

We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

6,900

Open access books available

185,000

International authors and editors

200M

Downloads

Our authors are among the

154

Countries delivered to

TOP 1%

most cited scientists

12.2%

Contributors from top 500 universities



WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Numbers displayed above are based on latest data collected.
For more information visit www.intechopen.com



Unity and Diversity in Geometric Gardens

Kabila Faris Hmood

Additional information is available at the end of the chapter

<http://dx.doi.org/10.5772/intechopen.71759>

Abstract

There are different types of gardens; each one is influenced by time, place, and science. Gardens' design was inspired by the scientific results of a particular age. It transforms the practical need of people into beautiful edifice and provides users with comfort and convenience. Gardens are characterized by the deep thinking of geometry and beauty, as in Andalusia, Istanbul, Iran, Afghanistan, and Italy. Besides simplicity, shapes in geometric gardens have unity and diversity. These foundations can achieve harmony. Geometric gardens have a type, embodied in many models and organized by this main type, leading to common characteristics. This chapter will discuss these characteristics and their diversity with a comparative analytical study between East and West gardens to find the bases of diversity and the elements' unity. It will discuss many models of geometric gardens through the concept of type and model. The chapter focuses on many examples to test its response to specific designing elements of landscape and how it reflects its experience of designing the garden. The conclusion is based on the interactive vision type, model, diversity, and unity to find common and noncommon characteristics in geometric gardens of different places and ages.

Keywords: geometric gardens, unity and diversity, place and time, symmetry and axially, type and model, common characteristics

1. Geometric gardens introduction

In urban environment of geometric gardens, people were looking for comfortable and convenient gardens to increase the harmony of their surroundings (**Figure 1**).

Through ages, gardens had multiform, different elements, design foundations, materials, etc. This chapter will discuss the geometric gardens in a comparative analytic methodology. The chapter adopted this methodology to identify both the common and uncommon characteristics within the geometrical design type in the landscape and the design of the gardens with



The garden between Sultanahmet Mosque and Hagia Sophia in Al Fateh Square - Istanbul - Turkey (Source ; Author 7/2017)



MiniTurk Gardens in Istanbul (author 8/2017)

Figure 1. Models of gardens in the geometric type that provide us with comfort, the importance of gardens in the urban fabric of humans (author 2017).

different sizes, according to the differences of place and time through the comparative analytical approach. There are several systems for planning the gardens such as the regular system, the natural system, the mixed or double system, and the modern system. This chapter talks about the regular system or the geometrical system. It is one of the types used in designing the gardens that humans have a clear role in forming according to the geometric shapes along with emphasizing the principle of symmetry as one of the most important elements of this design. This type is used in most gardens in different places and times. We can see it in the pharaonic Egyptian gardens; such gardens are divided into four sections, along with water as the main element and the symbol of beauty [1]. The Persian and the Greek gardens were also classified within the geometrical type. Moreover, the most famous garden in that era was Platon's garden. On the other hand, the Roman gardens joined both the natural and geometrical type. The Greek and Roman societies considered the gardens as the most suitable places for poetries because of their esthetic elements, regardless of whether they have a geometrical or natural type.

The origin of the geometrical gardens goes back to the ancient civilizations of Egypt. The hieroglyphics gave us the historical evidence on this aspect, but we did not receive sufficient ones in Mesopotamia. These two civilizations were based on the water element, by having the Nile River in Egypt and the Tigris and Euphrates Rivers in Mesopotamia [2].

2. Type and model: diversity and unity phenomenon

This chapter will use the term geometric garden as well as the term ornamental garden given by George Plumptre for the Renaissance gardens of Europe in particular. Plumptre assures that the classical traditions of the Greeks and Romans were reinterpreted until they became the backbone of the architecture and the ornament of the garden in the Renaissance period. He also assures that the gardens of the Renaissance can be fully understood through the past 400 years, especially in the Italian Renaissance gardens. The gardens' primary prototype is shown in Medici around Florence, but its origin was in Rome in 1503 by the architect Bramante. The most prominent element in the geometrical garden was the main axis, which crosses other axes at different levels of land. It appeared as terraces, fountains, sculptures, and stairs/staircases. Bramante was not the only architect who created those gardens, but the Renaissance architects created the designs of such gardens too. Renaissance gardens were not limited to Italy but flourished in France, England, and most of the Western world. The largest gardens were in France. The size of Versailles gardens allowed Louis XIV to present himself as the absolute king. On the other hand, the French and Dutch type influenced English gardens in England, in the seventeenth century. The instinct and innate love of English people of the countryside to live peacefully with the surroundings made them less influenced by the French type [3]. The Renaissance gardens have large spaces with geometric designs. Gardens in Italy were often held on sloping ground, which made it harder to achieve the geometric type in its gardens. In Versailles gardens in France, the balance between all elements of the garden can be seen without preference for an item over another neither esthetically nor functionally. Versailles garden was designed over an area of 6614 ha. It has trees and natural and human-made lakes. What distinguishes the garden are the main axes that are perpendicular to some secondary axes, with emphasis on the main axis that achieves the symmetry in the design. The symmetrical geometrical system was adopted in the English gardens' design before the natural gardens of England appeared in the eighteenth century [4]. The question is were the Renaissance gardens the only gardens that embodied the principles of geometric ones? Alternatively, were they among the models that embodied those principles that characterized the geometric type?

The goal of all designers is to create a connection with nature through the ages. Moreover, this is confirmed by all the scientific sources. They also confirm that the first gardens were geometric and that man intervened in their formation by controlling the natural factors. So, geometry is embodied in all the elements of the natural and human-made gardens. This gives the pattern style straight or circular lines. Therefore, we can notice the symmetry even in the planning of trees and shrubs. The trees are symmetrical in rows in regular dimensions, with uniformity of the green areas and the fences surrounding the garden to take a regular shape. The climbing plants are also planted on regular geometric wooden walls [5]. As previously mentioned, the pharaonic or Egyptian garden is one of the geometric gardens that came before the Renaissance gardens. It is considered as one of the first architectural models of gardens. It was originally closed for privacy, and then walls surrounded it. Its trees are organized in geometric rows, and the water was in rectangular basins and canals. In addition to the vineyards with statues, carvings, trees, and shrubs, which were planted in ceramic pots, they were undoubtedly influenced by the design of the Mesopotamia gardens [6]. The Persian gardens were influenced by the ancient Egyptian and the Mesopotamia gardens, which were

embodied later on in the Islamic gardens, especially the Mughal gardens in India. The Persian gardens (and then the Islamic gardens in Iran) were called the paradise gardens or Eden gardens. The main purpose of establishing the garden was to create a rich context to enjoy the beauty of the garden. The garden's most important feature is that it is isolated from the outside, to achieve privacy, safety, and security. [7] Despite the minor differences between the Persian gardens, which form the noncommon characteristics of these models, gardens often originated from the same structure that was imposed by the location. Most of the gardens have rectangular shapes, and they were divided into square or semisquare shapes. In contrast to the western gardens, the geometric structure of the Persian gardens does not follow the perspective principal, but it is mostly based on the integrative unity creation. The rectangular shape of the garden may change slightly in response to the different climatic conditions. The scheme of Shahzadeh-Mahan garden (in Kerman) is an example of the Chahar-Bagh pattern. It has a rectangular shape where the pavilion is located in the middle of the main water channels that define the north and the south axes. The Fin Garden (in Kashan) is also an extended form of Chahar-Bagh in a series of squares and rectangles with a pavilion and a square basin in the center. In the Chahar-Bagh garden, or Paradise garden, there are four canals of water, which usually carry the water to a central pond or fountain. These canals are considered as four rivers in paradise, filled with milk, honey, wine, and water (**Figure 2**) [8].

The Persian garden emphasizes the principle of closeness or openness to the inside (inward looking), which achieves the privacy especially in the gardens that were designed after the



Figure 2. Geometric type in the Bagh-e Fin garden in Kashan (Iran) (author + Flickr).

spread of Islam in Iran. This design principle was to protect the garden from the outside. The creation of closed places and the existence of the broad open view without any optical barriers provide an interactive opportunity with nature. Persian gardens seek to achieve that by adopting the philosophy of trying to arrange the components in their spatial coordinates not imposing any system on the landscape [9]. The interaction with nature is a common characteristic in the Islamic city, which was integrated with the climate and nature, corresponding to the human needs in the city (buildings and open spaces) [10].

The principle of openness to the inside is consistent with the design of the traditional houses, mosques, schools, palaces, and khans, except two khans: As'ad Basha Khan, which was built in Damascus, Syria, in 1156 AH/1743 AD, and Murjan Khan, which was built by the governor of Baghdad, Ameen Al-Deen Murjan, in 760 AH/1358 AD [11]. The garden's entrance starts from a public area to a semipublic one and then to a private sector. This principle forms a hierarchy of privacy starting with the public to a semipublic or semiprivate to the private entrance and then achieving the space that is called "Hashti." Waterways usually determine the path to the monument or the endpoint. This sequence or gradient is illustrated by the height, the color, and the size of the entire garden's components (**Figure 3**).

Symmetry as a classic esthetic tool was an indisputable principle design of the Persian gardens. Different aspects of symmetry can be found in designing the central open spaces, the palaces, the streams and the irrigation network, and the type and place of planting trees and plants, especially along with the garden's axes. However, under this apparent symmetry, vegetation provides an attractive view. Although the trees and plants are arranged symmetrically, plants cannot grow equally. Therefore, we can say that the garden is a symmetrical container, but nature's elements that are in the garden are asymmetry [12]. This is the first

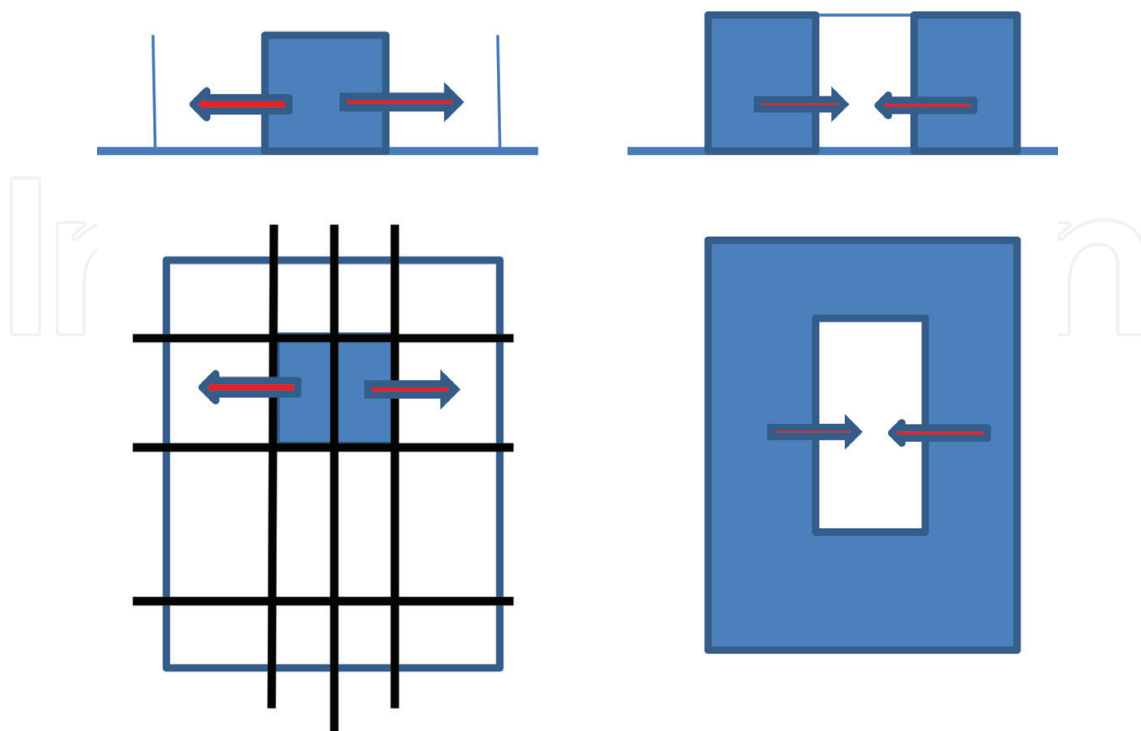


Figure 3. Privacy in models of geometric type gardens (author).

clarification of the unity and diversity phenomenon that this chapter will talk about: Mughal gardens are one of the most outstanding gardens that have contributed to the characteristics of the Persian gardens after Islam. Mughal gardens were influenced by the Persian gardens and gave them an innovative way of observing the characteristics of the Islamic gardens. The garden has a symmetrical and geometrical design, but it is larger than the Persian gardens. Mughal gardens are surrounded by palaces not centered by them like the Andalusia gardens. Therefore, they lacked the patio that was established by Islamic gardens. Their most prominent elements are water, along with the shadows to mitigate temperature (especially the Mughal gardens in India, where the most important items that developed greatly in the Islamic Mughal gardens are the intensive use of water, but they used less water in Humayun's tomb garden). Those gardens have few industrial establishments as Andalusia gardens. The garden was surrounded by trees with equal intervals, especially cypress trees. Mughal gardens were similar to the Islamic gardens by using the aromatic plants and fruit trees [13].

The Islamic garden is a reflection of paradise garden that awaits Muslims. As Ruggie sees it, it has achieved the development and diversity in forming the art that created the Islamic gardens and the landscape. All the models of the Islamic gardens have a close relation with the Islamic art, which is concerned with fine details in all fields. The Islamic garden has the Islamic spirit and a geometrical style with straight lines adorned with trees, shrubs, and flowers. It is surrounded by small fountains whose water is sprinkled in ponds and canals. Water is one of its most essential elements, which was used in various forms on the patio. Although the Islamic gardens have begun from the practical need to organize the land and enhance the yield of the land and the distribution of natural resources, they are distinctly evolving from these early agricultural efforts to the top of the beauty as in the famous gardens of Alhambra Palace in Spain and Taj Mahal in Agra [14], as well as the outstanding gardens that still exist in the palaces of the Ottoman sultans, which reflect the characteristics of the geometric type, the concept of the courtyard, the symmetry, and the pivotal. The ottoman gardens used the fountains and pools despite being located on the river banks and the Bosphorus shores, as the Topkapi Palace in Istanbul, and the other ottoman palaces and the fountains that are nearby mosques like the arena fountain that lies between the two great buildings, Sultan Ahmet Mosque (the blue Mosque) and Hagia Sophia, in Istanbul. The Islamic garden was characterized by the balance between its horizontal and vertical components and between the natural, the industrial, and the construction elements. Attention was paid to colors and strong aromatic smells by choosing flowers and plants that possess this characteristic, such as roses, jasmine, and *Rosmarinus officinalis*. In general, Islamic gardens have rectangular shapes and are often divided into four quarters, and their water channels represented the four Life Rivers. The Islamic garden was expanded widely in the Islamic world from India to Morocco and Spain for several centuries. [15]

The Islamic gardens are not confined to the gardens that are in India, Iran, Spain, Turkey, Morocco, and other countries of the Islamic world. There are gardens in Umayyad and Abbasid era, which cannot be found now, but they were mentioned in poems, literature, and history books. As Samarra Gardens in Al Manqoor or Balkuwara Palace, Jawsaq Al Khaqani Palace, or Bab Al Amma (Public Gate) Palace which was built by the Caliph Al-Mutasim. It is described as the palace of the city for its large area (172 hectares). It is characterized by its longitudinal axis, which starts from the gate and passes through a large pond surrounded by gardens



Figure 4. Geometric types of gardens with many models.

on both sides, down to the Tigris River through the pavilion. The Mediterranean garden is considered as one of the geometric gardens. So, what is the Mediterranean garden? Some say that it is just a courtyard with fruit trees and vineyards. It can be found in the countries that surround the Mediterranean Sea and enjoy a Mediterranean climate as desert climate, semi-desert climate (semidry), tropical climate, seasonal climate, and Mediterranean climate [16]. It often has vernacular features (this is what we consider as the main reason for the existence of noncommon characteristics of the geometric gardens, which lead to have a diversity phenomenon, at the time that the common features for these gardens have achieved the phenomenon of the unity). Others say that the Mediterranean garden is a place to grow plants within the temple or the palace. It has a specific area where different skills are developed to offer the ideal service for humans regardless of place or time. It was either a source of production or beauty. In the eastern gardens, there were no boundaries between these two sources. However, the western gardens were known more as a productive source and a place for enjoyment. This clear difference came from the different concept of paradise in the East and West. The diversity of employment, technologies, and the quality and quantity of requirements for designing the garden can influence and be influenced by the scale and size of the garden [17].

Andalusia gardens are considered as the ideal Mediterranean garden. They touch all man's senses: the sense of sight by seeing the lights, the shadows, and the colors; the sense of smell by smelling the fragrances of blooming fruit trees that also satisfies the sense of taste; the sense of hearing by hearing water sound; and the sense of touching by feeling the texture of garden's elements. Water is the most prominent element in the gardens, and it is essential for plant life. The black palace gardens are one of Andalusia gardens. At the turn of this century, some changes were made in Alhambra Palace in Granada, as planting plants that used to grow during Bani Alahmar time, making it 50 centimeters deeper than the pavement, so

the traditional method of irrigation became easier [18]. Al Rayhan courtyard in Alhambra garden has a large pool, which reflects the dome of the sky. The courtyard is divided into a linear shape. Water reaches the basin through two marble basins located at each end. On both sides of the courtyard, there are two columns with cubic capitals that have seven semicircular arches decorated with hollow diamond shapes.

Andalus gardens were characterized by the use of evergreen and aromatic trees, such as orange trees, roses, flowers, jasmine, and violet. Alhambra gardens were considered as the most beautiful among other Islamic gardens, because of their harmony with nature and attachment to the palace courtyards that have a rectangle and semisquare shapes. Water played a great role in these gardens especially in Al Areef that has a steep slope where water comes from the top to the bottom in channels between trees (**Figure 4**) [19].

3. Common characteristics and other noncommon characteristics of geometric gardens

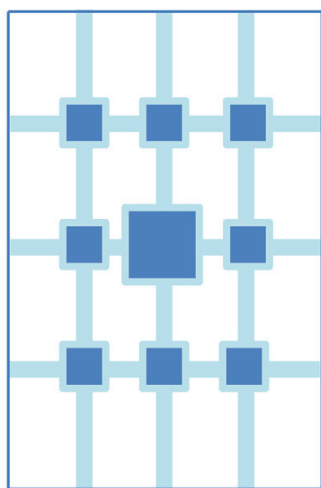
One of the main features of the geometric garden is the regular lines of plants, arranged in symmetrical sites and geometric designs. Plants are usually arranged in rows or other regular patterns. The architectural style of the gardens echoes the classical architecture in Greece and Italy. Although Islamic gardens were based on geometric lines, the classical influence and Renaissance had a stronger influence on the garden design over the centuries. Versailles and Fontainebleau are of the most famous gardens and were built by Andre Le Notre. These gardens are huge, but their characteristics can also work well on a small scale. The main principles of the geometric garden design include:

3.1. Symmetry

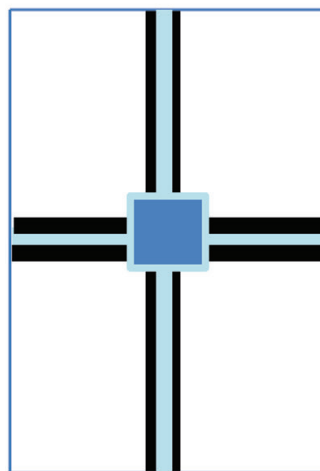
It is the symmetry that occurs on a central line, which may be a path or a garden, or over a central planting bed. In general, symmetry is achieved by having an axis that focuses on a dominant feature through a focal point that may be a statue, a building decoration with one prominent element or more on the rest of the designing elements. In the extensive gardens, we may find more than one axes intersecting each other and generating great views in multiple directions. When designing a geometric garden, the garden's space is often divided into two halves or quarters. The divisions of the garden should be large to create an extended visual impact. Water anchors, water pools, and garden paths are considered as the common features of the geometric design [20]. Symmetry is one of the most important elements of designing the Islamic geometric garden; it is achieved through the symmetry of the channel axis, which divides the space into two symmetrical parts. The symmetry in the patio or the courtyard is an important component of the Islamic garden. Symmetry can be achieved by having a high axial and the similarity of the adopted designing elements. The symmetry in the geometry gardens may be binary where the elements are repeated on both sides of the primary axis or a doubled symmetry in which the design unit is repeated several times on both sides of the primary axis or the secondary axes and can be used in medium or large spaces that were designed according

to the geometric system. The symmetry may also be round or oval, in which the parts/units are repeated in a circular or oval way around a circular or oval unit in the center of the garden, and it can be bilateral or doubled. It can be followed in the circular public squares or in the gardens that have fountains or statues or any building block. Symmetry can also be achieved where the garden's parts are repeated and are all out from one circular or oval source (**Figure 5**) [21].

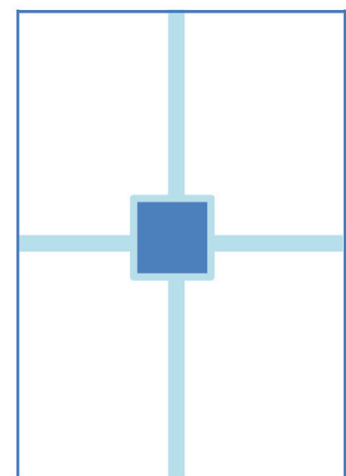
Water is one of the most important elements used in the geometric garden. It is the moving element alongside the presence of man, which gives the feeling of life in the garden. Moreover, the static water gives the feeling of calm and unity. Water is considered as the axis that connects the parts of the geometric garden. The form in which water is used is often associated with the climatic factors. In a humid climate, water is employed in the static form. In hot and dry climate, water is used to reduce the effect of the climate by having fountains or waterfalls or large pools. Moving water helps to soften the environment more than the static water. Water is used in geometrical design to achieve tranquility rather than excitation [22]. In the symmetrical



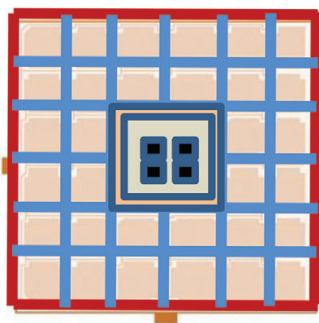
Multiple symmetry



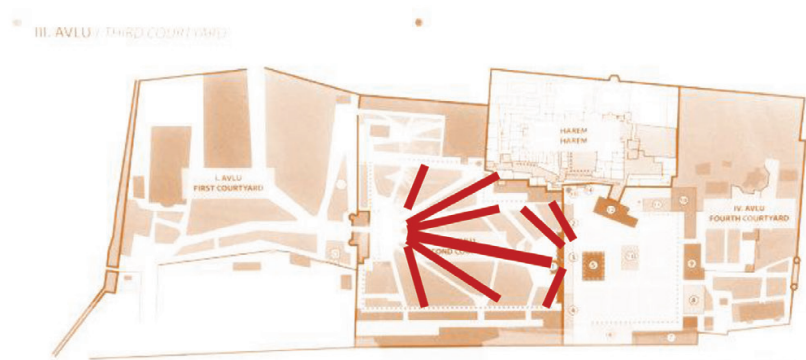
Double symmetry



Binary symmetry



Multiple symmetry
Humayun Shrine



TopKapi – Turkey Radiation symmetry

Figure 5. Types of symmetry in plans of some models in geometric-type gardens (author).

geometric system, the garden's parts are repeated around the main axis, which divides the garden into two symmetrical halves. Flower basins are on both sides of the axis in a parallel symmetrical way. Trees, shrubs, and other plants are distributed symmetrically regarding consistency of the flower colors the leave's shapes and types. This system includes planting the symmetrical trees of the same kind according to equal and regular proportions and maintaining green areas and cutting them consistently to look in regular shape. Symmetry as an important common feature of the geometric garden type can be achieved through axuality.

In the symmetrical geometric system, the garden's parts are repeated around the main axis, which divides the garden into two symmetrical halves. Flower basins are on both sides of the axis in a parallel symmetrical way. Trees, shrubs, and other plants are distributed in a symmetrical way in terms of consistency of the flower colors and the leave's shapes and types. This system includes planting the symmetrical trees of the same kind according to equal and regular proportions and maintaining green areas and cutting them consistently to look in regular shape. Symmetry as an important common feature of the geometric garden type can be achieved through the axuality.

3.2. Axially: which it means having one or more main axes that are perpendicular to a group of secondary axes

Each garden has its axes that depend on the garden's area. The axes are imaginary lines; some of them are main and longitudinal, and others are secondary or horizontal intersecting with the main one. Each axis has a beginning as the fountain and an end as the winning point on the opposite side. Having a submersible in the middle of the garden and a terrace overlooking the entire garden increases its beauty. What is called the main designing axis is important in designing the geometric garden type (**Figure 6**).

Water is one of the most important geometric designing-type elements that contributed effectively in achieving the axuality. In Chahar-Bagh garden in Isfahan-Iran, water axes led the visitor to the garden from its entrance to the main central pavilion and the secondary pavilion, through the turquoise water channel. The Chehelsotun garden design has a square shape to focus on the pavilion that exists at the intersection of the main axis with two large pools and another secondary axis with a small pool on the west side of the garden [23].

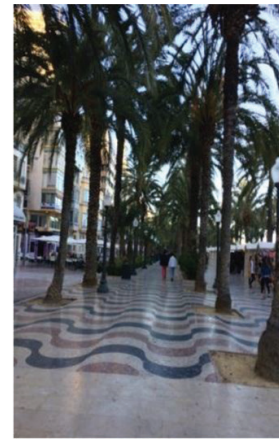
It is necessary to concentrate on the greatness of designing the gardens that have been implemented in Iran, which have exceeded with their quality the other best similar global examples that refer to different cultures and civilizations. (Chahar-Bagh and its side gardens were previously designed before Champs Elysees in Paris and Unter den Linden Avenue in Berlin). "Shahan square" includes a regular rectangle courtyard, with dimensions of 510×165 m, surrounded by two-level arcades dedicated for commercial spaces. Gardens have been planted on either side of the arena, whereas the center of the garden was for the big parties of racetrack and polo, a hockey-like sport practiced on horses with long rockets and wooden balls. The new buildings of the capital were located around the arena, as "Sheikh Lutf Allah" Mosque, which is located in the middle of the eastern side of the arena. Opposite the west side, there lies "Ali Kabi" the Shah's palace, while the entire northern side is connected to the building that forms the "Bazar." Its primary activities are the following:



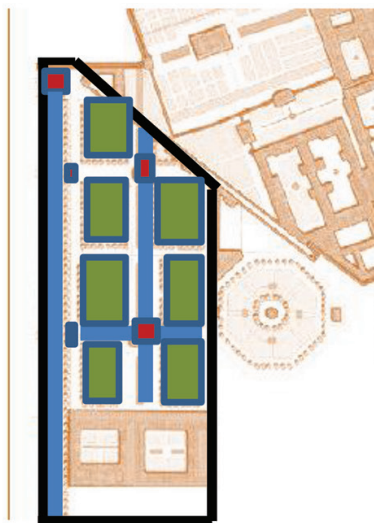
Topkapi Palace – Istanbul (2017)



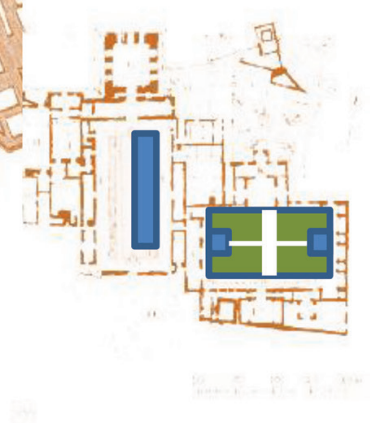
Fatih Seire –Istanbul (2017)



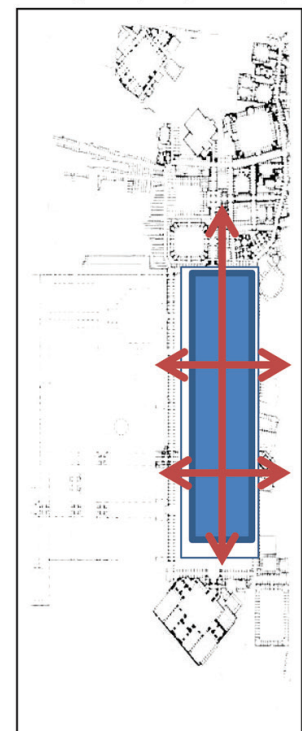
Alicante – Spain (may -2017)



Isfahan – Iran



Granada – Spain



Isfahan - Iran

Figure 6. Axiality and high geometry in a number of geometric-type gardens (author).

Water plays a great role in this garden. It can be found in water basins in front of the main entrance of the mall, in the middle of its patio, and on both schools' channels that are located on either side of the prayer halls. The roofs of water basins reflect many sections of the building. In many cases, they double the height of its architectural elements to increase the importance of these elements and their great role in creating creative formations [24].

The ancient Persians used water in their gardens; those traditional designs in the Islamic gardens were created after Persians converted to Islam. Water in their gardens was the source of happiness. This was reflected in the geometric gardens through crosscutting channels as the

traditional Chahar-Bagh garden, which made the intersection of those channels an attraction and a focal point. It is embodied in a building or a water reservoir, in an attempt to express the paradise, which is flooded with water. Water is what distinguishes the Islamic garden with its overall symmetrical scheme.

There are other examples of the use of water in designing the geometric gardens. In the Renaissance, in Lante Villa, they used the water. Moreover, as Osbert Sitwell said, water is the spirit of the garden, which is embodied in the blue fountains that reflect the purity of the sky. Water was first used in the gardens for functional reasons, like irrigation. Everything grows because they need water, but the esthetic, spiritual, and philosophical reasons for using water have been added to the gardens. Fountains and waterfalls revive plants and trees and refresh the souls and minds by meditation. In many cases, they overlap and integrate with the sculptures in the gardens. Water may be as pools and lakes with bridges to complement the esthetic landscape (**Figure 7**) [25].

3.3. Centrality

Centrality is clarified in the pavilion of the Persian gardens when the main axis of the garden intersects, as a focal point and a central area. It is emphasized through the regular tree rows that create the movement paths in the garden. In other geometric gardens, sculptures are the focal point, as gods' statues and the mythical creatures in the classical gardens (**Figure 8**) [26].

3.4. Privacy

Privacy is evident in the geometric gardens that have been fenced by the wall or adopted the idea of the patio or the courtyard. The Andalusia gardens and the Ottoman palaces adopted the second style. However, the first style can be clarified in the Persian and Islamic Mughal gardens. One of the unique features of Persian gardens is that they are fenced. The layout and structure of the Persian garden make it a walled garden, enclosed by walls to provide the mental picture of paradise in the heart of the deserts to be protected from strangers. The function of these walls was not only to create borders but also to act as an insulator between the hot, dry outer area and the inner green area, interior shaded area and semiparadise (**Figure 9**) [27].

The symmetry is achieved by having a high axial and the similarity of the adopted designing elements. The symmetry in the geometry gardens may be binary where the elements are repeated on both sides of the primary axis or a doubled symmetry in which the design unit is repeated several times on both sides of the primary axis or the secondary axes and can be used in medium or large spaces that were designed according to the geometric system.

The symmetry may also be round or oval, in which the parts/units are repeated in a circular or oval way around a circular or oval unit in the center of the garden, and it can be bilateral or doubled. It can be followed in the circular public squares or in the gardens that have fountains or statues or any building block. Symmetry can also be achieved where the garden's parts are repeated and are all out from one circular or oval source.

The Islamic gardens in Iran and India are the largest Islamic gardens that still have walls for privacy. In the past, the garden was part of the building in the courtyard model garden, and then the building became part of the large garden.



Granada – Spain ... author May- 2017



Alicante – Spain... author May- 2017



Garden of Sultan Ahmed author Aug. 2017



Sakarya –Turkey author July- 2017



Gardens of geometric type in Iran(Flickr)

Figure 7. Water in geometric-type gardens in Turkey, Spain, and Iran.

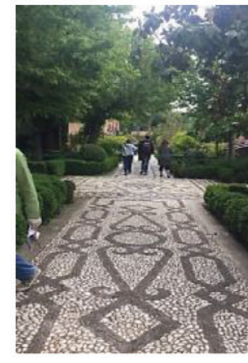
The Alhambra Palace can be divided into two large suites: Qamaresh Pavilion with the Ambassadors' Hall and Qamaresh Tower, which is above the hall. Moreover, the Lions Pavilion which the Lions Courtyard and a beautiful Lions Fountain in the middle of the lobby center. On the round marble basin of the fountain, there are twelve marble lions, where water comes out from their mouths according to day and night hours. The Lions courtyard is designed according to the perpendicular axes type, clarified by having two water channels that meet the courtyard fountain. They extend into the hallway arcades that surround the courtyard from the four sides, the channels in the arcades and with small fountains that have low basins. Al Rayhan courtyard and Patio de Alberca centered by a pool and shaded by beautiful basil trees are also there.



Topkapi sarayi (palace) in Istanbul – Turkey.... photo by author August 2017
Building of palace is the focal point



Sculpture or Tree is the focal point Alicante – Spain ... photo by author may 2017



Royal Palace in Madrid – Spain ... Granada gardens photo by author may 2017
Sculpture or building is the focal point at the end of main axis

Figure 8. The main axis and the focal point in gardens. Photo by: Author 2017.

The courtyards are important parts of the Islamic garden, especially in the palaces in Andalusia and Turkey, including the Abbasid palaces in Iraq, where there are multiple courtyards for having multiple buildings within one place.



Topkapi Palace – Turkey (Author Aug. 2017

Granada – Spain (Flickr)

Figure 9. Patio or courtyard in the geometric-type gardens in Turkey and Spain.

To achieve privacy, it is important while planning the garden to identify it, by creating a view that isolates it from differences of opinion so the view will be limited only to its content. Plants or walls fence the garden. In some cases, the design requires isolating the design's elements from each other to attract attention to its contents. This can be achieved by building a regular fence in the garden or by using a group of trees and shrubs to block the natural garden behind it. Thus, an isolated and independent place is identified to represent a certain character in the garden, but it is associated with the rest of the garden [28].

3.5. Harmony and balance

Harmony is achieved by linking two elements of the design, or each item with elements. Harmony is like plants, trees, shrubs, colors, and other materials. The difference of the plant's nature or its growth leads to the contrary. The choice of inconsistency or compatibility in designing gardens depends on the location and the importance of the designing element. If trees and shrubs are planted in a nearby area, it is preferable to be compatible. If planted at the end of the garden's boundaries, their inconsistency should be observed to attract the attention. Inconsistency maybe observed to show the importance of a particular component as the focal point in the garden.

Harmony is achieved by replicating some components of the garden's design, in the same system with a rhythm. Replicating the elements of the design of the symmetrical geometric garden is necessary. Diversity requires the use of frequency replicating. This is also used in designing the asymmetrical geometric gardens and nature landscape.

In the Persian gardens, harmony was used in various forms in organizing and designing the gardens' components, such as the types and locations of the green landscape, duplicating the geometric shapes between the natural and architectural elements, in the use of fountains, pools, floors, and in designing the walls around gardens. Moreover, integrating vertical linear of trees with the horizontal linear of waterways and pathways provides a harmonious rhythm in the gardens [29].

Along with the harmony between the components of the garden's design, there should be a clear proportion between its parts to achieve balance. Proportion is a general phenomenon in

the universe and is one of the most important elements of esthetic values. It uses the language of mathematics and geometry, to create musical harmony through its rhythm, in an attempt to form harmonic relationships [30]. Proportion plays a great role in designing and planning. The proportional systems take into account the relation between the whole with the part and the part with the other parts. The garden must have a balance between its parts and components. All parts of the garden must be balanced around the axes. The balance is identical in the geometric gardens. To give the sense of balance, both of them should be equal in attracting the attention. They may not be equal in numbers, but their effect must be the same.

3.6. Scale

Scale varies according to the area of the geometric gardens and the scale of its natural or industrial components. Scale and proportion are important factors in making a successful design because they affect the cluster size, the road’s width, and the height of the plants. If the garden has small size and space, the designer must design it in a way that makes it look bigger. The measure of each part is related to the other part as well as the human’s scale to be suitable for human’s use [31].

Finally, in geometrical style, gardens are united by their centrality and symmetry. However, they vary in the simple geometric shapes, the adopted symmetrical type, and the parts that are used as a focal point such as plants, trees and their fruits, the ways of using the water, materials, colors, scales, size, and the existence of the courtyard for privacy. With this unity and diversity, all the elements work separately to fulfill the garden’s purpose and to develop the interaction between man and nature by adopting simplicity. This helps to achieve the unity and the balance between the garden’s size and the natural or industrial element assimilation, without forgetting the idea of diversity that increases the esthetic value of the garden and keeps it away from boredom (Figure 10).

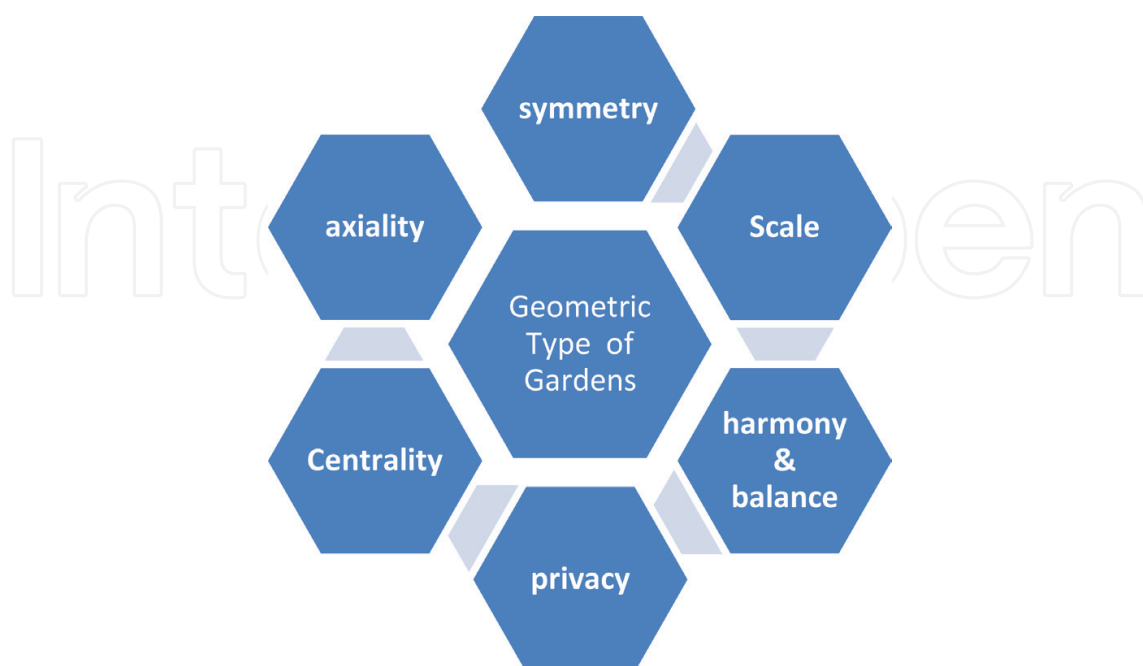


Figure 10. The main common key principles and characteristics for design of geometric gardens. Source: Author.

4. Conclusion

By reviewing studies of the adopted types in designing gardens, the researchers found that there are multiple types of designing the garden and the open urban spaces within the city fabric or the buildings within the city, for example, the palaces, mosques, shrines, schools, etc. Four types determine them: the geometric, the natural, the double or mixed system, and the modern one. This research focuses on the geometric type of gardens and landscape (the geometric type). It is a type in which man has a clear role in designing, despite its compatibility with climate and natural environment. It often appears with straight or circular lines in geometric shapes without reducing its beauty, peace, and security that man enjoys. Those were associated with many models of this type by the idea and the philosophy of paradise that man yearns for in different times, places, beliefs, customs, traditions, and cultures.

The origin of the geometric type of gardens goes back to thousands of years (BC). It is part of the achievements of the ancient civilizations of Egypt and Mesopotamia, the classical Greek, Persian, and Islamic civilizations, the Islamic gardens including Mogul Gardens in India, the Gardens of Spain, the Gardens of Iran or Turkey, and gardens of all western countries and especially the European countries.

The researcher referred to the term of “ornamental gardens.” In studying the geometric type of the garden, it was found that the ornament was one of the different characteristics of this kind. Perhaps, it is more relevant to the European Renaissance gardens, or unclear in the other models of this sort, or none of them in others.

Repetition was one of the methods that were adopted in the geometric type to make all or some of its characteristics common. The different features contributed in achieving the main idea of separation, which emphasizes the existence of unity along with diversity in the geometric types of gardens.

In the regular geometric type, the various components of the garden are replicated with a focal point that is dominant without compromising the compatibility and harmony of the garden's elements. The rhythm achieves a clear hierarchy and proportion between its parts because of its importance in achieving the balance and the harmony in colors. Symmetry, axi-ality, and centrality are important in forming the principal keys of the geometric type, as well as privacy that was evident in the geometric type of gardens. However, the means of achieving privacy varied among the models of that type, because of the existence or the absence of the courtyard. Alternatively, perhaps it achieved by adopting other methods, as using fences or isolating the garden from the surroundings in different ways. The geometric-type gardens are also varied in scale, size, and space for various reasons (**Figure 11**).

The chapter dealt with the fundamental principles of the garden. However, water is one of the elements and the designing means of producing geometric-type gardens. It focused on water because it had practical, philosophical, and intellectual dimensions, so it is a means and goal at the same time.

Gardens are united by their centrality, symmetry, and axi-ality. However, they vary in the simple geometric shapes, the kind of the adopted symmetry, and the means by which the

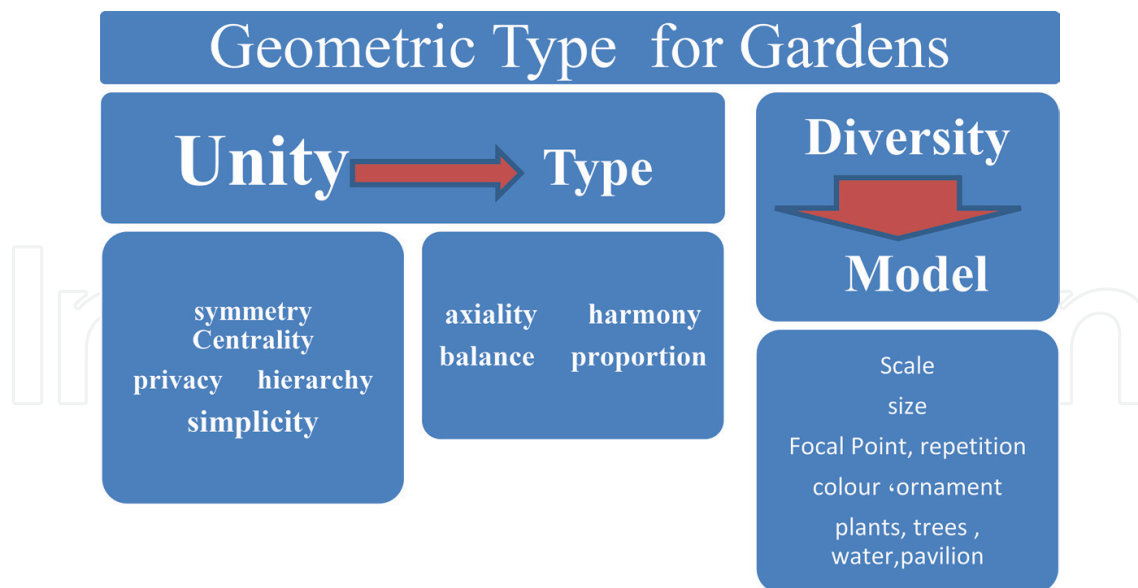


Figure 11. Unity and diversity in geometric gardens (types and models): common and noncommon characteristics. Source: Author.

models of these gardens match their centrality or symmetry or axially. What vary also are the elements that are used as a focal point, plants, trees, and fruits, the ways of using water, materials that are used, colors, scale, and size. With all this unity and diversity, all elements work separately to achieve the purpose of the garden and the development of the interaction between human and nature, without neglecting the idea of diversity. This increases the esthetic value of the garden and keeps it away from boredom and monotony. Diversity achieves models within a specific type to emphasize the idea of type and model.

Author details

Kabila Faris Hmood

Address all correspondence to: khmood85@gmail.com

Department of Architecture, Faculty of Architecture and Design, Al-Zaytoonah University of Jordan, Jordan

References

- [1] Al-Ghetani Y. Designing Gardens. Egypt: The Egyptian Anglo Publishing House. p. 5
- [2] Plumptre G. Garden Ornament. London: Thames and Hudson, Ltd; 1989. p. 26-27
- [3] Plumptre G. Garden Ornament. London: Thames and Hudson, Ltd; 1989. p. 18-25
- [4] Mahmoud K, Ameen K. Designing Gardens. The Ministry of Education and Research: Al Mosel, Iraq; p. 14

- [5] Bell S et al. Exploring the Boundaries of Landscape Architecture. London and New York: Routledge/Taylor & Francis Group; 2012. p. 23
- [6] Plumptre G. Garden Ornament. London: Thames and Hudson, Ltd; 1989. p. 25-26
- [7] Crowe. Garden Design. UK: Pachard Publishing, Ltd; 1981. p. 6
- [8] Ruggles F. Islamic Gardens and Landscapes. Hopkins Fulfillment Services. Penn Studies in Landscape Architecture Series. USA: University of Pennsylvania Press; 2008
- [9] Pirnia MK. Iranian Gardens. Abadi Journal of Engineering. Iran. 1994;4:17
- [10] Hmood K. Traditional markets in Islamic architecture – Successful past experiences. In: WIT Transactions on the Built Environment; Structural Studies, Repairs and Maintenance of Heritage Architecture XV. UK: WIT Press. 2017;171:265
- [11] Hmood K. Conservation and restoration of archaeological and historic buildings – Some successful experiences. Proceedings of the 4th Historic Mortars Conference HMC 2016; Santorini, Greece: Laboratory of Building Materials, Department of Civil Engineering, Aristotle University of Thessaloniki; October 2016; p. 267-268
- [12] Naghizadeh M. Representations of Beauty in Persian Gardens, Manzar; The Iranian Scientific Journal of Landscape, Iran; 2013;5:6-9
- [13] Al Ghetani Y. Designing Gardens. Egypt: The Egyptian Anglo Publishing House; p. 717
- [14] Jasem N. A Study of The Reality of Al-Zawra Park [PhD Thesis], Faculty of Agriculture; University of Baghdad. Baghdad, Iraq; 2001
- [15] Hmood K, Zghoul W. The traditional Arabic architectural environment and its importance to the rationalization of energy consumption in the contemporary Arabic architecture. Zaytoonah University International Engineering Conference on Design and Innovation in Sustainability 2014; (ZEC Infrastructure 2014), May 2014, Amman, Jordan; p. 4
- [16] Ruggles F. Islamic Gardens and Landscapes. Hopkins Fulfillment Services. Penn Studies in Landscape Architecture series. USA: University of Pennsylvania Press; 2008
- [17] Jonnes L. Mediterranean Landscape Design. London: Thames and Hudson, Ltd; 2012. p. 144-145
- [18] Oryoyla A. Reproduction of al-Hamra Palace, the Memory of Andalusia. Granada: Al Hamra Palace, The Center of Andalusia Studies and the Civilizations Dialogue, The Higher Institute of Scientific Research. p. 152-154
- [19] Ruggles F. Gardens, Landscape, and Vision in the Palaces of Islamic Spain, Penn Studies in Landscape Architecture series. USA: University of Pennsylvania Press; p. 65
- [20] Pavlovicová G et al. Geometry in Gardens and Parks; ResearchGate; pp. 108-109. <https://www.researchgate.net/publication/265273317>
- [21] Hannebaum L. Landscape Design, 4th ed. Prentice Hall Inc, USA; 1998. p. 85-86
- [22] Jellicoe S, Reoffery. The use of water in landscape architecture. 1991. p. 130

- [23] Farahani L et al. Persian gardens: Meanings, symbolism, and design. *Landscape Online* 2016;**46**(1):1-19. DOI 10.3097/LO.201646:Official Journal of the International Association for Landscape Ecology – Regional Chapter Germany (IALE-D); Germany; january 2016. <http://www.landscapeonline.de/wp-content/uploads/DOI103097-LO201646.pdf>
- [24] Al-Sultani KH. The building of imam mosque in Isfahan. Decoration has an architecture value. In: *Almada Culture; Almada Newspaper*; September, NO. (760); p. 1. <http://www.almadapaper.net/ar/>
- [25] Plumptre G. *Garden Ornament*. London: Thames and Hudson, Ltd; 1989. p. 79. (Book)
- [26] Borazjani V, Javadi MR. *Persian Garden: Ancient Wisdom, New Perspective*. Iran: Contemporary Arts Museum of Tehran Publications; 2004
- [27] Massoudi A. *Acquaintance with Iranian Gardens Bagh-e Shazdeh*. Teheran: Faza Publication; 2009
- [28] Anan A. The Rest of Andalusia Archaeology in Spain and Portuguese: The Magnificent Islamic Civilization in Andalusia. <http://islamstory.com/detailes.php?module=artical&slug>
- [29] Sarbangholi S, Shahed M. Review of Similarities between Persian Musical Concept and Architecture of Persian Garden (Case study: Kashan Fin garden); *Memari va Shahrsazi Arman Shahr* 9; Tehran-Iran; 2012. pp. 97-110
- [30] Hmood K. The Intention and Spontaneous in Islamic Proportional Systems; at conference “Relationships between Architecture and Mathematics” organized by Nexus Organization and middle East University; in; Ankara, Turkey, June 2014. p. 1
- [31] Liu F. *A Study of Western Formal Geometric Gardens and Eastern Informal Natural Gardens: Master of Landscape Architecture*. Winnipeg, Manitoba: University of Manitoba; 1989. p. 35