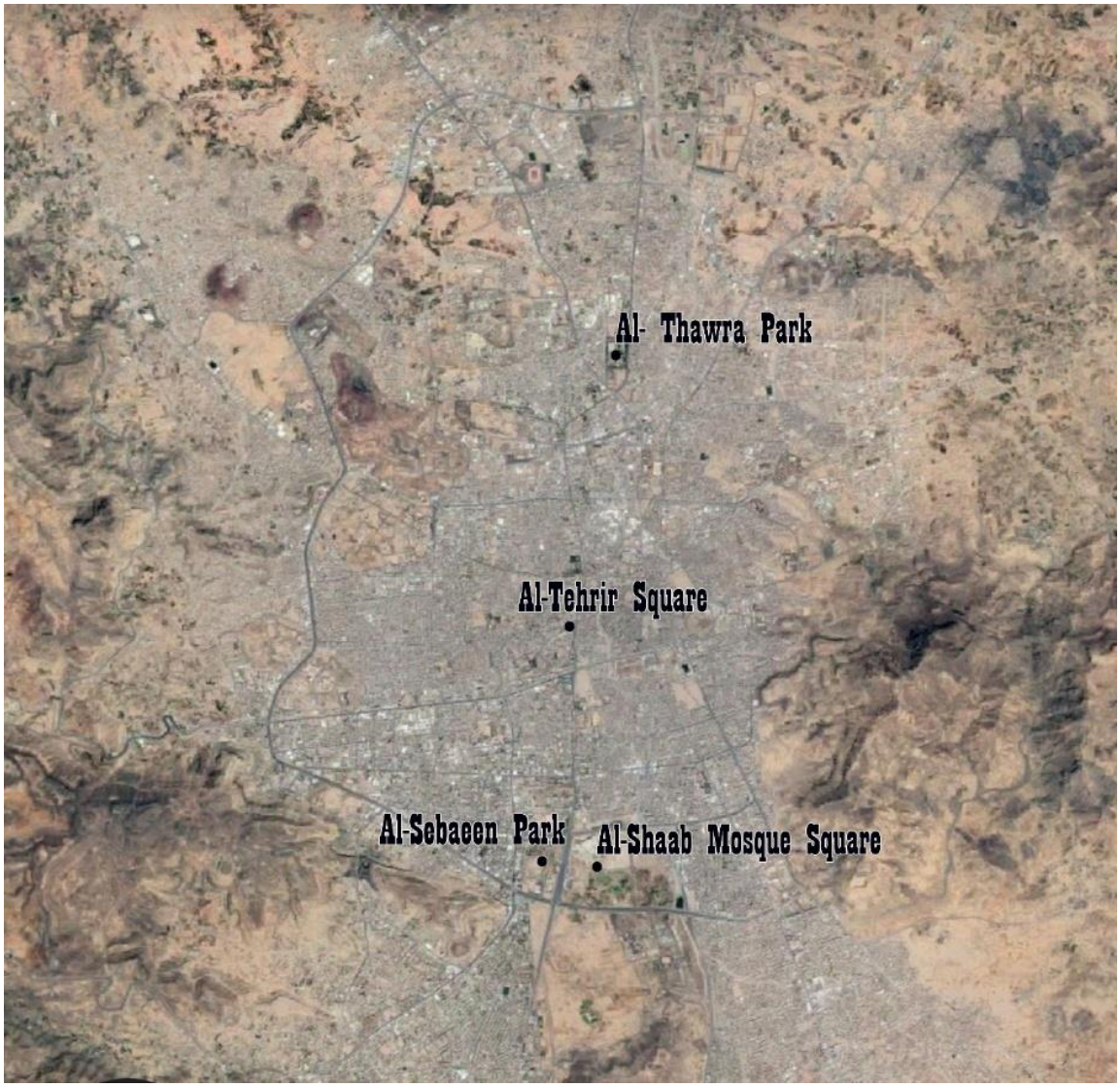

Figure 2. Shows the location of selected public spaces in Sana'a city; Al-Tehrir Square, Al-Shaab Mosque Square, AlpSabeen Park, and Al-Thawra park. (Author).

3.2. Methods

Many methodologies have been designed and applied in visual perception in urban spaces studies, as the mental map [40], visualization method [41], the method of measuring the effect of motivation [42], GIS-based 3D volumetric vision analysis [18], using SegNet [43], analyzing the shape of the sky [19], DepthMap software [44], using the remote sensing [20], method of observation [8], visual analysis [45], and many other research methods. They all confirm the importance of visual aesthetic issues in urban and landscape studies.

Since the study discusses the visual design criteria comprehensively, it is not possible to use new technological methods that still check a limited number of visual design criteria, such as integration, connectivity, and continuity. In contrast, the current study deals more thoroughly with the visual design criteria. The human perception is still crucial in visual and aesthetic issues. Therefore, in this study, the direct observational method is used to determine the extent to which selected spaces have come to visual design criteria and to identify their impact on the integration and

harmony of the visual landscape.

The teamwork used direct observation to determine the extent to which visual design criteria were met for four selected urban spaces in Sana'a city. The number of teamwork participating in the direct observation was nine professors and master's and doctoral students who were trained to conduct the investigation.

The maps and aerial images were collected from the General Authority for Urban Planning – Sana'a, then the four selected spaces were visited in August 2019 and February 2020. The visual observations on all parts of the selected spaces were recorded. The visual design principles and criteria, pointed out by the literature review above, were investigated.

The analysis of how the four selected spaces achieved visual design principles was carried out. The visual criteria and the design principles that have much impact on the integration and harmony of the visual landscape were investigated.

Each space has been previewed and investigated, along with an examination of its maps as follows:

Determining the ordering principles by which the space elements have been arranged and designed is as follows. Determining the main axes of space, referring to them in maps, and then defining their beginnings, ends and identities. The same steps are repeated in the case of the sub-axes. Investigating the degree of symmetry. Checking the hierarchy of levels, scales, colors, and shapes for landscape elements. Checking the rhythm and repeat for arranging trees and shrubs, tiling floors, and organizing the rest of the landscape elements. Examining the presence or absence of transformation. Checking the existence or not of the Datum.

Examining the spatial signals of landscape elements, their locations, and their relationship (nearness, enclosure, interlock and overlap, continuity, and form and figure).

Checking the degree of similarity in style, shape, color, height, building materials, etc.

Checking the degree of diversity in elements, scales, colors, shapes, and textures.

Investigating the identity and spirit of the space. Examining the uniqueness and distinction of space design, the presence of unique elements or characteristics in the spaces, and the elements that reflect the city's identity.

Examining the achievement of the human scale in the dimensions of spaces parts and elements, the suitability of the elements scales for the beholder's eye, correct proportion, and the human visual scale.

Verify the balance of the two-dimensional formations by examining maps and aerial photographs of the spaces.

Checking how 2-D configurations appear on the 3D landscape through direct observation.

Examination of some other issues that may influence the visual landscape image. Space cleanliness, level of maintenance of equipment, appliances, and green elements, and the spaces are free from visual distortion elements such as vandalism and signs.

Investigating the harmony and completeness of the visual landscape image. Taking photos at the entrances, major axes, and seating areas, and then examining the completeness of the vision and clarity of the skyline in each space.

3.3. Coding data

Using the five Likert scale, each author, while visiting the specified spaces, checked the verification of the above-mentioned items, and gave a mark for each item in the space separately, where 1 stands for 'weak' and 5 stands for 'very strong'.

The teamwork estimate rates were then calculated for all items and summarized in **Figures 3** and **4** and **Table 1**. For the sake of a practical and useful discussion of the marks achieved by the spaces in the specific items shown in **Figure 3**, the teamwork, while visiting the specified spaces, recorded visual observations related to those items in each space. **Table 2** summarizes the visual observations in the four spaces, representing the visual qualitative evaluation according to principles and criteria for the visual design in the selected spaces.

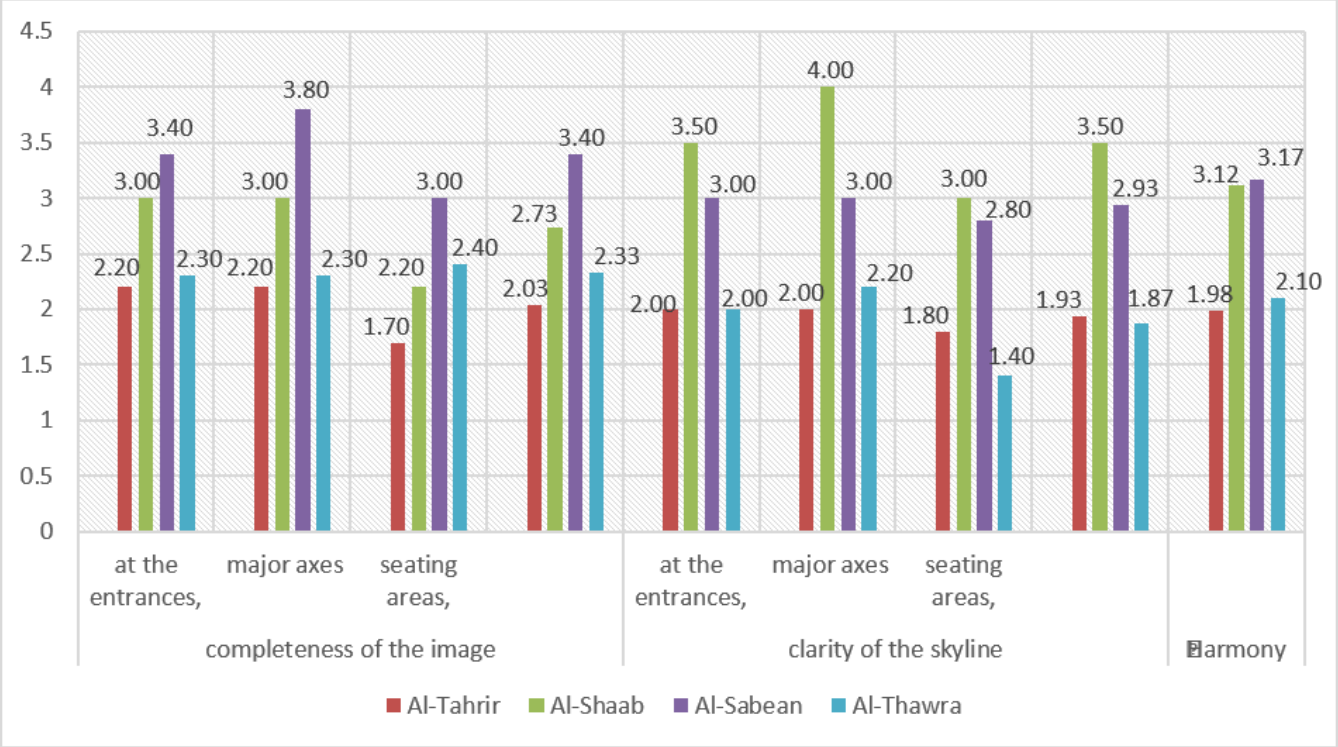

Figure 3. Shows the harmony in selected open spaces in Sana'a city. (Author).

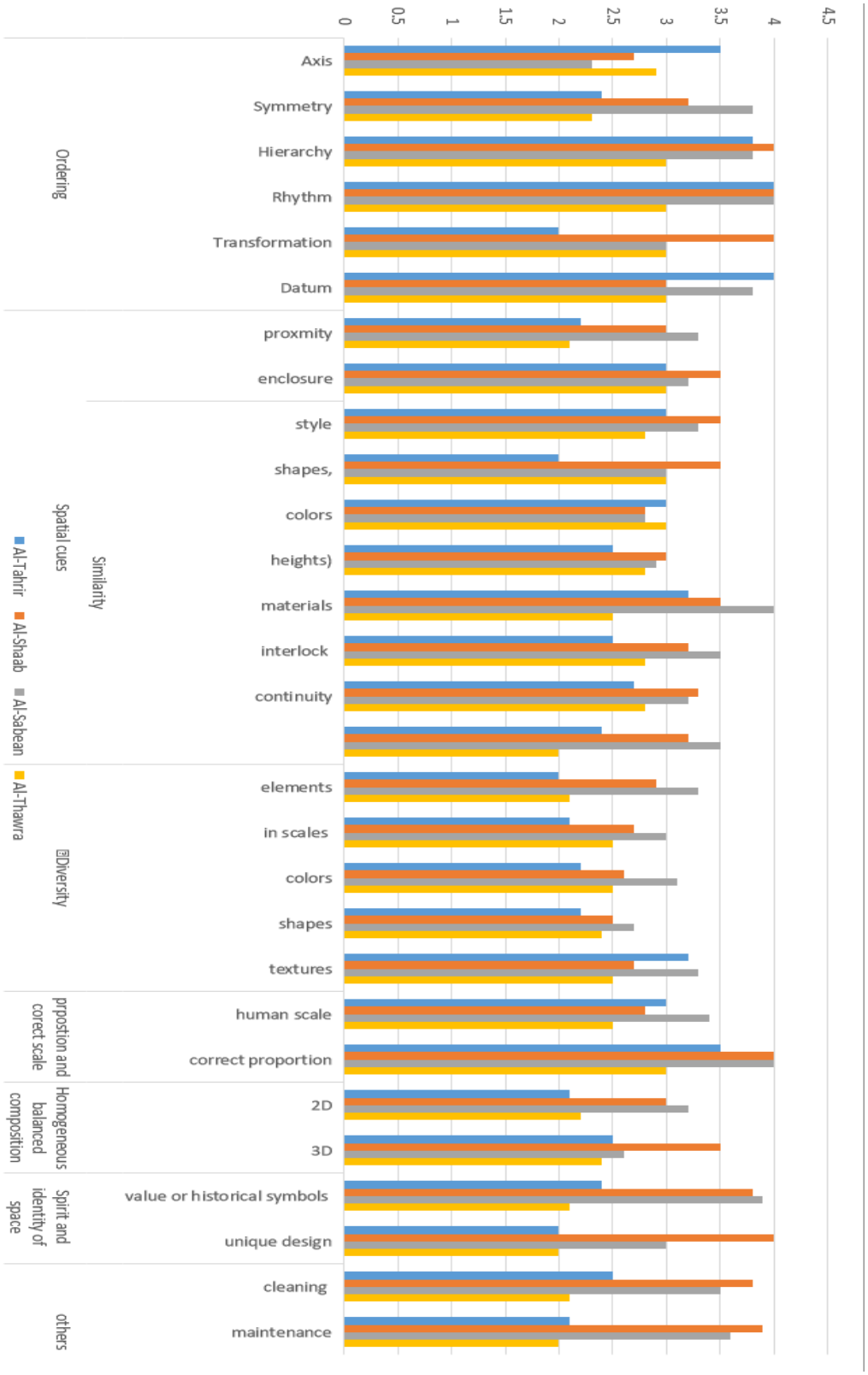

Figure 4. Shows the visual design criteria in selected open spaces in Sana'a city. (Author).

To examine the relationship between the visual standards and foundations of the visual design and the harmony of the image of the visual scene, the study uses the Pearson correlation coefficients to measure this relationship and to determine which of the foundations of the visual design has a statistically significant correlation with

harmony in the visual landscape.

4. Results

In general, The results of the harmony and completeness of the visual scene image of the spaces under study shown in **Figure 3** indicate a relative advantage for each of the Al-Shaab Mosque Square and the Al-Sabean Park (3.12, 3.17), while Al-Tahrir Square and Al-Thawra Park obtained fewer marks in the harmony of the landscape image (1.98, 2.10).

4.1. Correlation between the principles of visual design and the harmony of the visual landscape

The study mainly aims to determine the visual factors and foundations that enhance the completeness and harmony of the image of the visual scene in open spaces. The study investigated the relationship of these foundations and the completeness of the visual image in four selected public spaces in Sana'a city in Yemen. **Table 1** shows the results of visual design principles and their correlation with harmony in selected open spaces. The results indicate that the harmony of the visual image is positively related to each of the hierarchy (r = 0.957*, p = 0.043), enclosure (r = 0.974*, p = 0.043), the diversity of elements (r = 0.969*, p = 0.031), the diversity of scales (r = 0.973*, p = 0.043), shape and background (r = 0.983*, p = 0.017), the reflection of the two-dimensional formation in the three-dimensional appearance (r = 0.992**, p = 0.008), the distinction and uniqueness of the space design (r = 0.978*, p = 0.022), the level Maintenance of space, surfaces and green elements(r = 0.978*, p = 0.022), and space being free from the elements of visual distortion (r = 0.981*, p = 0.019). On the contrary, the results indicate a negative correlation between the visual image's harmony with some of the visual design principles, such as similarity in the heights of the elements (r = −0.962-*, p = 0.038). The similarity in the height of landscape elements gives a feeling of boredom and monotony. It reduces the diversity in height and scale, which is considered one of the most important criteria for the visual quality of a visual landscape. Similarity in height may be appropriate for official buildings or sites that aim to create a formal appearance and prestige for the place, while it is not suitable for squares and parks that need dynamism and diversity in the visual landscape.

Table 1. Results of visual design principles and their correlation with harmony in selected open spaces.

			Al-Tahrir Square	**Al-Shaab Square**	**Al-Sabean Park**	**Al-Thawra park**	***r***	***p***
	Harmony		1.98	3.12	3.17	2.1		
P1	Ordering	Axis	3.2	3.5	3.8	3.5	0.759	0.24
P2		Symmetry	3.7	2.7	2.8	2.5	−0.45	0.55
P3		Hierarchy	2.2	3.2	3.8	2.3	0.957*	0.04
P4		Rhythm	3.5	4	3.8	3	0.818	0.18
P5		Transformation	4	4	4	2.5	0.513	0.49
P6		Datum	2	4	3	3	0.727	0.27

Table 1. (*Continued*).

				Al-Tahrir Square	Al-Shaab Square	Al-Sabean Park	Al-Thawra park	*r*	*p*
P7	Spatial cues	proximity		4	3	3.8	3	−0.15	0.85
P8		enclosure		2.2	3	3.3	2.1	0.974*	0.03
P9		Similarity	style	3	3.5	3.2	3	0.836	0.16
P10			shapes	3	3.5	3.3	2.8	0.897	0.1
P11			colors	2	3.5	3	3	0.725	0.27
P12			heights	3.1	2.8	2.8	3.2	−0.962-*	0.04
P13			materials	2.5	3	2.9	2.8	0.836	0.16
P14		interlock		3	3.5	4	2.5	0.877	0.12
P15		continuity		2.4	3	3.7	2.8	0.833	0.17
P16		figure and background		2.7	3.3	3.2	2.8	0.983*	0.02
P17	Diversity	In elements		2.3	3.2	3.5	2.1	0.969*	0.03
P18		in scales		2	2.9	3.3	2.1	0.973*	0.03
P19		colors		2.1	2.7	3	2.5	0.882	0.12
P20		shapes		2.2	2.6	3.1	2.5	0.738	0.26
P21		textures		2.2	2.5	2.7	2.4	0.872	0.13
P22	scale and proportion	human scale		3.2	2.7	3.5	2.5	0.289	0.71
P23		correct proportion		2.5	2.8	3.6	2.4	0.807	0.19
P24	Homogeneous balanced composition	2D		3.5	4	4	3	0.869	0.13
P25		3D		2	3	3.2	2.2	0.992**	0.01
P26	Spirit and identity	value or historical symbols		2.5	3.5	2.6	2.4	0.652	0.35
P27		unique design		2.4	3.8	3.9	2.1	0.978*	0.02
P28	Others	cleaning		2	4	3	2	0.888	0.11
P29		maintenance		2.2	3.8	3.5	2.1	0.978*	0.02
P30		free from visual pollution		2.1	3.9	3.6	2	0.981*	0.02

*. Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed).

4.2. Results of examining the principles of visual design and harmony in specific spaces

The results of the harmony and completeness of the visual scene image of the studied spaces shown in **Figure 3** indicate a relative advantage for each of the Al-Shaab Mosque Square and the Al-Sabean Park over Al-Tahrir Square and Al-Thawra Park.

Al-Sabean Park and Al-Shaab Mosque Square achieved this preference in visual harmony due to their obtaining higher marks in the visual factors and foundations that lead to creating a homogeneous visual landscape, as indicated in the results of the correlations in **Table 1**.

Figure 4 displays detailed results of the extent to which visual design criteria were met in the four selected spaces. Al-Shaab Square and Al-Sabeen Park got high marks in the hierarchy (3.2, 3.8) item, while there were a few in Tahrir Square and Al-

Thawra Park (2.2, 2.3). Likewise, the diversity of elements was high in Al-Shaab Square and Al-Sabeen Park (3.2, 3.5), while it was less than in Al-Tahrir Square and Al-Thawra Park (2.3, 2.1).

The results show an increase in the diversity of scales index in Al-Shaab Square and Al-Sabeen Park (2.9, 3.3), and a decrease in Al-Tahrir Square and Al-Thawra Park(2, 2.1). The degree of enclosure was high in Al-Shaab Square and Al-Sabeen Park (3, 3.3) and low in Al-Tahrir Square and Al-Thawra Park(2.2, 2.1). Al-Shaab Square and Al-Sabeen Park got high scores in the item harmony of shape and background (3.3, 3.2), while were moderate in Al-Tahrir Square and Al-Thawra Park (2.7, 2.8).

The results show a good reflection of the 2D design in the 3D appearance in Al-Shaab Square and Al-Sabeen Park (3, 3.2), while it is less in Al-Tahrir Square and Al-Thawra Park(2, 2.2). Likewise, the degree of distinction and uniqueness of space design is high in Al-Shaab Square and Al-Sabeen Park (3.8, 3.9) and low in Al-Tahrir Square and Al-Thawra Park (2.4, 2.1).

The results also indicate a high level of cleanliness and maintenance of space, appliances, and green elements in Al-Shaab Square and Al-Sabeen Park (3.8, 3.5), and a low degree in Al-Tahri Square and Al-Thawra Park (2.2, 2.1). Likewise, a high level of the space is free from the elements of visual distortion in Al-Shaab Square and Al-Sabeen Park (3.9, 3.6), and a lower degree in Al-Tahrir Square and Al-Thawra Park(2.1, 2). This means the spread of visual distortions in Al-Tahrir Square and Al-Thawra Park.

Table 2. Summary of the visual qualitative evaluation according to principles and criteria for the visual design in the selected spaces.

		Al-Tahrir Square	**Al-Shaab Mosque Square**	**Al-Sabean Park**	**Al-Thawra Park**
Ordering	Axis	Two main axes. - They are defined by games area, tent, tree, and shrubs.	- Main axis and many sub-axes heading to the mosque. - They are defined by trees, shrubs, and landscape elements.	- Two main axes and many gradual sub-axes - They are defined by green and game areas, trees, and shrubs.	Two main axes. They are defined by green and game areas, high trees, shrubs, and tall trees on both sides.
	Symmetry	Semi-symmetry.	The area adjacent to the mosque's south entrance is symmetrical to confirm the mosque's importance as an important symbol.	Space, in general, is nonsymmetric, but the south-east is complete symmetry.	Semi-symmetry
	Hierarchy	The hierarchy has been weakly achieved in levels, paths' depth, and some landscape elements	The hierarchy is relatively achieved in buildings', trees' and shrubs' heights and paths' depths.	The hierarchy is achieved by heights of trees and shrubs, path depth, areas of zones, change in shape, and gradient in visual axes.	Weak hierarchy in the depth of paths, areas of zones, and motor nodes
	Rhythm/Repetition	Random repeat and interactive repeat in organizing trees and shrubs, paving the floors, and arranging the rest of the landscape elements.	Random repeat and interactive repeat in organizing trees and shrubs, paving the floors, and arranging the rest of the landscape elements.	Random repeat in organizing and arranging trees and shrubs. Repeat interactive in paving the floors and arranging the rest of the landscape elements.	Random repeat in organizing and arranging trees and shrubs. Repeat interactive in paving the floors and arranging the rest of the landscape elements.
	Transformation	Tringle, Circle, semi-circle, rectangle	Circle, semi-circle, polygon	Circle, semi-circle, oval, rectangle	Un clear transformation
	Datum	Other than the main axes, there is no reference line around which the elements are organized.	The mosque is a kernel of all axes.	Some elements and axes are reference lines for organizing some elements.	Some axes represent a reference line for some elements.

Table 2. (*Continued*).

		Al-Tahrir Square	Al-Shaab Mosque Square	Al-Sabean Park	Al-Thawra Park
Spatial cues	Nearness	Landscape elements much get closer together in groups.	Part of Landscape elements get closer together forming visual tapes, and there are elements scattered over large areas	Many of Landscape elements get closer together, creating visually related groups	Part of Landscape elements get closer together, and there are elements scattered over large areas.
	Enclosure	Partial enclosure in some seating areas.	Partial enclosure in the areas near the mosque.	Enclosure in most seating areas and some activity areas.	Enclosure in some seating areas.
	Similarity	in style, shapes, building materials.	in style, shapes, colors, building materials.	in style, shapes, colors, building materials.	in style, shapes, colors, building materials, and building heights.
	Interlock	- Relative overlap in the two-dimensional configuration elements. - overlap in the three-dimensional configuration is absent.	- Overlay of two-dimensional composition elements. - Mosque block overlay with elements organization lines.	- Wide overlay for 2D composition elements. - Simple overlay for 3D composition elements.	Simple overlay of 2D configuration items.
	Continuity	There is a relative continuity in the arrangement of the elements, but the spaces do not flow together.	There is good continuity of arrangement of elements in the mosque's vicinity, and there is no flow of spaces.	Good continuity in arranging elements and flowing spaces together.	Continuity is relatively good in the arrangement of elements in some parts and lacks the clarity of continuity and flow of spaces.
	figure and background	No clear ground hosting landscape elements, and adjacent buildings are not a suitable ground.	The mosque serves as a suitable ground for the landscape elements.	Some of the broad elements represent backgrounds for the other landscape elements, and some adjacent buildings represent backgrounds for some of the elements.	Much of the landscape elements are without a clear background.
Homogeneous of composition	Human Scale	The human scale is mostly achieved in space.	The human scale is achieved in the near part of mosque and dose not achieved in others.	The human scale is mostly achieved in all the park parts.	The human scale is partially achieved in some park parts.
	Correct Proportion	The proportions are relatively good in the dimensions and heights of the elements.	The proportions are suitable for the dimensions of the 2D elements and the heights of some elements.	The proportions are right in the dimensions, heights, and sizes of elements, corridors, and spaces in most parts of the space.	no well proportion in dimensions and heights of elements and areas.
	Uniformity of 2D Composition	Homogeneous and consistent composition.	Interconnected radial composition.	Varied interconnected organic composition in most space parts.	Inconsistent composition,
	Reflection of the 2D configuration in the 3D appearance	Is not clear	It is evident in the area near the mosque.	Relatively evident in some parts of space	Is not clear
Diversity		Variety in 2D shapes and levels.	Variety of scales, types and shapes of trees, shrubs, and some landscape elements.	Variety of scales, types and shapes of trees, shrubs, and some landscape elements.	A slight variation in the height of some trees in a few parts of the park
Identity (the shape of space, landmarks, elements express city identity)		The fountain and memorial do not enhance the place's identity, and no elements reflect the city identity.	The mosque strongly promotes space identity, as well as many elements that reflect the city identity.	Organic composition can represent the park identity, and no elements reflecting the city identity.	Landmarks clearly don't define the park identity, and no elements reflecting the city identity.
others	level of cleanliness	Poor	Good	moderate	poor
	The level of maintenance	Moderate	Moderate	moderate	poor
	free from visual pollution	Elements of visual distortion in space: metal fences, damaged elements, strange elements as the tent, advertising plates, garbage, people sleep in the space, and cars park in the game zone.	Elements of visual distortion in space: Large asphalt and large negligent green area	Elements of visual distortion in space: Guiding boards, electrical installations, irrigation connections, garbage bins, and neglected areas,	Elements of visual distortion in space: Guiding boards, electrical installations, irrigation installations, garbage bins, dumped garbage, damaged trees, damaged toys, metal fences, guiding boards, vast neglected areas, and new construction.

The quantitative evaluation results of the extent to which the design of the studied space has achieved the foundations and principles of visual design are consistent with the qualitative evaluation results and the teamwork observations on the achievement of the studied spaces for those principles. **Table 2** displays a summary of visual qualitative evaluation according to principles and criteria for the visual design in the selected spaces.

4.2.1. Al-tahrir square

The ordering has been achieved in the square through axes, hierarchy, reparation, transformation, and datum. Two main axes: the first one starts from the northern entrance and ends at the square center. The second one connects the western entrances with the eastern ones. They are defined by the game area, the tent, trees, and shrubs. The hierarchy has been weakly achieved in levels and depth of paths. Weak hierarchy in the rest of the landscape elements. Random and alternate repeats organize the trees and shrubs, paving the floors, and arranging the rest of the landscape elements. Transformation is through the change of 2D composition, from triangle to circle to semi-circle to rectangle. Other than the main axes, there is no reference line around which the elements are organized around.

The spatial signals for the relationships between space landscape elements are as follows: the landscape elements get much closer together in groups, partial enclosure in some seating areas, the similarity in style, shapes, building materials, relative overlap in the two-dimensional configuration, no overlapping in the three-dimensional composition, relative continuity in the arrangement of the elements, but the areas do not flow together, no clear ground hosting landscape elements, and adjacent buildings are not a suitable ground for landscape elements.

The human scale has been mostly achieved in space, and the proportions are relatively good in the dimensions and heights of the elements. Diversity is in two-dimensional composition and the levels. The 2D design in this square is homogeneous and consistent with multiple forms: triangle, circle, semi-circle, and rectangle, but it was not reflected in a three-dimensional appearance. Although there are a fountain and a memorial, they do not enhance the place's identity, and no elements and landmarks reflecting the city identity.

The level of hygiene in the space is low, and the maintenance level of the equipment, landscape elements, and hardscape elements is moderate. Many elements distort the visual landscape image, like: metal fences, damaged elements, strange elements as the tent, advertising plates, garbage, people sleep in the space, and parking in the game zone (see **Figure 5**).

Figure 5. Al-Tahrir Square, an aerial photograph and photographs showing the visual components of the square. (Author).

4.2.2. Al-shaab mosque square

The ordering has been achieved in the square through all principles: axes, symmetry, hierarchy, rhythm and repetition, transformation, and datum. The central axis starts from the southern gate toward the mosque. Also, many sub-axes are heading to the mosque. They have been defined by trees, shrubs, and landscape elements. The area adjacent to the mosque's south entrance is symmetrical which confirms its importance as an important symbol. The rest of the square is asymmetrical. The hierarchy has been mostly achieved in the heights of buildings, trees, and shrubs and the depth of paths. Random and alternate repeats organize the trees and shrubs, paving the floors, and arranging the rest of the landscape elements. Transformation is through the change of form from a circle to a semi-circle to a polygon. The mosque is a datum

as a core of all axes.

The spatial signals for the relationships between space landscape elements are as follows: part of Landscape elements get closer together forming visual tapes, there are elements scattered over large areas, partial enclosure in the areas near the mosque, similarity in style, shapes, colors, building materials over overlay of two-dimensional composition elements, Mosque block overlay with elements, organization lines, good continuity of arrangement of elements in the vicinity of the mosque, no flow of spaces and the mosque serves as a suitable ground for the landscape elements.

The human scale has been achieved in the near part of the mosque and has not been achieved in other regions. The proportions are right for the dimensions of the 2D elements and the heights of some elements. Diversity has been achieved by a variety of elements and shapes, such as trees, shrubs, and flowers. In addition to the variety in the scale of some landscape elements, the composition is interconnected through many radial axes and semi-circles that the rectangular mosque mass embraces. The design is mostly balanced through similarity, directing, interlock, enclosure, and continuity. The two-dimensional configuration is reflected in the 3D appearance in the areas close to the mosque.

The mosque strongly promotes space identity as well as many elements that reflect the identity of the city.

Figure 6. Al-Shaab Mosque Square, an aerial photograph and photographs showing the visual components of the square. (Author).

The level of cleanliness of the space is right, the level of maintenance of landscaping elements is moderate, and there is the neglect of maintenance of the vast green areas far from the mosque. Large asphalt and the large neglected green area may harm the visual landscape's harmony (see **Figure 6**).

4.2.3. Al-sabean park

Some principles achieved the ordering in the space design. Two main axes start from the northern and southern gate, and they end at the green, sitting, and game areas. They were defined by green game areas, trees, and shrubs. Many gradual sub-axes were specified by green sitting and game areas, trees, and shrubs. The square in general, is nonsymmetrical, but the south-east zone is completely symmetry. The hierarchy is achieved through the heights of trees and shrubs, depth of paths, areas of zones, changing shape, and gradient in visual axes. There are random repeats in arranging the trees and shrubs and alternate repeats in paving the floors and organizing the rest of the landscape elements. Transformation is through the change in 2D composition, from circular to semi-circular to oval to rectangular. Some elements and axes are reference lines for organizing some elements.

The spatial signals for the relationships between space landscape elements are as follows: many landscape elements get closer together creating visual groups, the enclosure is established in most seating areas and some activity areas, the similarity in style, shapes, colors, building materials, wide overlay for 2D composition elements, simple overlay for 3D composition elements, a good continuity in arranging elements and flowing spaces together, some of the broad elements function as backgrounds for the other landscape elements, and some adjacent buildings serve as backgrounds for some of the elements.

The human scale has been mostly achieved in all of the parts of the park. The proportions are right in the dimensions, heights, and sizes of elements, corridors, and spaces in most parts of the space. Diversity has been accomplished by the variety of elements and their forms, such as trees and shrubs, and the variety in the scale of some landscape elements. Diversity relatively maintains unity and balance.

Varied interconnected organic composition in most parts of the space. Hence the composition is mostly balanced through nearness, similarity, interlock, enclosure, and continuity. The two-dimensional configuration is relatively evident in the 3D appearance in some parts of space.

Figure 7. Al-Sabean park, an aerial photograph and photographs showing the visual components of the Park. (Author).

The organic composition can represent the park's identity, and many elements reflect the city's identity. The level of cleanliness and maintenance of landscaping elements of space is moderate. A few elements distort the visual landscape such as; Guiding boards, electrical installations, irrigation connections, garbage bins, and neglected areas (see **Figure 7**).

4.2.4. Al-thawra park

The ordering has been achieved in the park mainly through two axes and reparation. The first axis starts from the northern gate, and it ends with green areas as well as games areas. It has been defined by the above-mentioned green areas and

games areas, high trees, and shrubs. The second axis connects the western and eastern gates. Tall trees on both sides have defined this axis. Randomness is repeated in organizing trees and shrubs. An alternative is repeated in paving the floors and arranging the rest of the landscape elements. Transformation is not apparent in the forms, and some axes represent a reference line for the organization of some elements.

The spatial signals for the relationships between space landscape elements are as follows; Parts of landscape elements get closer together, and there are elements scattered over large areas. The enclosure is achieved in some seating areas, and there is a similarity in style, shapes, colors, building materials and building heights, simple overlay of 2D configuration items. Continuity is relatively good in the arrangement of elements in some parts, and the lack of clarity of continuity and flow of spaces to each other. Many of the landscape elements are without a clear suitable background.

The human scale has been partially achieved in some park parts, and there is no right proportion in dimensions and heights of elements and areas. Diversity is simple in some tree scales, and there is often no diversity in the rest of the landscape elements. The composition is inconsistent, and there is no correlation between the shapes of the elements and the relationship between them, which neither supports balance nor enhances space vitality. Landmarks do not represent the park's identity, and no elements reflect the city's identity.

Figure 8. Al-Thawra park, an aerial photograph and photographs showing the visual components of the Park. (Author).

The level of cleanliness and maintenance of landscaping elements of space are low. Many elements distort the visual landscape image, including guiding boards, electrical installations, irrigation installations, garbage bins, dumped garbage, damaged trees, damaged toys, metal fences, vast neglected areas, and new constructions (see **Figure 8**).

5. Discussion

Although previous literature discussed a wide variety of visual design principles and elements for open urban spaces, still, none of them has comprehensively and empirically examined and selected the principles and criteria which have a more significant positive impact on the harmony and completeness of the visual landscape image. Furthermore, sorting the principles and criteria for the visual design of urban open spaces is not easy because most of the criteria are intertwined, such as diversity, hierarchy, and rhythm. Sometimes they are conflicting, such as diversity and unity or balance and tension. That may raise the ambiguity and complexity of urban designers and architects in determining the most influential factors in increasing the visual landscape image quality. In this study, the author summarized the most important of these principles and criteria from a wide range of previous studies, depending mainly on Bell's foundations in his book "The Elements of Visual Design in Landscapes." the study also evaluated the visual quality of the four selected public spaces in Sana'a city as a secondary goal of this study. The main goal is to define the criteria that affect visual landscape quality as a general concept. The study investigated the visual landscape principles that enhance the harmony of the visual landscape.

In this study, the authors discuss the visual harmony of the visual landscape as a result of the rest of the visual landscape design criteria and principles. Results of the study indicate that harmony of the visual landscape image is positively correlated with several factors, namely, hierarchy, diversity of elements, diversity of scales, enclosure, shape and background, reflection of the two-dimensional configuration in the three-dimensional appearance, characterization of space design, level of maintenance, and the space free from elements of visual distortion. The results of this study agree with the results of a group of sporadic and separate previous studies. Arriaza et al. [46] indicated that visual quality increases according to the degree of decreasing importance, implying hierarchy. Diversity leads to complexity, but balanced organized complexity leads to creating vitality and increasing the visual landscape quality in open spaces [27]. Schirpke, Tasser, and Tappeiner [47] stated that landscape diversity and shape complexity are positively related to visual image quality. Xu et al. [48] pointed out that design intensity and diversity in raising the aesthetic visual quality are important. Also, Wang et al. [42] indicated that the consensus about visual landscape quality increases when examining multiple types of landscapes. Perovic and Folic [8] also noted that diversity and dynamics in public spaces have a visual impact on users. Also, adequate green spaces and natural elements in the composition may support improving the harmony of visual landscape images.

The results of the present study did not confirm the correlation of the harmony of the visual landscape image with the human scale and the correct proportion. This may be due to the low score achieved by Al-Shaab Mosque Square in these two items,

which negatively affected their association with the harmony of the visual image. Al-Shaab Square did not achieve good results on the human scale and in the correct ratio due to the vast parking spaces that go between the space and the vast seating areas lacking landscape elements.

The golden section has not been achieved in the four studied spaces in this study. Bell [27] stated that applying the golden section in the landscape elements design in open spaces is almost impossible. In this respect, Carmona et al. [23] pointed out that the golden section has a critical role in the contribution of the quality of the visual harmony.

Furthermore, based on the visual evaluation that the study conducted for the studied spaces, the study can also refer to several factors which negatively affect visual harmony and visual landscape quality, such as the vast expanses of asphalt pavements and the vast neglected green areas. There are also many other negative factors related to management issues such as the lack of maintenance of the landscape elements which creates damaged elements and abandoned areas which reduce the visual landscape quality. Visual landscape quality increases with proper care for landscape elements and expands vegetation coverage [42].

Regarding the four studied spaces, Al-Sabean Park and Al-Shaab Mosque Square achieved visual harmony over Al-Tahrir Square and Al-Thawra Park. Still, the level of visual harmony in them does not rise to the required level which achieves the three-dimensional quality integrity. Although space designers were concerned with two-dimensional compositions, in most cases, these compositions were not reflected in the three-dimensional compositions and designs. The 2D Design of Al-Tahrir Square is relatively good, but it does not reflect the three-dimensional landscape. In addition to the smallness of the square area, many new elements, which led to the destruction of the harmony of the visual image, led to the damage of the identity of one of the most important cultural places in Sana'a city, as pointed out in Shams El Din [49] study. As indicated above, our field studies were carried out in two periods, August 2019 and February 2020. Therefore, the study noticed differences in the visual landscape of the studied spaces in winter and summer. The selected spaces appear greener and more beautiful in summer when it rains, whereas they are paler and drier in winter because of the negligence of maintenance and irrigation as management aspects besides stoppage of rain in that period.

This study is essential for two reasons. The first reason is that it is not only a visual evaluation of the selected public open spaces in Sana'a city, but it also presents a visual analysis based on the principles and criteria of the visual design of open spaces. A methodology for the visual evaluation of open spaces can be re-implemented in similar public open spaces. The second and most important reason is that it contributes to enriching the theoretical concepts of the relationship between the principles and criteria of the visual design of open spaces. It determines the correlation and contradiction between them. It also indicates the most important principles and criteria which affect the visual harmony and quality of the visual landscape. The study demonstrates that the resolved hierarchy, diversity of elements and scales, enclosure, shape and background, reflection of the two-dimensional configuration in the three-dimensional appearance, and characterization of space design are the most critical principles and factors which enrich visual landscape image and promote visual

harmony. The study also emphasizes that attention should be paid to maintenance, irrigation, and hygiene work as critical administrative issues. Consequently, this study contributes to supporting and assisting urban designers, architects, landscape architecture designers, and other related parties when developing the existing open spaces or designing new public spaces.

6. Conclusion

The study dealt mainly with visual design principles and some management issues related to the quality of the visual landscape, focusing on the principles and criteria of visual design which are mainly derived from what Bell [1] pointed out. The study relied on the direct observation and photographic documentation of the visual aesthetic aspects of four selected public spaces in Sana'a city in Yemen.

The study investigated the degree to which those spaces meet the criteria and principles of open spaces visual design. Simultaneously, the study discussed the relationship between these design criteria and the visual harmony in a landscape image. The study identified the most influential principles in the harmony of the visual landscape and the completeness of the visual landscape image.

The study listed some of the principles and criteria of visual design which contribute to enhancing the harmony of the visual image and raising the quality of the visual landscape image. These principles and criteria are hierarchy (as one of the order principles), diversity of elements, variety of scales, enclosure, and shape and background (as some principles of spatial signals), reflection of the two-dimensional configuration in the three-dimensional appearance, and characterization and uniqueness of space design. The study also indicated that reflecting the two-dimensional composition in the three-dimensional appearance is important, and it effects in enriching the visual image and increasing the visual landscape quality. These principles can help architects, landscape architects, and urban designers and developers to make appropriate design decisions which can contribute to producing visual landscape images of open spaces, thus, enhancing the quality of the visual image and the efficiency of urban spaces and open areas.

As administrative issues, the study figured out the visual distortions caused by negligence in cleaning and maintenance and the visual adverse effects of new interventions and maintenance work which has not studied well.

Limitations of the study are relatively few since it is based only on the opinions and observations of the teamwork by the visual field study. However, specialists' views in architecture and urbanism are better and deeper than those of the space users in the visual and aesthetic aspects. According to Beer and Higgins [50], people can only understand the current tangible needs. They cannot predict the future, and they cannot adequately understand the visual issues. Also, Dupont, Antrop, and Van Eetvelde [51] pointed out that experts discover visual images largely, while people focus on a limited number of landscape features so that views may be different. The study is also limited to only two types of public open spaces: parks and squares. The methodology of the study can be applied to other public spaces such as streets, markets, campuses, etc. Furthermore, for the sake of accuracy and updating, methodology or parts of it can be applied through computer software programs, such as DepthMap,

GegNet, another software, or an advanced computer application.

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