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Acknowledgement

In the Name of God

Dear Readers,

I, on behalf of the editorial board, am proud to present this issue of the *International Journal of Applied Arts Studies (IJAPAS)* under the sponsorship of the Islamic Azad University, Yazd Branch. We were driven to found the *IJAPAS* by a noticeable lack of journals, in the Islamic Republic of Iran in particular, devoted to architecture, urban design, urban planning, architectural conservation and restoration, painting, art history, graphic, digital arts, fashion design, performing art, industrial design, aesthetics and semantics. Although the academic world is increasingly driven by cross-disciplinary visions and models, we seek multi-disciplinary views, an attempt to inform researchers, graduate students, and professionals about the trends, ideas and innovations being put forward in applied arts. To this end, in addition to standard articles, in every volume of the *IJAPAS* we hope to provide a special issue related to a respective field with innovation.

We are also sending out a call for papers related to *Applied Arts* to appear in the next issue of *IJAPAS* in Aug – Sept 2019.

Finally, I should mention that we are committed to a speedy refereeing process for every article submitted to us. We effort to reply to all papers submitted within five weeks' time with a response about acceptance or rejection. We also do not require formatting for submissions in our style until *after* the paper has been accepted by us for publication.

I would like to thank our Editorial Board for their work so far in helping to establish the *IJAPAS*. And, finally, I would like to extend my deepest gratitude to Dr. Ali Boloor, the assistant editor of the *IJAPAS*, for all of his hard work to ensure the timely completion of the issue.

I am delighted to invite you to visit us at www.ijapas.org.

Sincerely,

Dr. Abolfazl Davodi Roknabadi
Editor-in-Chief
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Algorithmic Comparison of "Shamsah" in Iranian Architecture, Carpet and Pottery

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Abstract

During various art periods of Iran, three art fields of pottery, architectural decorations and carpet weaving have had a significant contribution to the artistic trends of the Islamic period. The purpose of the present research was to explain and analyze the geometric patterns used in the Islamic artworks of pottery, architecture and carpet weaving and the influence of these three fields of art on each other. Other research objectives were also to examine the common features of above-mentioned fields of art in order to provide a schematic model based on their artistic nature. The main question of the present research were as follows: 1.What are the common features of Shamsah, in terms of geometric shape, in the three above-mentioned fields of art, given their different historical intervals and art periods? 2. How is it possible to achieve similar shapes through changing the geometrical parameters in the mathematical algorithm of these Shamsah? This research was conducted using a comparative-analytical approach. Data were collected using desk studies – due to the research literature – and field studies – because of observing and taking pictures of some decorations in three above-mentioned fields of art. Finally, computer simulation was used to do data analysis. The results of this study indicated that the principles of composition of geometric patterns in the three studied fields of art were based on the order, arrangement and organization of motifs to achieve a coherent format.

Keywords: Shamsah; Pottery; Architectural Decoration; Carpet Weaving; Smart Algorithm; Shape Grammar

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1. Introduction

Decorative art in Iran comes from the cultural ideas governing the minds of artists, and sometimes their creative minds. In the early Islamic centuries, Iranian artists achieved valuable concepts in the process of forming their artistic structure through combining ideas and thoughts arising from Islam and the historical periods, especially the Islamic period. On the other hand, the knowledge of mathematics and geometry was invented by human beings to discover the relationships between different phenomena and organize their surroundings. The use of geometric patterns is one of the most ancient methods of decoration in the Iranian art industry. Geometric patterns appear in the composition of geometric shapes based on the concepts and regular creativity (Zaero-Polo and Moussavi, 2013). Three art fields of pottery, architectural decoration and carpet weaving during various art periods of Iran have had a significant contribution to the artistic trends of the Islamic period. Due to the impact of religious beliefs, as well as economic and social issues, these three areas underwent dramatic changes in terms of the form and criticism. In the meantime, geometric patterns played a significant role in the division of other patterns as a coherent method.

Geometric and mathematical calculations of patterns, their location, type, number and geometric sizes, as well as the calculations taken place with regard to the application and positioning of the patterns, indicate that traditional geometric patterns are complicated and follow specific rules, despite their simplicity or their superficial ease in comparison with other decorations (Soltanzadeh, 2009). When complexity increases in geometric rules, it takes more time and effort to draw, understand, and analyze the mathematical relationships used in them. Today, with the development of technology, especially computer science, it is possible to draw complicated geometries using computer tools. In the past, the outdated Code software accelerated the drawing time of geometries; but in this type of software, if one of the geometric components were removed or modified, the modeling relationship might have been eliminated. Another aspect of the matter is that the geometric grammar of shapes can be transmitted to a computer by an algorithmic grammar. "The algorithm is a computational process that involves a few parameters or a group of parameters as inputs" (Barrios, 2006: 10). Algorithms provide variables as outputs after the completion of the process. Therefore, an algorithm expresses a set of computational steps that converts inputs into desired outputs. In algorithmic methods, one can use the "shape grammar" method and achieve a geometric instruction based on its constructive parameters through applying a series of commands or rules executed on an initial shape. Hence, the parametric shape grammar allows the lengths of the lines, the angle between the lines and other geometric parameters to be varied in different shapes (Stiny, 1985: 32).

Therefore, parametric design strategies are used to help solve this complexity. Parametric design makes geometry more relevant and dependent. As a result, geometry is introduced as a smart geometry in a new complexity.

Given the description provided, the purpose of the present research is to explain and analyze the geometric patterns used in the Islamic artworks of pottery, architecture and carpet weaving and the influence of these three arts on each other during various historical periods of Islamic art in Iran. Other research objectives include the examination of their common features in order to provide a graphic design based on their artistic nature. The main questions of the present research are as follows:

1. What are the common features of Shamsah, in terms of geometric shape, in the three above-mentioned fields of art, given their different historical intervals and art periods?
2. How is it possible to achieve similar shapes through changing the geometrical parameters in the mathematical algorithm of these Shamsah?

Awareness of how these art fields influence each other in different Islamic periods, as well as discovering common geometric patterns and analyzing their mathematical relationships are of great importance.

2. Methodology

The present research intends to introduce various types of geometric patterns used in the design and decorations of three art fields of pottery, architecture and carpet weaving as well as discover their influences and commonalities in different periods of Islamic art while examining the executive aspects and techniques of these three areas of art. This research was conducted using a comparative-analytical approach. Data were collected using desk studies – due to the research literature – and field studies – because of observing and taking pictures of some decorations in three above-mentioned art fields. Initially, the images of the Seljuk and Ilkhanid pottery were collected from the archives of Daphneh Museum, as well as Reza Abbasi and National Museums and their geometric patterns were examined. In the next step, the authors photographed the patterns of decorations of the specific buildings of the Ilkhanid and Seljuk eras. Finally, the geometric patterns used in the Safavid carpet patterns were analyzed using the same analysis method used in the two previous fields.

In this paper, the quantitative research method was employed along with computer simulation. First, data were collected and selected as the statistical population, through desk studies. Then the authors classified the typological categories based on the geometry of their fields. In the next step, the authors employed computer simulation to analyze the form development of the Shamsah. For this purpose, initially AutoCAD was used as a non-algorithmic application. Then Rhino, Plugin, and Grasshopper were used as graphical scripting languages to run the tests.

3. Literature Review

About the studies on shape grammar, several authors have provided sound reasons for the usefulness of grammars in design research (e.g., Stiny, 1994; Knight, 1998; Flemming, 1987; Gips, 1975; Stiny and Mitchell, 1978). In an article titled "palladium grammar" Stiny, G., and W.J. Mitchel, attempt to make a recast parts of Palladio's architectural grammar in a modern, generative form. The rules of a parametric shape grammar that generates villa ground plans are specified. In many cases these rules are direct translations of Palladio's explicit canons of design (Stiny and Mitchell, 1978).

In the paper "Shape Grammars and the Generative Specification of Painting and Sculpture" by James Gips and Stiny, formalism for the complete specification of families of non-representational, geometric paintings and sculptures has been presented (Stiny and Gips, 1972).

Ramesh Krishnamurti in "The maximal representation of a shape" investigates the rules and grammar of geometric shapes, this paper starts by giving a motivation for studying grammars in design and is based on considerations of style, discovery, and constructive techniques. This paper goes on to survey a variety of spatial grammar formalisms from an implementation standpoint. For each formalism, the salient computational issues pertaining to rule application are discussed. Two aspects of shape grammars are considered in detail: (a) the conditions for reversibility of shape rules, and (b) the recognition of planar shapes (Krishnamurti, 1992).

Researchers such as Kaplan (2004), Hankin (1925), and Al-Jalali (2003) conducted some studies on the mathematical and computational relations of Islamic geometry and the way in which the knots, geometric drawings and Islamic patterns were drawn. In the book of "Geometric Patterns in

the Islamic Art", Al-Sa'id (1984) studied the geometric patterns and motifs in different Islamic buildings using basic geometric shapes, especially circles.

4. Theoretical Foundation

Grammar formalisms come in a large variety, requiring different representations of the objects being generated, and different interpretative mechanisms for this generation. Altering the representation may necessitate a rewrite of the interpretative mechanism, resulting in a redevelopment of the entire system (Stouffs and Krishnamurti, 2001).

In the other hand, shape grammars that generate languages of designs have been used widely over the past several years to describe and understand a diversity of architectural and other styles of designs. These grammars have been developed to address two fundamental concerns in design: 1) the analysis or description of contemporary or historic styles of designs, and 2) the synthesis or creation of completely new and original styles of designs. A vocabulary of shapes by itself does not determine designs; it merely determines the pieces from which designs may be made. To actually construct designs, the ways that shapes in a vocabulary can be combined with one another must also be specified. These particular ways of combining shapes are given with spatial relations.

Each architectural style has its own special grammar of shape. There are two main types of shape grammar: standard grammar and parametric grammar. In the standard grammars, most properties of the shapes are constant; but in parametric grammars, the shapes tend to be more flexible and variable (Stiny, 1985: 39). In fact, parametric design allows the use of a system in which a set of relationships between several variables that make up the parameters of a larger entity interact with each other. This system connects geometric grammars and mathematical relations of the shapes in such a way that if the quantitative parameters of a certain shape changes; then, this change is reflected on other variables of the related shapes and changes the initial characteristics and properties of the shape (Woodbury, 2010: 34). The direct entry of graphic programming languages into architecture in recent years has led to the emergence of a "parametric design" approach in the field of controlling those parameters that are effective on design. The parametric design, or grammar of geometry shapes is a new branch of computer science the purpose of which is to discover and apply mathematical and logical relationships between numbers and figures, on the one hand, and between numbers and shapes, on the other hand (Oxman, 2017: 45). Another important issue that has a significant impact on parametric architecture is algorithmic thinking, which is defined for the architecture design process. "Algorithm is a computational process that involves a few parameters or a group of parameters as inputs" (Barrios, 2006: 10). After the completion of the process, algorithms provide variables as outputs. Therefore, an algorithm is the expression of a set of computational steps that converts inputs into the desired outputs (Khabbazi, 2013: 58). In algorithmic methods, a "geometric grammar" can be achieved by applying a series of grammars or rules executed on an initial shape by a "shape grammar". By changing the existing parameters, one also can find a similar set of shapes, the formation of which follows certain principles (Hemberg et al., 2007: 32). According to Terzidis, the purpose of using algorithm in the formation of smart and computational geometry is not to invent a new geometry, but rather to consider its speed and generalizability (Terzidis, 2005: 34). Definitely, smart geometry provides a rule-based geometry in which geometry can be defined with a set of variables and mathematical relations as an algorithmic environment; an environment in which straight and curved lines, points, surfaces, and volumes can be converted to each other (Day, 2005: 12). Hence, using fixed and variable parameters in the algorithm, a generative geometry is formed which is smart to the changes in the variables. In this

way, the possibility of controlling and manipulating geometric relationships increases, and as a result, new and unpredictable controlled forms of buildings also increase.

5. Geometric Patterns Related to the Art of Pottery

Geometric patterns are one of the most popular decorative designs of prehistoric, historic and Islamic periods implicated on pottery. Due to its unique unity and despite the formation of various decorative techniques in the cities of Islamic lands, pottery art is displayed under a general framework. The evolution of the art styles after Islam is a combination of Sassanid and Eastern Byzantine artistic sources and patterns used in the great deal of Islamic eras. "With the advent of Islam in Iran, the pottery industry was changed, until a large part of the Sassanid style was abandoned, so that these products found another shape that was a combination of the elements of Islamic pottery and Iranian styles (Mohammad Hassan, 1987: 148). Motifs with plain, geometric, and arabesque lines were drawn on glaze-less ceramics (terracotta) in the first Islamic era and also in the late 3rd century AH, when the technique of glaze was invented. In the 3rd century AH, Iranian governments became independent from the Iraqi Caliphate. Governments such as Taherian, Safari and Samanids developed a special style of Sassanid period in different cities (Abbasian, 1991: 89). With this trend, ancient Iranian culture was gradually revived, and this process was manifested in the artworks of that period. Simultaneously with the political and social trends, the art of pottery was also flourished (Kayani and Karimi, 1984: 46). It seems that the decoration of pottery with the geometric shapes reached to its peak in Iran in the fifth century AH. The middle ages of the Islamic period are politically and culturally important among different periods of the Islamic civilization in Iran; and some researchers have named the period between the fifth to the eighth centuries AH as the Golden Age of the pottery industry. "In this period, pottery enjoyed a special position among other Islamic industries, so that it was considered in close connection with other art fields such as metalworking, painting and book designing (bibliopegy)" (Illenbran, 1994: 142,). In Table 1, there are a number of geometric patterns on ceramics (terracotta) carried on by two conventional techniques of under-glaze and in-glaze paintings.

6. Geometric Patterns of Architectural Decoration

In the Iranian architecture, the interest in decorating the surfaces was of the same importance of constructing unique buildings, and decorative designs were constructed in the immediate vicinity of all components of construction, so that this connection was even less visible among the real elements of the building. Decoration of building during the Islamic period of Iran is usually composed of three kinds of brick, plaster, tile or a combination of them (Wilber, 1967: 33-35). Geometric patterns in the building decorations are often in the form of knots, as well as the combination of regular polygons, sometimes simple polygons and sometimes multi-point stars or Shamsah (Rouhani, 2014).

The Seljuk and Ilkhanid periods can be considered a milestone in the history of Iranian architecture. New forms of architecture and decorative techniques have led Iranian architecture to gradually develop a final shape and ultimately achieve complete coherence and sophistication. Application of two elements of plaster (stucco) and brick, as the materials and a part of decorations, is one of the most important architectural features of this era. The main features of the Seljuk and Ilkhanid architecture have been the use of bricks and stucco, respectively. The history of the use of bricks dates back to ancient times, and the bricks were the oldest building materials used by human beings after the stone. Plaster has also long been used in Iranian architecture both as a binding agent

and an ornamental material (Baykusoglu, 2009). The architecture of the Seljuk era was the continuation of the earlier architecture, i.e. the Sassanid era and Buyid dynasty. Although there were changes in the art of stucco during the Seljuk period, but this art reached its ideal perfection during the Ilkhanid period. The widespread use of stucco decorations, along with a variety of geometric patterns and knots, has led to the creation of tremendous works. The use of bricks was also widespread in the Seljuk architecture; so that a variety of geometric patterns were used in bricks during that time. The art of bricklaying and beautiful brick decorations, especially the creation of geometric patterns using gauged bricks, is one of the features of the Seljuk architecture (Bosworth, 2001). (Table2).

7. Carpet-Weaving Geometric Patterns

In various historical occasions, textiles have always been considered by governments as one of the fields of art. In the Islamic world, precious textiles have a symbolic role in expressing political power and religious backgrounds and have been a good tool for displaying and defining different criteria of beauty (Mackie, 2015: 12). In the meantime, the art of carpet weaving can be considered as the most significant element in the art of textiles. Carpet weaving is one of the most original and valuable arts with a long history in Iran. This original art has an unbreakable link with the ancient culture of this territory and has been an important achievement of Iranians for centuries. It is currently a part of the life and culture of the Islamic society of Iran. The presence of geometric motifs in the carpet designs has put this art in the category of decorative arts. Unfortunately few high-quality textiles of the Seljuk and Ilkhanid periods, especially carpets, have been remained.

But after this period, i.e. during the Safavid era, especially in the tenth and eleventh centuries AH, a new paradigm in the history of Persian carpet was formed (both quantitatively and technically and in terms of quality and design). In the Safavid period, due to the quality of raw materials consumed, the use of standard tools and quality carpet weaving materials, paying attention to providing favorable conditions for workshops, as well as paying special attention to the stability, variety of colors and coloring of carpets, the art of carpet weaving was developed (Bosworth, 2001: 19).

The geometric patterns used in the carpets of this period can be classified into urban (curved), rural and nomadic (broken) patterns based on the movement of the lines of patterns. However, according to the structure of their design, they can be divided into major groups of bergamot and lachak, bergamot-bergamot, afshan, altar, etc. In this regard, the structure of bergamots (Shamsah) has more geometric features than other motifs (Baker, 2006). In the Safavid carpets, bergamots in the middle are often embroidered with around them, and thus makes the concept of the Shamsah more vivid. Another factor influencing the geometry of motifs can be the type of knots used in them. Wrapping by turning the silk (pile) around a pair of warps (up and down) in such a way that the two ends of the warping thread come out from the carpet after wrapping around the warps and provide double pile on the surface of the carpet is called a knot (Bier, 2014). The carpet is in fact a knotted carpet composed of hundreds of thousands of knots in parallel rows. In general, the carpet weaving technique during Safavid period was based on two types of knots, i.e. symmetrical (Turkish) and asymmetrical knots (Persian) (Table3).

Table 1 Pictures of pottery (ceramics) from the fifth to the eighth centuries AH and the technique of the execution of motifs on them (Archives of National Museums, Daphneh and Reza Abbasi)

Under-glaze painting technique	Fig 1 Pottery with Wheel Technique, Kashan, 6th Century AH	Fig 2 Sultan Abad Pottery, 8th century AH	Fig 3 Lacquered pottery, Kashan, Ilkhanid era
In-glaze painting technique	Fig 4 Ceramic lustrous plate, Kashan - Isfahan, 8th Century AH	Fig 5 ceramic, enameled and gilt pot, Gorgan, 7th century AH	Fig 6 Enameled standing plate, Ray, late 6th century AH

Table 2 Pictures of geometric patterns used in the brick and stucco decorations of prominent Ilkhanid and Seljuk monuments

Methods of performing geometric patterns using bricks	Fig 7 Decorations of Male Zuzan Mosque	Fig 8 Decorations of Jameh Mosque of Varamin	Fig 9 Decorations of Male Zuzan Mosque
	The use of pre-cut and molded bricks	The use of pre-cut and molded bricks	Knot making through the use of brick cutter and paint
Methods of performing geometric patterns using plaster (stucco)	Fig 10 Decorations of the Dome of Soltaniyeh	Fig 11 Decorations of Jameh Mosque of Forumad	Fig 12 Decorations of the Dome of Soltaniyeh
	The technique of low stucco relief (hollow and filled)	The technique of high stucco relief	Painting on stucco

Methods of performing geometric patterns using bricks, plaster (stucco) and tile	Fig 13 Jameh Mosque of Zavareh	Fig 14 Pir Bakran mausoleum	Fig 15 Jameh Mosque of Varamin
	Knots with bricks and honeycomb stucco	Combination of stucco and tile decorations	Combination of Brick and tile decorations

Table 3 Pictures of Safavid period carpets and their categorization based on the symmetric and asymmetric knotting methods (National Carpet Museum)
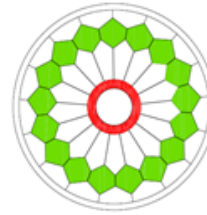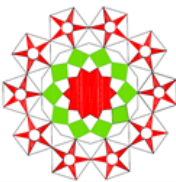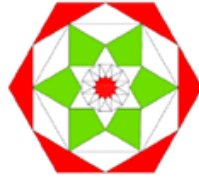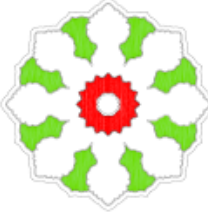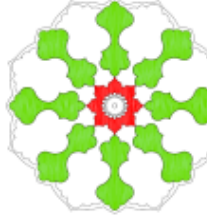
The technique of carpet weaving with symmetric knots	Fig 16	Fig 17	Fig 18
The technique of carpet weaving with asymmetric knots	Fig 19	Fig 20	Fig 21

8. Analysis and Evaluation

The most prominent feature of geometric patterns in decorations of three art fields is the presence of regular polygons and multi-point stars. Multi-point geometric shapes, sometimes in the form of Shamsah on potteries or bergamot decorations in textiles, are systematically displayed with a central point. Most of the stars have regular 5, 6, 8, 10, 12, or 16 points or are drawn in the form of a part of a circle beside another similar circle. In decorations related to the architectural design, there are a large star in the middle together with other stars and geometric shapes around it that are drawn on different scales. The center of the star, the center of the circle and its other points are tangent to the circle's circumference (perimeter). These geometric patterns are based on the rotation, multiplication and combination of a number of regular polygons in the horizontal and

vertical direction. Regular tetragonal, pentagonal, hexagonal, octagonal, decagonal, and dodecagonal shapes are most used compared to other forms. In fact, these forms are in some way similar and can be generalized to each other; so that the three shapes of regular octagon, decagon and dodecagon are respectively formed through the rotation of the regular tetragonal, pentagonal and hexagonal shapes under a certain angle. As a result, three regular tetragonal (square), pentagonal, and hexagonal shapes can be considered as three basic geometric shapes in decorations, the other shapes are formed on the basis of alterations to them.

Table 4 Examination and analysis of geometric patterns used in the samples of ceramics (potteries), architectural decorations and carpets

Geometric patterns on ceramics	Drawing of geometric details of Fig 2	Drawing of geometric details of Fig 4	Drawing of geometric details of Fig 6
Geometric patterns in architectural decorations	Drawing of geometric details of Fig 10	Drawing of geometric details of Fig 12	Drawing of geometric details of Fig 14
Geometric patterns of bergamot in carpets	Drawing of geometric details of Fig 20	Drawing of geometric details of Fig 21	Drawing of geometric details of Fig 17
Common features of patterns (motifs)	**Symmetry:** One of the most important features of traditional arts is to create symmetry in shapes, because it brings balance. Symmetry has a complementary and perfectionism aspect. **Geometric Centeredness:** The most important feature of centeredness is the issue of timelessness. With a number of centres, the main centre gets the critical importance, to which the identity of the rests depends. **Fitness:** Scale or fitness, with the mathematical concept of implementing geometric points, is of great importance and application. The level segmentation is used to determine the balanced ratios in order to find the relationship between the components of the patterns or motifs.		

The study of the structure of geometric designs and patterns in various artworks during the Middle Islamic historical periods has shown their common features indicating that the arts schools used in different art fields affect each other. In general, the execution of motifs that differs in three

art fields has common features. Different types of Shamsah in each of the three art fields are also redefined based on three parameters of the length of regular polygon sides, the number of regular polygon sides and the angle between the sides of the Shamsah.

For example, in each of the three art fields, the use of octagonal Shamsah is quite evident. With equal number of sides and their inclusion in a regular octagon, these three Shamsah are geometrically distinct in terms of their geometric forms due to differences in angles between the sides. Shamsah are drawn based on a bottom-up approach. Thus, by drawing one of the corners of the regular polygon and multiplying it around the center of polygon, the desired roundel will be formed based on the number of polygon sides. As a result, the authors found a common modular structure containing one of the corners of the roundel to draw different types of Shamsah through redefining the way in which it was drawn in algorithmic language. As shown in Fig 3, the ABCD tetragon is a shape containing one of the angles of roundel, but since this shape is symmetrical in relation to the AC axis, the ABC triangle can be assumed to be a common base modulus of the shape. Among different geometric shapes of Shamsah, the ABC triangle is drawn based on a distinct and fixed method; so that it is carried out based on drawing a triangular with three sides. These three sides include the half of the base shape (AB), the line drawn from the vertex to the center of the shape (AC), and the line drawn from the middle to the center of the shape (BC). Given that the ABC triangle is of the right-angled type, the ABC angle is always 90 degrees. But two other inner angles (Θ and β) are functionally dependent on the number of polygon sides. For example, in a regular octagon, the angles created in the ABC triangle are derived based on relations 1 and 2, whereby the values of Θ and β are 22.5 and 67.5, respectively. But the factor that causes the changes in the geometry of the Shamsah is a line that begins from the regular polygon vertex (A) and cross the BC line (from the center of the side to the center of the shape) at M point. The AM line can be considered as a factor of changes in the three Shamsah formed based on the parameter of the angle α (the angle between the AM line and the AB side). On the other hand, it should be noted that the angle α, as a variable parameter, can only include values between the open interval 0 and β. Then, by mirroring the AM line relative to the AC line, the other side of the roundel (AN) will be formed. AMN can be considered as one of the corners of the roundel and part of a whole unit. Now, the desired roundel in formed through rotary multiplication of AMN based on the number of polygon sides around its center,
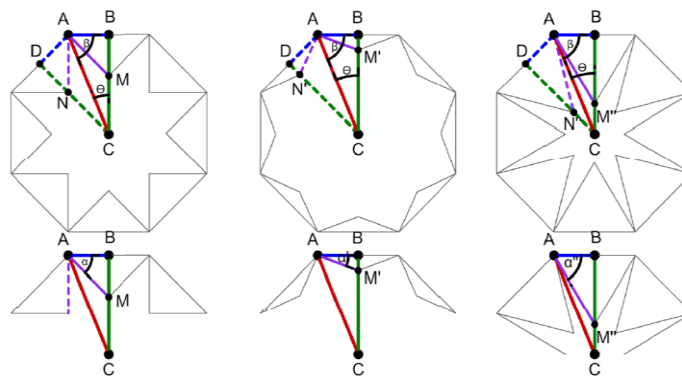
Fig 22 Identification of the common modulus between three octagonal Shamsah and analyzing geometric and mathematical relations based on fixed and variable parameters

Relation 1: $\theta = \dfrac{180}{n}$

Relation 2: $\beta = 90 - \theta$

Relation 3: $0 < \alpha < \beta$

After identifying the common modulus and the formation factor of the Shamsah (AM line), it was possible to redefine it in algorithmic language and transfer it to the computer to draw up a variety of polygonal Shamsah. In this section, using the Grass Hopper graphic programming language, the authors redefine the geometric algorithm of different Shamsah based on three parameters of the regular polygon side length, the number of regular polygon sides and the angle between the sides of roundel (α). It is noteworthy that only with the above three parameters, it is possible to draw the AM line from all polygon vertices and there is no need to mirror and rotate it around the center.

9. Algorithm steps to draw Shamsah

1. Draw a regular n-side polygon with the center of O and the side length of L.
2. Draw a line from the middle of the sides of the n-side polygon to the center of it.
3. Draw a line from the vertices of n-side polygon to the center of it.
4. Draw a line from the vertices of n-side polygon with an angle of α [the beginning of the angle with respect to the sides adjacent to the vertices] in order the drawn lines cut the lines drawn from center to the center of the shape.
5. Draw n-side polygon with the center of O and side length of L from the intersection of the points of the created lines.
6. Repeat steps 2 to 4 n-times through creating a loop.
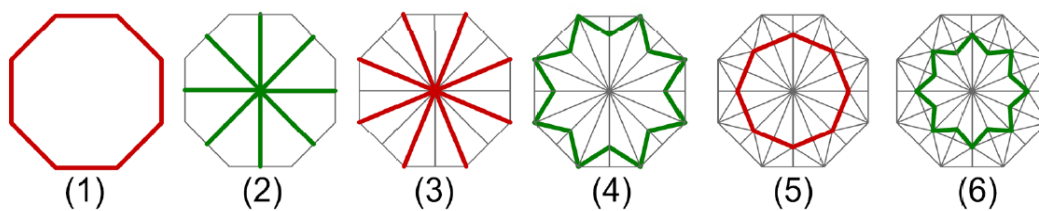
Fig 23 Drawing the steps of the algorithm proposed for the production of an octagonal roundel and its generalizability (Source: Authors)

The obtained algorithm can be considered as a smart geometry-based and generative algorithm, since this algorithm allows the use of different angles for parameter α to achieve Shamsah with different geometric forms based on their polygons. Using steps 5 and 6 of the algorithm, it is also possible to reproduce inner-oriented Shamsah within the shapes themselves. This process can be generalized to a desired number by creating a loop (Table 4). Then, using the proposed algorithm for different polygons, geometric shapes and various Shamsah can be drawn and produced in the short time (Fig 5, 6, and 7).

Fig 24 Drawing the steps of the algorithm in the Grass Hopper plugin (Source: Authors)

Table 5 Process of the formation and generalizability of the Shamsah pattern in regular polygons based on the parameters of the number of sides and angles between the sides

	Internal angels	Variable angle parameter	Angle values	Base module	Replication of the shapes inside the roundel (3 times)
Regular tetragon			45Ө= 45β= 45<α<0		
Regular pentagon			36Ө = 54β= 54<α<0		
Regular hexagon			30Ө = 60β= 60<α<0		
Regular octagon			22.5Ө = 67.5β= 67.5<α<0		
Regular decagon			18Ө = 72β= 72<α<0		
Regular dodecagon			15Ө = 75β= 75<α<0		

10. Conclusion

In this study, in the first step, techniques for the implementation of pottery in various periods of history, especially Seljuk and Ilkhanid periods were examined. The two techniques of under-glaze and in-glaze paintings were of the most important decoration techniques of potteries. The motifs of these ceramics (terracotta) were mostly composed of Shamsah and multi-point stars in the form of painting. In the next step, the architectural decoration of the Ilkhanid and Seljuk monuments was examined and evaluated. The use of two elements of brick and plaster (stucco), both individually and in combination with each other, by the Muslim artists provided the opportunity to create various geometric patterns. In relation to the techniques used with bricks, different types of bricks, especially pre-cut, and molded bricks were used for making knots in the monuments, especially during the Seljuk era. Another material used in this period was plaster (stucco). It was used in decorations of buildings (monuments) by designers, especially the artists of the Ilkhani era, using the techniques of low stucco relief (hollow and filled), high stucco relief and a combination of tiles and paints. The third field of art discussed in this research is the art of carpet weaving, due to the lack of quality works from the pre-Safavid period, the elements used in the carpets of the 10th and 11th centuries AH were reviewed. In the carpet texture of this period, two techniques of symmetric knotting (Turkish) and asymmetric knotting (Persian) were common. The motif of bergamot is one of the most used motifs in the decoration of carpets of this period. In the last step, the geometric patterns of the works of the three aforementioned art fields were examined by computer tools in a two-dimensional evaluation. The results of the analysis showed that despite the differences in the time periods of these works as well as the differences in the manner of implementation and taking into account the formation of motifs, materials and tools for their implementation, the geometric patterns used in these three fields of art have common and fixed features that have been used by artists for centuries.

According to the results, scripting languages enable designers to create algorithms and geometrical grammar of shapes based on their constituent parameters. The most important difference between algorithm and non-algorithmic applications is the execution of commands by designers in the design modeling process. In non-algorithmic applications, commands are formed and executed separately step by step. However, the execution of commands is a continuously integrated process in algorithmic applications. The distinct feature of algorithmic applications is that designers can make forms parametric based on the input data. The parametric feature enables designers to use a system in which a group of relationships interact with each other between several variables contributing to a larger unit. In this method, it is possible to change or modify every command packet. In other words, if an error occurs in the selection of the input data by the designer, it will not be necessary to restart all of the commands and redo the modeling process. In fact, it is possible to modify and change every command whenever necessary. Another useful feature of this methods is the use of algorithmic design to achieve the smart geometry, in which a mechanism is defined to redefine geometrical grammar and regulations of shapes in a series of variables and mathematical relations by suing the scripting language. Therefore, constant and variable algorithms can be used in the algorithm to form a particular style of geometry which can operate smartly toward changes in variables. This system relates the geometrical grammar to the mathematical relations of shapes. If the parameters of a shape are changed, the modification can be reflected on the variables of other dependent shapes to change the primary features and specifications of the form. The third and final feature of the research process was the generative quality of the resultant geometry. The quality of being generative can bring about novel forms by changing input data. Such novel forms are beyond a designer's prediction and imagination.

However, the non-algorithmic design of the initial forms should be developed mentally by designers to some extent. They can then employ applications to draw and edit the initial forms. Another useful feature of the generative geometry is the generalizability or expandability of the written algorithms. Generalizability provides an environment in which direct and curved lines, dots, surfaces, and volumes can be transformed into each other. Moreover, changing the existing parameters can bring about morphogenic shapes, which comply with specific principles.

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Design of Neighborhood Squares in the Old Neighborhoods of Isfahan City Regarding the Issue of Dryness

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Abstract

Cities as complex systems are highly vulnerable to nature threats, human activities and droughts. The characteristics of human activities make cities more desirable to live. It is a natural risk factor that could disrupt the activity of cities. Urban design could improve the quality of cities and has a major role in sustainability and identity. Neighborhood squares is one of the urban design structure's that makes Isfahan city one of the most important cites of Iran, as a classical identity.

The canals network gives Isfahan beautiful effect. Reducing air pollution, creating attractive environment are some of these effect. Today drying of these canals changes the appearance of old squares and some of them have been destroyed. The Zayanderod River, the cause of the life of the canals, is being destroyed and so canals become dry so these squares lose their boom. This study evaluates the effect of dryness on Neighborhood Squares as well as tracking urban projects for their reconstruction. In this study, using the combination of SWOT and student t tests, we first evaluate and identify the current situation and we recommend solutions for the reconstruction of neighborhood squares to achieve optimal implementation methods. Given the current state of the squares and using the AHP method, the execution priorities are specified and, three - dimensional model is presented. Here, the main approach is to find ideal method for the reconstruction and renovation of the neighboring square.

Keywords: Neighborhood Squares; Canals; SWOT; AHP Prioritization

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1. Introduction

The city which can actually be called an alive creature, requires a vibrant and vibrant life. In our country the neighborhoods square which creates an environment for people's social communication and the culture of a community within it is steadily declining. One of the necessities of the dynamism of neighboring squares is the presence of people around them. In the Esfahan neighborhoods, due to the presence of Mudi[†], there are entrances that along with them, neighborhoods squares have been able to emerge. The issue of Zayanderod dryness which is one of the most pressing current issues in Esfahan, has had a profound effect on the city's structure especially on Mudi which has also created challenges for neighboring squares. In fact, the integrity and dynamism of the people's communities in the present era is not as old as the past and the communications of the people have been steadily decreasing. The issue of dryness Mudi not only has a negative effect on the function of people, but also caused frazzle and destruction of many old tissues. In such a situation, it is vital to provide a specific plan for managing these cultural and social developments, as well as providing the right tools to decide on this issue in order to solve the relevant management issues. These actions should be such that they can help to bring the issue to the benefit of the knowledge and values of neighborhoods in decision-making. Here decision makers managing these squares not only can provide national, regional and neighborhoods, but by attracting more tourists, they can effectively help maintain and promote Iranian-Islamic culture. This study by perceiving and evaluating the consequences of the effects of this dryness on neighborhoods and examining examples of Zayanderod dryness effects on areas as well as tracking urban projects for their reconstruction, research on drought, revival, reconstruction and renovation neighborhood squares.

2. Research Objectives

Since Esfahan's neighborhood squares are of national, regional and neighborhoods interest in identity and culture, the study also evaluates issues relating to the design of squares in the old Esfahan neighborhoods, considering the issue of dryness Mudi and to achieve this goal, By identifying the quality status of neighboring squares based on the conditions of dryness Mudi, deficiencies and problems in this area can be gained in the samples that are examined and then, based on the factors influencing the situation of neighboring squares and the consequences of these factors, effective design strategies Redefined and appropriate.

2.1. Assumptions

- In the current situation, neighborhood squares do not have their previous performance and attraction
- In the current situation, there is a direct and significant relationship between dryness of the Mudi and the diminution of the attractiveness of neighboring squares.

[†] Mudi: The rivers that flow from the Zayanderod river and along the course along the path in the heart of the city, the neighborhood and the alley, and in addition to irrigating the fields and gardens, are an important part of the urban-spatial structure of Isfahan, and the elemental field Historical and environmental aspects are considered in the context of the city. Among the most important materials of Isfahan, it is possible to mention the material of Qomeish, Fadan, Neyasrm, Tiran, Jobshah, etc

- The indicators related to structural and social dimensions are the most important factors for redesigning neighboring squares

3. Methodology

The manner in which this research is pursued is a descriptive-evaluation type. In the descriptive section, a theoretical approach to research is used where articles related to the introduction of neighborhoods concepts, neighborhoods square, neighborhood square in Esfahan as well as the definition of Mudi are discussed and then indicators related to selective approaches of the results are deduced and then with the help of field research, the required information is provided through a questionnaire and research results in the community (Elliyadoran neighborhood and Kohanestan neighborhood). After completing the process of identifying the neighborhoods in these two neighborhoods, we can assess the weaknesses, strengths, threats and opportunities in these neighborhoods using the SPSS single instance t test and then the SWOT survey and based on its results from the final solutions, choose the optimal solution based on AHP prioritization.

4. Theoretical Background

4.1. Determining Research Concepts

In fact, neighborhood squares in the form of a neighborhood get their meaning. The meaning of the neighborhood can be defined as the social and cultural contribution of the people living there. (Shia, 2009, pp. 67-66). The neighborhood community can be defined as the network of interacting people who are usually concentrated in a certain range. (Johnston, 2001: 102). The neighborhoods are also based on ethnic, neighborhood, religious, guild and sometimes even social classes and in some cases the issue of the integration of neighborhoods based on religious identity (Habib, 2007: 111). Although the notion of neighborhood in different countries has a certain definition, but in terms of urban planning, each neighborhood is defined as a specific area of the urban or mixed area in which the needs of the inhabitants are provided in the structure of a city (Cowan and Hall, 2005, 256).

According to historical studies, in general, different periods of history can divide the phenomenon of urbanization in Iran into two parts before Islam and after Islam. Mainly social and economic factors, especially the existence of different social classes, have contributed to the formation of boundaries associated with residential neighborhoods. After Islam entered Iran until the first Pahlavi period, the concept of the neighborhood is one of the important elements of the structure of Iranian cities (spatially and socially) and this concept has so far been public. The neighborhoods in different cities of Iran have different shapes due to their history and identity, each with its own characteristics (Habibi, 2001, 48, Falamaki, 214, 1995, Taghizade and Dorodiyan, 2008, 78, Pakzad, 2003, 32, Tavasoli, 2003, 24). However, it can be argued that all cities of Iran, in their social structure, have

Certain structural-spatial foundations, these can be expressed as follows:
- ***Link between city center and neighborhoods***: In most historic cities in Iran, the spatial structure of cities has relied on the link between the city center and the neighborhoods of the main bushes and squares (Tavasoli, 1997, 8), a structural city complex - Spaces are created from the number of neighborhood and a hybrid city center.
- ***Centrality***: The center of each neighborhood is the main social space and in fact its heart. The neighborhoods of each city are the symbol of the places where there is the largest

number of communities and communities in each neighborhood. It also places the most needed services for the neighborhood's inhabitants. The mosque which is a pivotal place for activities, acts as the main and most significant element of the structure of each neighborhood (Habibi, 2003).

- ***The link between the regional bus network and the main network of the neighborhoods***: The regional network of passes through the city entrances creates the city's neighborhoods and gradually the houses, the center of the neighborhood and other neighboring elements such as mosques around them they are formed and developed.
- ***Range of neighborhoods***: The space of each neighborhood has a certain range that almost all inhabitants know. There was also a major road to or from the city and people were trying to get away from its public and crowded atmosphere.
- ***Hierarchy***: There were three hierarchical approaches: hierarchy of accessibility (neighborhood protection of traffic), functional (public service in centers) and space.

In general, each neighborhood has a set of social features in which specific occupation, religious minorities and social classes are present. This collection has its own socio-cultural atmosphere. Here each neighborhood has unique identity and also has social-affiliated features such as religion (Muslims, Jews, Armenians), ethnic and racial (Kurds, Turks), occupations and economic activities (Coppersmith neighborhood, Sherbafan neighborhood) and groups with common aspirations. Also in a neighborhood, management was an autonomous one and provided security as a sheriff (Theghatoleslami, 2013).

In these neighborhoods, there were small squares that created the connection of residential neighborhoods called local field (Soltanzade, Hossein, urban areas of Iran).

This element which should be built in the center of each neighborhood, was known as the most common space and it also usually called the neighborhood. In fact, this square could have created a favorable social space for the inhabitants. Here essential elements such as the water storage, mosque, bathroom, shops, etc. around the square are created which increases the attraction of the neighborhood square for the inhabitants. Indeed, the presence of these services in the neighborhood of neighborhoods not only makes the inhabitants unnecessary to visit other neighborhoods, but also provide a good basis for the growth of social communication and the sense of belonging to neighborhoods (Pakzad, 2012).

In Esfahan, these squares next to the Mudi have a link with their centers at varying scales making these squares more beautiful and productive. The problem now encountered by these Mudi is the dryness of the Zayanderod River which, according to Hosseiny Abri (2001), the relative dryness or the amount of water entering Zayanderod did not have a certain route (According to reports from the Regional Water Organization of Esfahan). The problem is that the droughts did not have a certain trend which indicates the severe climate instability in the area. Therefore, given the fact that the Mudi are dependent on the Zayanderod River and, accordingly, the beauty and dynamism of the neighboring squares is also dependent on the Mudi, hence the expression of Mudi is one of the main factors in the quality of life of a neighborhood in Esfahan. Here one can see the various functions of the Mudi with regard to the neighborhoods streets, as the most important urban issues in the city (Kalantary, 2013). In fact, the Esfahan neighborhood squares along with the Mudi architecture have created a special identity for Esfahan, so based on two urban village and new urbanism approaches, we evaluate these squares and how they improve their performance.

4.2. Research Approach

Urban Village Approach: According to Cowan and Hall (2005), urban village is a metropolitan area that has a specific identity and a combination of capabilities, usually one of which forms the residential area. The main features of a city village can be summarized as follows: (Daneshpoor, 2014).

- Development with a variety of uses, fitted between working people and inhabitants, an area with access to everywhere within 10 minutes walking distance, having a population of 3 to 5 thousand people in a way that can be a major part of the activities but it is small enough that all inhabitants can know each other and have neighborly relations.
- Has an attractive environment for walking
- It has the necessary facilities for cars, but does not encourage the use of cars
- It has a wide range of building types in different shapes, sizes and architectures
- It has many alleys and convenient pavements to the center.
- It has a high population density, so the density goes up to the center
- It has facilities for daily purchases of people, health services, schools, cultural and recreational facilities and parks that increase on the margins.
- Here is the emphasis on building a community and a humanitarian environment.

The pyramid Maslow which means safety and protection that has no pollution, noise, congestion, accidents and delinquency. Daneshpoor also defines its socioeconomic status based on the third and fourth levels of the pyramid Maslow which means a guiding social environment. Here we can also describe the structural characteristics of urban village in the form:

- ***Size***: The urban village has an area of about one hectare that can be inhabited by about 3 to 5 thousand people. In fact, the urban village is so small that people have a sense of living in a neighborhood and this creates social relationships and frequent exposure of individuals. Also, the urban village is large enough to provide a wide range of facilities in a rational way.
- ***Communication Network***: The design of access modes and the sustainable communication network in a city village is one of the main factors that make a successful urban village. Here are priority routes, trails and special cycling routes. The access range is also 600 meters in order to minimize the use of cars and encourage people to walk. Here trails have more attractiveness to people. The car's route widths are also considered for speed control.
- ***Facilities and activities***: Comfortable and diverse functional facilities that are within walking distance of the house and are active at various times providing a beautiful view to these areas.
- ***Landscape***: The diverse landscape on the sidewalk which attracts people is related to the fifth level of the Maslow pyramid addresses the issue of creativity.

New Urbanism (Classical Neighborhood): Since in this study the redevelopment techniques of neighboring squares in neighborhoods of Elliyadoran are evaluated according to dryness Mudi, here the two urban village and new urbanism approaches are compared. The theoretical approach in this research is summarized in Table 1 after evaluating more than 20 items of history.

4.3. Determine Theoretical Approach and the Structure of Research

New urbanism, modern urbanism and other similar names, relates to the ideas of contemporary American urbanists who are struggling to solve the problem of scattered growth and the lack of integration of American cities. Here are some different views on new urbanism that are shared in several features:

Everyone draws a center and a margin
- In all of them there is a combination of relevant activities (shops, occupation neighborhood, recreation neighborhood and all kinds of homes).
- In them, the optimal dimensions for the units next to each other are 4.1 miles from the center to the margin. This distance is a typical 5-minute walk that provides an appropriate distance for people's access to services, bus and shop stations and more.
- The streets with large sidewalks and trees are more likely to walk and bike.
- Here priority is given to building public places and finding places suitable for civilian buildings.
- Places such as squares, parks, playgrounds, places for gathering and fun.

Table 1 History of theoretical approach in this research

Topic	Dimension		Approach
		Urban village (city village)	New urbanism
Redesign neighborhood squares	Spatial	-To focus on the human scale -Create identity and sense of belonging place -Speak and joyfulness -Combination of functional features and attention to their attractive items	-Notice to the general areas -Searching from the local neighborhoods -Painting and beauty -Combination of functional facilities
	Structural	-Diversity and stability in architecture -Save -Accessibility of routes and public services -Sidewalks and cycling routes -Green and public -Recreational and welfare services -Possibilities -Social Inclusion (meaning no social classes) -Social relations -Participation -Group activity -Active presence -To connect with neighbors	- Courage and flexibility in architecture - Interconnection between private and public sectors of structures - Access to services and vehicles -Appropriate sidewalks and bike paths -Appropriate parks and green space
	Social	-Social Inclusion (meaning no social classes) -Social relations -Participation -Group activity -Active presence -To connect with neighbors	-With the quality of the public environment -A recreation and public -Educational activities -Cultural and religious activities in the form of groups -Taking people to use urban space -Creating security for people's presence

Relation to this issue, there are researches such as the research of Dr. Mohhamad Hasan (2009) that considers squares, due to the turbulence in displaying the identity of the urban element in the design field, unclear elements. Soraya Memar (2011) also describes these squares as a tool for

covering social needs and enhancing the quality of community life. Ebrahim Ansary (2002) in an article evaluates the social status of the neighborhood in Islamic cities, considering Esfahan and defines its various elements which also has a similar view to Mrs. Memar. In fact, the school of urbanization in Esfahan, attributed to Seyyed Kianosh Lary (1999), in the interaction between Islamic teachings and the results obtained by the urbanists, could be attributed to Sheykh Bahaey which emphasized the existence of Mudi to create such an environment. Research Forotan (2014), Ezady (2014), Khatonabady (2014) and Rashtorm (2003) also emphasize the identity of neighborhoods and warn of the destruction of these sites due to poor planning. In fact, little attention has been paid to the issue of neighborhood squares and the impact of Mudi on their attractiveness and dynamics, considering the two urban village and urban approaches to redesign, so here's our goal to evaluate this approach in Table 1.

5. Determining the Research Model

Now that dimensions are associated with the theoretical approach, using a conceptual model, the concept of square in the Kohanestan neighborhood and Seyyed Javad haj Square in Esfahan from the squares of neighborhoods has been selected as the prototype and the main purpose of the research. Given the basic indicators in this regard, we developed a questionnaire and distributed it in both neighborhoods. After evaluating the questionnaire by means of statistical surveys, using the evaluation and scoring of the indicators, we obtain the SWOT matrix and then, using the AHP hierarchical survey, among the solutions we have obtained, we select one item with careful selection. On this basis, the methods of this research are presented in Fig 1.
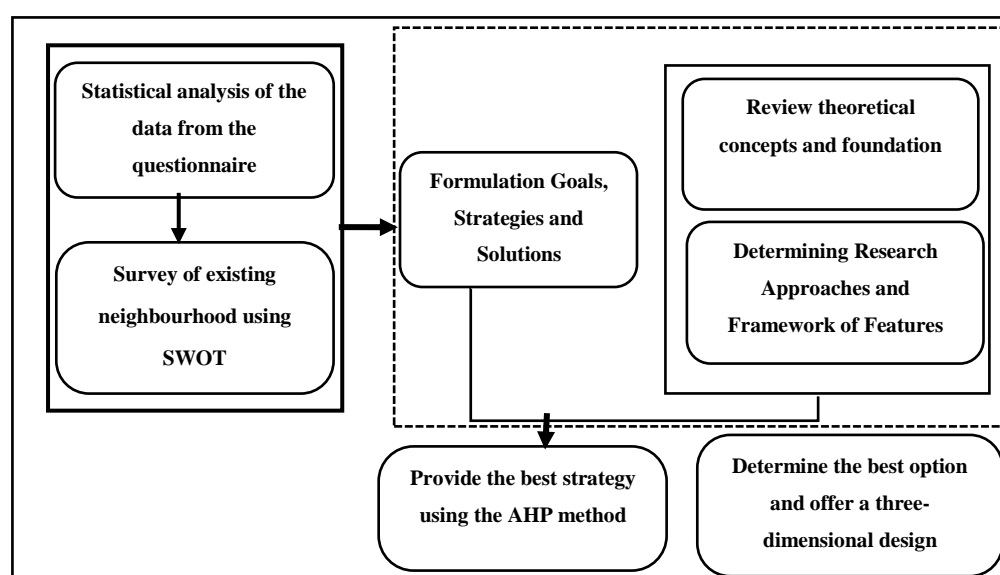
Fig 1 Research study model

6. Case Study Esfahan

The area of Esfahan province is about 107090.1 square kilometres, located on the central plateau of Iran. Esfahan has a temperate climate and its four seasons are regular. The city is located in the northern, southern, eastern and western parts of Iran and has been at the crossroads of various tribes and cultures in different historical periods. Esfahan city is the capital of Esfahan Province, located on one of the main highways of Iran (Esfahan Governorate, 2008: 45). Zayanderod which passes

through the city, forms part of the fourth-quarter geological sediments. The Zayanderod Plain is from the sediments of this river as well as the Karun sources in the province of Chaharmahal-o-Bakhtiyary which passes from the Lenjan to Esfahan and then crosses the city into the Gavkhony marshland which is considered as a special attraction of the attraction of the area. In fact, only the current water in Esfahan belongs to the Zayanderod permanent river which originates from Zardkoh and in its path, small, large fountains join it. (Engineer Consulting Engineers, 1972). The issue of the water distribution system in Esfahan is considered by some of the historical books owned by Ardeshir Babakan. There is a famous story in which Ardeshir Babakan is the first to issue a Zayanderod water divorce order. Recent research and surveys on the Zayanderod irrigation area show that there are 56 Mudi between Falaverjan and Polkale, whose names are not visible in the Sheykh Bahaey text, so they are divided in the next and out of the system. Sheykh Bahaey water has been created (Shafaghy, 2003: 130-132). After 1942 and prosperity of the region and the importance of the precise water distribution issue, the Sheykh Bahaey text again serves as a reference point for water rationing. The neighborhood squares in fact are the main field of social interaction in the neighborhoods and, based on this, small squares have gradually grown. These squares have been able to create an integrated tissue based on the principle of continuity in the combination of urban areas in which units and structural regions are connected in a connected manner.

6.1. Regional Location of Neighborhood Kohanestan and Elliyadoran

The neighbouring Elliyadoran and Kohanestan neighborhoods are in the 1st and 9th areas of Esfahan's neighborhoods. Esfahan has 14 district municipalities that include a part of the city center with historic tissue. The location of neighborhoods of Elliyadoran and Kohanestan in Esfahan in Fig 2 and the location in the non-area of Esfahan in Fig 3 has been shown.

The neighboring Elliyadoran and Kohanestan neighborhoods are in the 1st and 9th areas of Esfahan's neighborhoods. Esfahan has 14 district municipalities that include a part of the city centre with historic tissue. The location of neighborhoods of Elliyadoran and Kohanestan in Esfahan in Fig 2 and the location in the non-area of Esfahan in Fig 3 has been shown.

Fig 2 Location of neighborhoods of Elliyadoran and Kohanestan in Esfahan
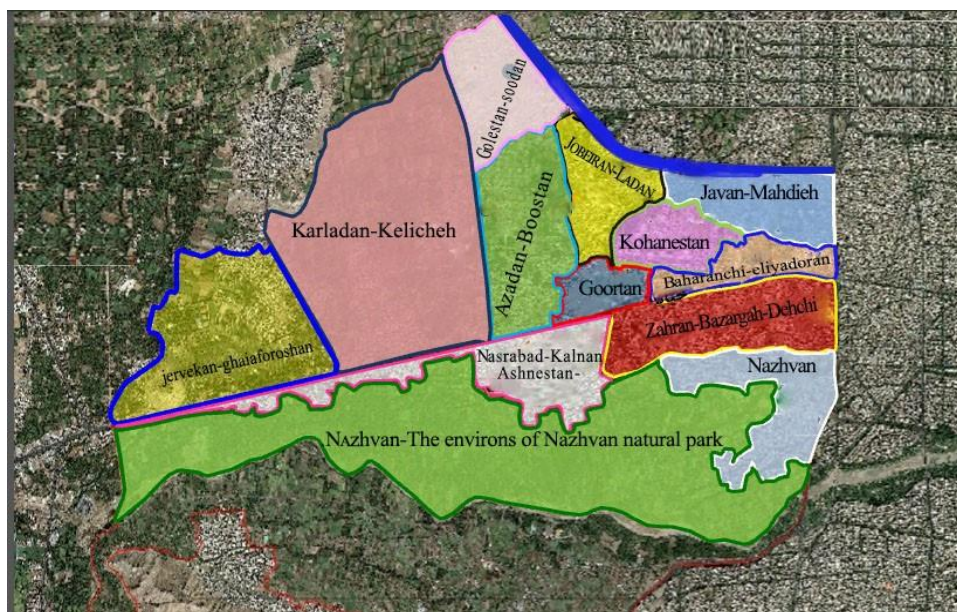
Fig 3 Location of Elliyadoran and Kohanestan neighborhood in Esfahan

Elliyadoran Neighborhood: This neighborhood is one of 11 neighborhoods in area 1, north of Nava Safavy, west to Kharazi highway, east to Kashany Street and south to Saramiyeh Avenue. In the western part of the neighborhood, the Hejazy Street and Neighborhoods of Javan, Baharanchi and Kohanestan are not considered in urban planning. in accordance with Fig 4, based on urban research, the existence of historic crossroads and prominent elements divide the neighborhood into eight sub-neighboring's, the Shotorgalo, Tiran and Bidabad Mudi as the most important sidewalks and the main elements of the neighborhood around them. Usually these passages are east-west because the neighborhood extends to the city center and the market.
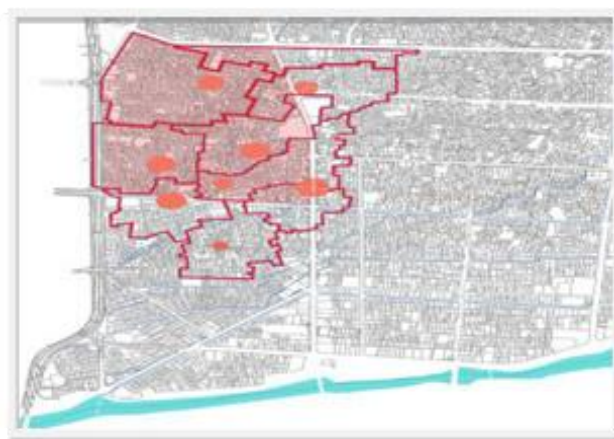
Fig 4 Elliyadoran neighborhood and its important squares

In accordance with Fig 5, here is one of the most important squares of neighborhoods, Haj Seyyed Javad Square which has a continuous spatial and structural system that prevents structural

fatigue and allows them to be redesigned. Also, placing it at this ideal point for the main routes will make people's sense of belonging to this place more. This square for other neighborhoods is also known as a small market next to the Elliyadoran Mudi, so it can be chosen as a suitable square.

The historical axis of Rozatoha is one of the oldest neighborhoods on the eastern side of the square which is located on the haj Seyyed Javad Square and the end to Chaharsogh. Chaharsogh is one of the Squares of Esfahan, located on the edge of the neighborhood, along the historic and market houses, alongside the Tiran Mudi square.

Also, the Mudi has a green space that plays the role of a sidewalk. At the end of this path, we encounter an applied space located on the northern side of the square and forms part of the Mudi and square of the city at the beginning of this area (Safa Mosque and economic and educational area) Kashani hospital is located on the western side of the Square.
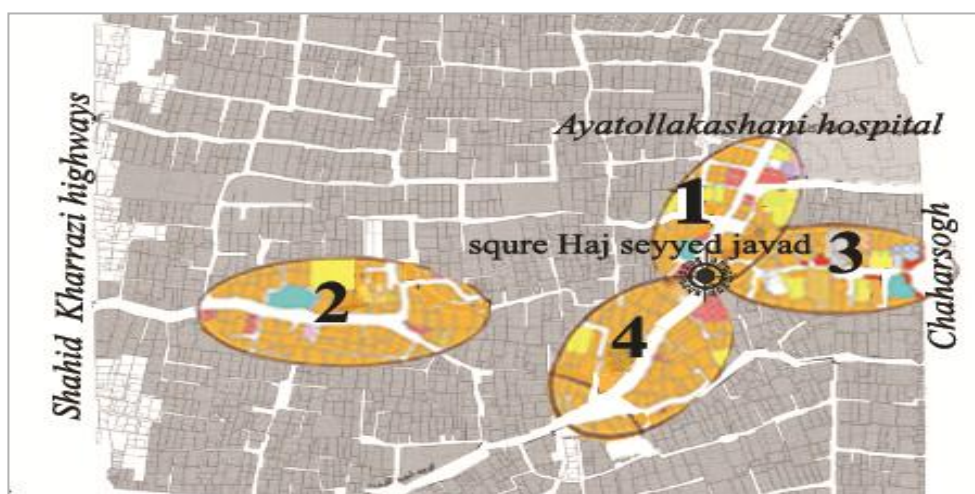
Fig 5 Design priority in the local square (Source: Haji Seyyed Javad)

Kohanestan Neighborhood: This neighborhood forms some part of Esfahan district 9 which creates the main passage of the northern section of the Kohnadej street (Ashrafi Esfahani), the southern part of the Atashgah street and the western part of the local Ashoryan street.

A Direct‡, in accordance with Fig 6, dividing the neighborhood into two sections. This area has been the main site of many popular activities in recent centuries and the most important squares of the neighborhood being formed at the beginning and end of this area. One of the unique features of this neighborhood is that, this neighborhood is surrounded by other neighborhoods and there are several Muddies around making a green edge, separates the neighborhood from other neighborhoods.

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‡ The 4 main ways that pass through the center of the neighborhood, like the spine for the neighborhood, allow communication between the urban area outside the city and other neighborhoods and urban centers. At its intersections, there are larger open spaces than the passageway that the center of the neighborhood or local area the neighborhood mosque, Sangkhaneh, bazaar, various shops, religious center, Baths, Zurkhaneh, and other important local land use were located in the district. This space was public and the observance of the principles of confidentiality and defense was essential. (Ansari, 2003)
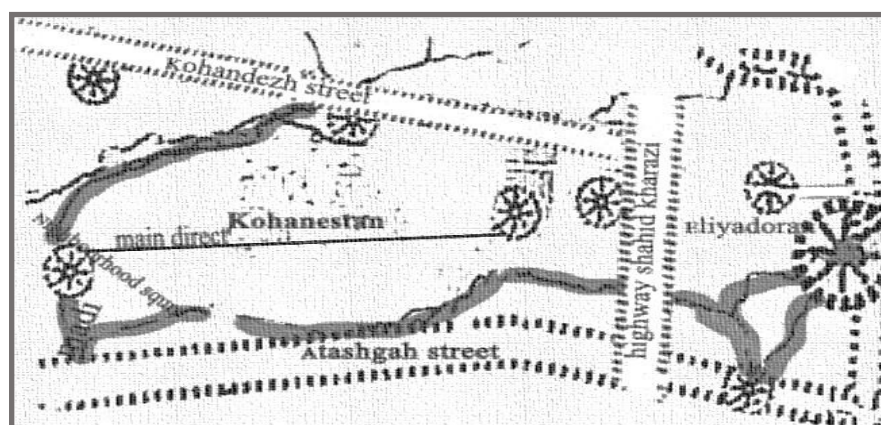
Fig 6 Neighborhood direct in Kohanestan and Elliyadoran neighborhood and position of the field in its vicinity

The western square of Kohanestan, in accordance with Fig 6, like its entrance is located at the beginning of Kohanestan neighborhood and in the western part of the neighborhood and in fact most urban amenities have been gathered so it has been one of the most popular places. In fact, the neighborhood's Mudi area provides a good place to perform various activities that have many uses as a communication loop. In fact, these applications can be evaluated in two aspects: their role as a place where different activities are carried out and their role as a ring of urban communications, here in the city part, the role of communication and connecting Mudi like a city junction at the square. Also along the street of this neighborhood, two main and historic streets called Atashgah and Kohnadezh connects each other. The role of these activities and functions of the Mudi as a place alongside squares and the creation of passages has created an ever-expanding series.
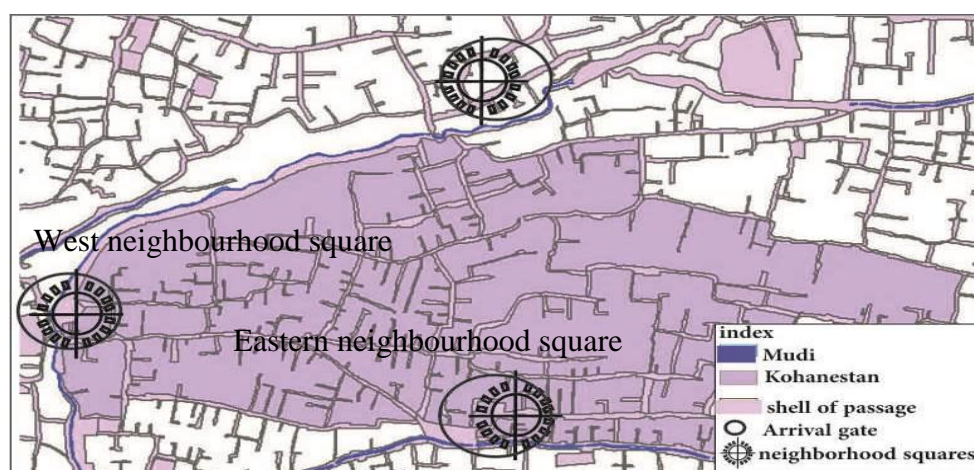
Fig 7 Location of local squares in Kohanestan neighborhood

7. Research Method

The research methodology is a set of valid, structured rules, tools and solutions for evaluating facts, finding unknowns and solving problems (Khaki, 155, 2006). Here a researcher uses a descriptive survey method as a basis for a better understanding of the status of the research and how variables are distributed. These descriptions and surveys in the introduction to the field we are

studying are used to better understand a problem. This research is descriptive-survey, so we have tried to provide relevant information for mastering the subject and using other relevant external and internal results and based on descriptive methods, we have expressed intuitive results, theoretical perspectives and definitions. Here research methods and skills include the models used in the research process:

7.1. Statistical Survey

The questionnaire is one of the most common tools for providing information in the research. In fact, the research questionnaire acts as an important tool and consists of two sections of general questions and specialized questions. The questionnaire questions are designed to fit the subject of research and its related assumptions. The questionnaire has two parts: the first part is general, in which the individual characteristics of the individuals are evaluated and in the second section, each of the relevant aspects, in order to determine the priority of the indices for assessing the quality of neighborhoods squares in Elliyadoran and Kohanestan neighborhoods will be examined. In this questionnaire, participants are asked to express their response or analysis to each indicator on the basis of intuitive or subjective criteria. These answers range from very large to very low. The questionnaire is in the form of a Likert spectrum. Statistical analysis was performed using SPSS software. Their reliability is confirmed by Cronbach's alpha and narrative based on expert opinions. Also, for each of the indicators and the results of the analysis, the t one sample test is used here.

7.2. SWOT Table

SWOT review is an effective tool for identifying environmental conditions and internal capabilities. The basis of this tool is strategic planning and urban planning, identification of the environment, strengths, weaknesses, opportunities and threats. SWOTs that write it in other forms such as TOWS, have been made from the beginning of Strength, Weakness, Opportunity and Threat words. The issue of the strengths and weaknesses associated with the internal issues of an organization and the issue of opportunities and threats is also related to the organization's external environment. After considering the weight of each of the methods, we examine the solutions developed by locating internal factors against external factors. In this context, we have four solutions:

Contingency strategy: A solution that works with the help of existing opportunities to eliminate threats

Adaptive strategy: An approach that attempts to cover weaknesses through opportunities of existence.

Defensive strategy: A solution that takes into account existing threats and weaknesses to resolve existing problems.

Offensive strategy: A strategy that works with the strengths and opportunities available to provide an appropriate solution (Golkar, 2006: 12).

7.3. Priority AHP

This methodology is used to obtain the best solution after the SWOT step in this research. Initially, by determining the desirable indices for these two neighborhoods by assigning weight, we examine each of the indices of these two neighborhoods and then, using the geometric mean of each of these indices, the pair of points is assessed in both neighborhoods. In addition to assessing

compatibility, in the end, based on a paired comparison, the best solution for each of these neighborhoods is determined.

8. Steps to Run

This research consists of three steps, the questionnaires are first examined by the inhabitants in the two neighborhoods. In the second step, the strategies of the SWOT table are obtained and in the third step, the best solution for the neighborhood squares is presented. The following is explained below.

8.1. Questionnaire Review

To obtain more accurate results, the narrative questionnaire was evaluated by experts in this field and with a pre-test distributed among 20 people in these two neighborhoods, a reliability of 81% was obtained. This figure indicates the high reliability of the questionnaire.

In these questionnaires, about 64% of the people in the Elliyadoran neighborhood were male and most of the interviewees had an undergraduate degree. It attempts to ask questions from people with different qualifications. In the Kohanestan neighborhood, about 58 people had male gender. Most people also have a bachelor's degree. Here based on the one-sample t-test, each of the indicators in these two neighborhoods is evaluated and compared.

With the help of a single sample t-test and according to Table 2, it is observed that both quarters in terms of spatial dimension, in which the efficiency of neighborhoods squares was moderate, but the feeling of identity and belonging to the square, the highest score won. In both neighborhoods, the squares in terms of green space are still in a good position, but in other applications and activities, there is no specific population. In Kohanestan neighborhood, the largest square is dedicated to green space. The diverse and attractive architecture of buildings around neighborhoods is more than any other area. Sculptures and urban elements are also seen in the Elliyadoran neighborhood.

Lighting around Mudi and neighborhood square has also not attracted particular attention to people and there is no willingness to participate and improve this issue. There is also a special religious and cultural activity here but the neighborhoods square which is a public place is not attractive to people.

Given the various access routes around the haj Seyyed Javad square, public traffic services around this square are easier and faster and like the sides of a triangle, there are links to access on this square which provides urban and neighborhoods connects each other. In the western square of Kohanestan, considering that the Mudi are located around the neighborhood, access to the main streets has more problems, but the main street of the neighborhood, alongside the square, has created a suitable bike ride and sidewalk. Here are two main streets of Atashgah and Kohandezh which are among the most historic Esfahan streets, so the square plays the main link here. Indeed, the neighborhoods squares have lost their recreational utility to some extent around the squares, but with the presence of the most important public places alongside them, they continue to play the most important role in social gatherings. In fact, the issue that still survives the squares is the presence of popular participation. The neighboring squares and the surrounding area and especially the presence of gardens surrounding squares and Mudi, are one of the most important dryness factors in Zayanderod. They have not caused the destruction of squares, but have also created worn tissues to the central points of the neighborhoods.

According to studies, the priority of designing local fields near the Muddies in the Kohanestan is neighborhood of the West Square; and in the neighborhood of Elliyadoran Haj Seyyed Javad Square has led to the destruction of local fields and the main orders, transformation of the Mudi and neighborhood.

Table 2 Comparison of the situation of neighborhoods squares in Elliyadoran and Kohanestan neighborhoods based on theoretical aspects of research

Dimension	Property	Questions	Elliyadoran neighbourhood		Kohanestan neighbourhood	
			t	Possibility	t	Possibility
Spatial	Creating identity and sense of belonging place	On the sense of belonging to neighbourhoods squares impact of existence	-4.137	0.001	-2.824	0.014
		The impact of neighbourhoods squares on the sense of identity	2.324	0.035	5.264	0.000
	Dynamic and beautiful	Charm of space neighbourhoods squares	-3.727	0.002	-6.813	0.000
		The presence of a desirable space with a joyful neighbourhood	-1.542	0.144	-4.795	0.000
	Combining attractive features	Services that meet the daily needs of the inhabitants	0.000	1.000	0.269	0.792
		The presence of people's favourite activities and activities	-2.496	0.04	-2.514	0.025
		Attractive and efficient public districts	-3.259	0.007	-2.175	0.047
Structural	Diversity and Stability in the Riddle	Architectural diversity and charm of buildings around neighbourhoods square	0.000	1.000	4.583	0.000
		Use sculptures or urban elements to create a sense of identity	-2.076	0.000	0.000	1.000
	Health	The sanity of space around Mudi and neighbourhoods square	2.546	0.022	0.269	0.792
	Access to public roads and services	Access to public services	-4	0.001	3.500	0.004
		Access to public transport	2.324	0.035	5.264	0.000
		Easy access to the main streets	-1.542	0.144	-4.795	0.000
		Recreational and recreational facilities in neighbourhoods squares	-3.727	0.002	-6.813	0.000
		The neighbourhood square creates a link between the private and public environments	0.863	0.401	1.976	0.068
	There are sidewalks and cycling routes	Walking path and proper cycling	-3.922	0.001	1.586	0.135
	Green and public space	Enough green space around the Mudi for all neighbourhoods	-21.958	0.000	-3.833	0.002

		A sufficient number of parks in the neighbourhood to address the lack of green space	0.333	0.743	-0.397	0.698
		The effect of dryness Mudi on the problem of reducing the boom of neighbouring squares	3.758	0.002	0.456	0.655
	Suitable facilities and stations	Suitable facilities and stations	-2.076	0.5	0.000	1.000
		How to light around the Mudi and the neighbouring square	-4.392	0.001	-2.739	0.016
Participation and social composition (elimination of social classes)	Participation and group activities	Participation of people in improving the situation of the neighbourhood and solving its problems	0.565	0.58	1.000	0.334
		The interest in financial and practical participation in the implementation of the projects	-7.904	0.000	-2.175	0.047
		Conducting community and community activities in the neighbourhood	0.863	0.401	1.976	0.068
		Perform religious and cultural activities for more interactions	2.546	0.022	4.583	0.000
	Communic ating with people	The positive effects of the neighbourhood square problem on improving people's relationships	0.00	1.000	0.269	0.792
		The charm of the neighbourhood square for people as a public place	-11.211	0.000	-7.483	0.000

After assessing the characteristics of these neighborhoods by means of questionnaires § and statistical surveys, now, based on the SWOT approach, we can examine and describe the existing solutions among the various alternatives that exist, using the AHP method.

8.2. Step 2: SWOT Tables

According to the Table 3 and 4, in this section, due to the features of Elliyadoran and Kohanestan neighborhoods, we need to provide SWOT tables related to each of the neighborhood squares so that we can select a suitable solution with the help of the prioritization approach, among the various choices we have.

As we have already said, the Elliyadoran neighborhood is on the path to one of the main roads that is ecologically and near the Mudi which is important. This passageway is a connecting point that passes through the alleyway of Rozatiha and connects to Chaharsogh and Farhady alley near Kashanay hospital and connects Hosseinzadeh's alley to the Kadkhodaey passage.

These three entries are the most important inputs of the neighborhood. Table 3 illustrates the strengths, weaknesses, opportunities and threats of this issue in terms of research objectives, in order to provide a suitable solution for them. Here it should be noted that Kohanestan is surrounded by a number of Mudi. This Mudi network can be considered as one of the main historical routes adjacent to these neighborhoods, but considering the dryness of the Mudi and the problems associated with these paths and changes in the lifestyle of people, the definition of these routes will also be different.

These neighborhoods are like a gate at the beginning of the neighborhood that are located in the western part and in fact services and facilities are concentrated on them which are considered to be

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§It should be note that the number of completed was 60 in each neighborhoods

the most important part of the neighborhood. It has also been one of the most important places for popular gathering in the neighborhoods.

The public swimming pool, the Kohanestan mosque, the mosque, the fourteen innocent mosque and its related facilities, including the caravanserai, hermitage and the trees and greenery and its gardens are some of the public facilities in the area. Table 4 shows the weaknesses, strengths, opportunities and threats of the Kohanestan neighborhood based on the theoretical approach of this research.

Table 3 SWOT neighborhood square haj Seyyed Javad in the neighborhood of Elliyadoran

	Inner environment		Outer environment	
	Strengths	**Weakness**	**Opportunities**	**Threats**
Spatial	-Square is the place to carry out activities and space for the construction of different facilities and the presence of people alongside each other -Locating at a central point with urban performance -Variety of features -High quality landscape due to green space -Flexible on margins and spaces -The existence of historically valuable monuments -The existence of old trees and natural spaces -Stationary space -Existing buildings and valuable spaces along the Mudi	-without regard to the creation of facilities -Failure to determine the privacy of the Mudi and the failure to enforce the law in determining them -Not fitting the facilities with existing needs -Lack of amusement space -Drying of Mudi and reducing the boom of many functional spaces -Lighting at night -Converts the channel's path to the Heath Avenue which does not have a high user value -Reduce the sense of belonging to drought Mudi -Inconsistency in the activities	-Possibility to create facilities on vacant land -Attention to human scales during the design and construction of buildings -Create attractive environments based on the style of my new and old architecture -Possibility to perform celebrations and exhibitions in the space of old squares -Elemental elements on the route of the Mudi and around them that bridge neighborhoods are new and old -Create a charming place for cultural activities, tourism, services on the Mudi route	-Convert some features to the warehouse -Get some facilities around the square neighborhood -Destruction and fragmentation are part of the historical architecture of tissue -Reduced attractions in the neighborhood -The risk of degradation of the organic tissue of the neighborhood and neglect of the valuable areas of the neighborhood -Gradual decline of the important and historical elements of the neighborhood

Structural	- Ability to access all the important points along the square and the Mudi - Appropriate access to the old and new tissue of the city - There are trails along the Mudi And the existence of hierarchy of access to old tissues And the exuberance of the presence of trees and surrounding gardens - The presence of appropriate vegetation - Special design of sidewalks on most inner-neighborhoods neighborhoods - Cleanliness of neighborhoods and townships - There is a green wall in the path - There is paving on the part of the square	-Construction of uneven buildings in terms of height, appearance, materials -Lack of sufficient parking -No use and degradation and exhaustion squares -Misalignment of position and architecture with the identity of buildings and public spaces -Creating gaps in neighborhoods due to the creation of new streets -Non harmony in the distribution of urban amenities -Incompatibility of functional facilities with squares -Lack of signs - Broken down the pavement	-Lighting and execution of other designs -Easy access to the main streets that pass through the tissue -Creation of brush lining in tissue -Possibility to create favorable spaces for walking -Increased walking safety along the Mudi and square by building suitable floorboards -Ability to attach tissues to square and Mudi -The presence of green space and trees on the Mudi route	-Possibility of creating various types of pollution and destruction of neighborhoods green space -The absence of an appropriate pattern in the implementation of building facades -Neighboring heavy traffic and traffic on vehicles -The increase in the number of accidents due to the entry of vehicles to the neighborhood from different directions -Confusion in the tissue due to inconsistent structures that are in conflict with the traditional tissue -Removing the main crossroads of the market and communication spaces such as square neighborhood -Remove the squares neighborhood and create an identical pattern for residential spaces
Social	-Communication in the cultural and commercial areas -Highlights of these places and the presence of the people -Integration of active population in square and optimal tissue structure -There is a suitable potential for attracting tourists and introducing Iranian and Islamic architecture -Being excited at this during the day and early nights -Square has a suitable economic, religious, cultural, sporting and communication background among people	-Lack of security for people in these places -There were no night-time functionalities to increase the security of the people and their presence	-The favorable influence of neighborhoods' communication features on social communication -Creating public spaces based on multidimensional activities -The possibility of people's participation in the cultural-economic section -Possibility to create opportunities for night activity and increase supervision	-Reduce traffic at night -Analysis of square space that created the field of communicative communication -Remove social links by removing squares neighborhood -Delete social links by removing squares neighborhood -Lack of natural monitoring in the neighborhood and reducing the security of the people

Table 4 SWOT Kohanestan neighborhood

	Strengths	Weakness	Opportunities	Threats
Spatial	The presence of squares at neighbourhood's connectivity with connectivity between them increases the serviceability and commercial performance of this tissue -The presence of old trees in the original tissue and creating a refreshing environment -There are various possibilities to meet the needs of the inhabitants	-The lack of coordination of the routes with the current needs -Inappropriate combination of facilities and activities -Lack of neighbourhood services and facilities and lighting at night -Disturbance in the context of the context -Angular with crowded places	-Possibility to create an attractive environment with a variety of facilities -Ability to use spatial communication features to create community-based communication in the neighbourhood -Can enhance input connections based on square adjacency -To create a suitable environment for fun -Increased sense of belonging with efficient design -Continuous use of natural and artificial agents to enhance the attractiveness -Creating a favourable relationship between man and nature based on the natural indices of the neighbourhood -Ability to connect points in tissue with squares	- Creates a distorted and heterogeneous mental attitude towards the neighbourhood - Reduced referral to places due to lack of facilities -Getting organic urban tissue by neglecting valuable spaces within the tissue - The risk of removing the integrity of the interior space - The risk of removing integrity by developing an inappropriate pattern within the neighbourhood - The risk of removing the square and the canal by creating an identical pattern for residential buildings -Lack of a proper pattern in the design and placement of facilities
Structural	–There is a suitable potential for attracting tourists and introducing Iranian and Islamic architecture -Use of native materials in the construction of old tissue -Jade walkway from the street on the side-lines of the canals -There is paving on the part of the square -There is a green wall along the way -There are mosques and old houses along the way	-The lack of facilities and stations at the connecting points of the canals route -There are a lot of vehicles than people -Lack of special cycling routes and impaired people -The dryness of canals and tissue erosion and the reduction of the presence of people in them and the inconsistency of new structures with old tissue	-Easy access to the main streets that pass through the tissue -Encouraging people to walk with appropriate sidewalk design -The presence of green spaces and trees on the canals route -Application of the surroundings of canals for walking and cycling -Possibility to liberate the space around the canals	-Burnout and removal of the square surrounding the monuments -Removing historical architecture -Remove hierarchies related to access to features -The presence and traffic of strangers and reduce security and relaxation -Disturbance in tissue due to inconsistent construction -Remove the main passages and communication spaces and square neighbourhood -Inappropriate clustering
Social		-The absence of night-time facilities to increase the security and presence of the people -Lack of space for cultural and social activities	-Possibility to perform ceremonies in the neighbourhood and hold exhibitions in the square neighbourhood area -To create multipurpose environments that are suitable for variety Investing in the cultural sector and people's participation and using indigenous capabilities for improving the environment -Can be able to carry out cultural activities, tourism, providing services in the route of the canals	-Reduced traffic at night due to lack of adequate light -Not paying attention to the ability of people to improve the neighbourhood -The disappearance of unity and social integration and communication between inhabitants

8.3. Step 3: AHP

In this section, after reviewing the questionnaire and reviewing the SWOT model, we choose the hierarchical process of AHP which is a flexible, powerful and simple method and it can be used to decide on the decision indicators. There is a contradiction between choices. Here in order to select the best plan for redesigning neighborhoods squares, Kohanestan and Elliyadoran neighborhoods, we can prioritize each of the suggested alternatives by weighting the indices.

8.4. Suggested Alternatives for Neighborhood Square Haj Seyyed Javad Elliyadoran

As shown in Fig 8 and 9, for the Elliyadoran neighborhood, two alternatives are proposed which has been introduce below and the characteristics of each of them are also expressed:
First Alternative:
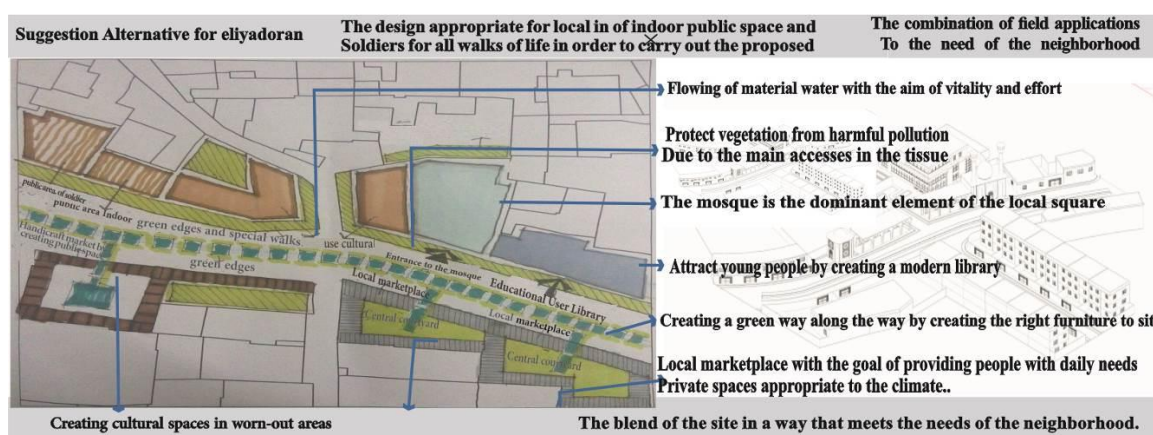
Fig 8 First alternative for the Elliyadoran neighborhood

Second Alternative:

Fig 9 Second alternative for Elliyadoran neighborhood

These alternatives include combining existing features with the creation of diverse margins for environment dynamism and integrity to meet the needs of people in a square. Here the mosque is known as a relevant square element which is a place for social activities. Civic areas are also created as venues for public gatherings and their social connections. In realizing this, there are opportunities on the margins of the Mudi to sit people and their well-being. There are also facilities for using cultural sites to preserve historical monuments.

8.5. Suggested Alternatives for West Square Kohanestan Neighborhood

For redesign the Kohanestan neighborhood square, two alternatives have been proposed which has been shown in Fig 10 and 11.
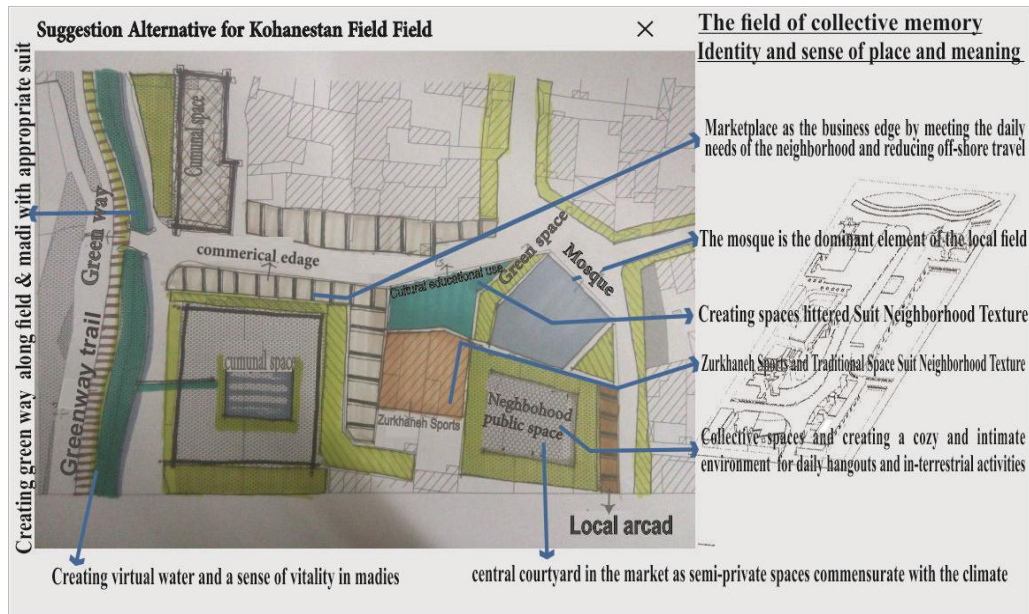
Fig 10 First alternative for Kohanestan neighborhood
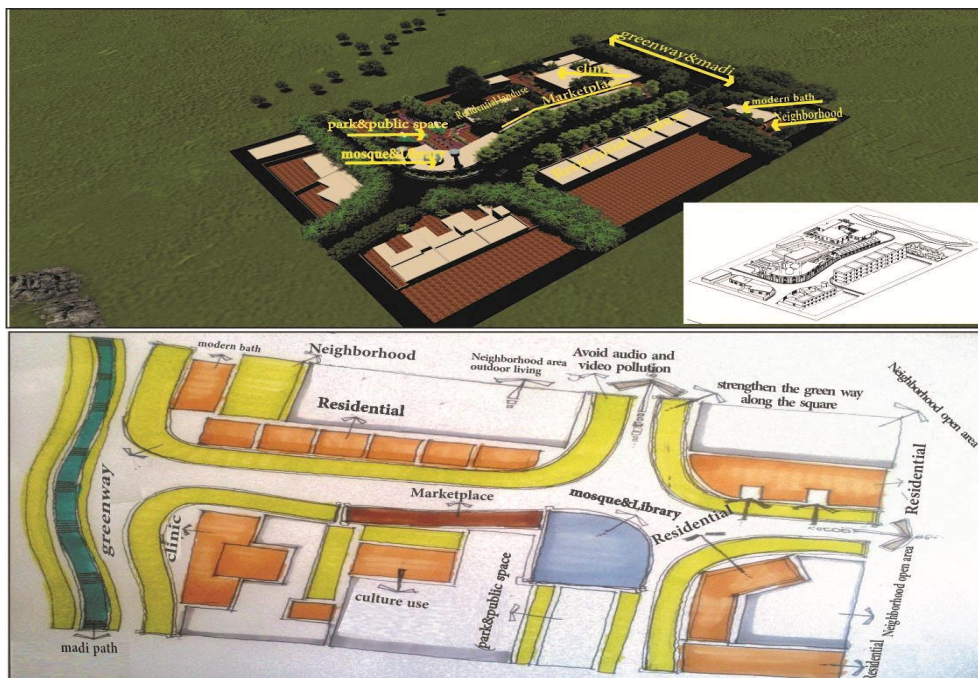
Fig 11 Second alternative for Kohanestan neighborhood

In these alternatives, the mosque is an indispensable element for square which can create identity and sense of belonging in people. There is also a green space around the square to create a beautiful and attractive environment for walking. Here the market is a trading point that aims to meet the needs of the people and reduce the number of trips outside the neighborhood. There are also some places for daily activities and related activities within the neighborhood.

9. AHP model

Now with the help of this model and identifying its elements that include targets, indicators and non-indicators, we can create a hierarchical structure as shown in Fig 12. After determining the indexes in the first step, in choosing the final alternative, based on the importance and priority of each indicator relative to other indicators and according to the characteristics of each neighborhood and the results of the questionnaire, we assign each indicator with a weight and compare them pairwise.
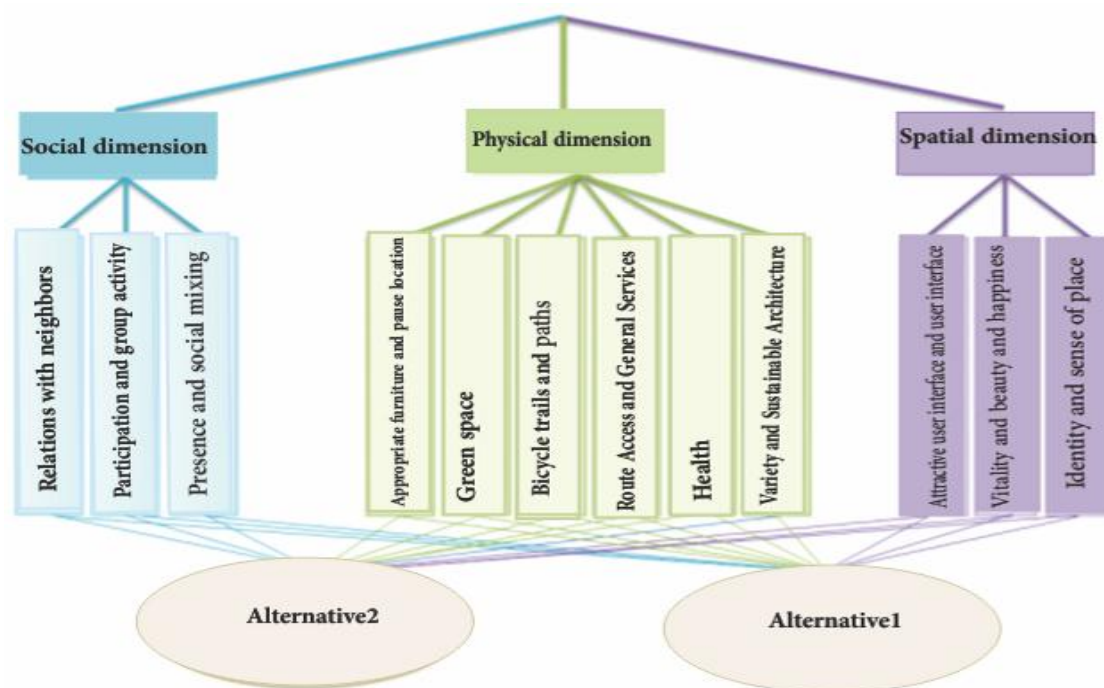
Fig 12 AHP model

Comparing pairwise, based on the purpose of the research, we provide an appropriate design for the Kohanestan and Elliyadoran neighborhoods squares. Here the priority of each of these indicators is determined by the values of the following quantities.

The priority of an indicator relative to its own index is equal to one and its factors are inversely proportional to each other. Priority 3 is the importance of a little more. Priority 5 importance related to more, Priority 7 importance related to much more and Priority 9 is the importance of absolute. Values 2, 4, 6 and 8 are used when there are mid-states (Tofigh, 1995, 24).

The coefficient of importance of the indices chosen is replaced by the approximate method (the arithmetic mean) in order to choose the appropriate index so that after the comparison, the values of

each column are summed together and then the values of each Element of the matrix divided by the total sum of the column in the final step, the average Elements of each row are computed.

In accordance to Table 5, different dimensions are compared with each other. This table is derived from the determination of the coefficients importance of the indices and we observe that the sum of the coefficients of the indices in it is equal to one and this relative problem shows the importance of the indices that, in redesigning the neighborhood squares, for these two neighborhoods. The coefficient of significance associated with structural dimension is 0.57 which is higher than other dimensions and after that, the index or social dimension of the coefficient is more important.

Table 5 Dimensional weights

Dimension	Spatial	Structural	Social	Importance factor
Spatial	1	1.4	1.5	0.097
Structural	5	2	1	0.570
Social	4	1	1.2	0.333
Total coefficients				1

For each of these indicators, in the redesign of neighborhoods squares and according to the selective approaches of this research, sub-indicators are presented. Based on the importance of each and the effect on improving the quality of neighborhood squares, concessions each of them is scored on an hourly basis. The Table 6 shows the importance of sub-indicators.

Table 6 Characteristic weights

Medium Importance	Spatial			Structural						social		
	Identity and sense of belonging place	Dynamism, beauty and vitality	The combination of features and their attractiveness	Diversity and Sustainability in Architecture	Health	Route Access and Public Services	The presence of a pedestrian and cycling route	Green and public space	Facilities and stations	Participation and social composition	Participation and group activity	Communicating with people
	0.356	0.346	0.298	0.166	0.12	0.226	0.186	0.171	0.131	0.413	0.327	0.26

After determining the coefficient of importance of indices and sub-indicators, the coefficient of importance of alternatives is determined. The allocation procedure in this situation is similar to the hourly quantity scale. In the Table 7, each of these alternatives is based on sub-indicators.

Table 7 Feature priority

Mansions	Attributes	Kohanestan		Elliyadoran	
		Alternative 1	Alternative 2	Alternative 1	Alternative 2
Spatial	Identity and sense of belonging place	0.238	0.762	0.500	0.500
	Dynamism, beauty and vitality	0.340	0.660	0.125	0.875
	Combine the features and attractiveness of them	0.500	0.500	0.125	0.875
Structural	Diversity and Architecture Stability	0.500	0.500	0.500	0.500
	Health	0.500	0.500	0.500	0.500
	Access to routes and public services	0.340	0.660	0.225	0.775
	The presence of a pedestrian and cycling route	0.338	0.662	0.125	0.875
	Green and public space	0.500	0.500	0.500	0.500
	Facilities and stations	0.410	0.590	0.325	0.867
Social	Participation and social composition	0.338	0.662	0.125	0.875
	Participation and group activity	0.410	0.590	0.325	0.867
	Communicating with people	0.500	0.500	0.500	0.500

The proposed importance coefficient Table 8, is evaluated for determining the best alternative in redesigning the neighboring square using the adaptation process. Here the compatibility issue is confirmed otherwise, we should rethink the estimates which means the binary matrix should be re-indexed and the index of their randomness should also be made using the table below and based on the incompatibility index calculation.

Table 8 Randomness indicator

n	2		3	4	5	6	7	8	9	10	11	12	13	14	15
R.I	0		0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

With the help of relevant surveys, the inconsistency index is 0.03 and the incompatibility coefficient is 0.052 which is less than 0.1, which confirms the compatibility. In the final score, each of the alternatives is presented as a matrix for each indicator. Here the reward of each alternative for each index in its coefficient of significance is multiplied and then the scores are accumulated together and each of the alternatives that can earn more points gets more priority.

Table 9 Determine the final rating in the alternatives

Alternatives	Final score (Kohanestan)	Final score (Elliyadoran)
The first alternative	0.3346	0.3175
The second alternative	0.6254	0.6825

In accordance to Table 9, the output of the AHP hierarchy shows that in the redesign of neighborhoods squares of Elliyadoran and Kohanestan and with respect to the alternatives and sub-indicators of the second alternative, the higher priority is given to both neighborhoods.

10. Conclusion

Neighbourhood squares, most popular places and gatherings in the old neighborhoods of Esfahan have been for centuries irrigated in its canals and this has had a great impact on the boom and dynamism of these areas and related activities. Today, due to the lack of water in the canals, most of these structures have been exhausted and this has disrupted their activities. In fact, these areas that remain largely unidentified are now being forgotten in the neighborhoods and this gradually erodes the structure and destroys it. The results of this study indicate that local squares are not as effective as the past and because of the dryness of the canals, the dynamics of the local squares and their surroundings has decreased. Local tissues in these squares are connected to each other, so any changes in these squares can affect the whole area. On the other hand, the lack of service, commercial and sporting facilities is clearly seen here so there is a need to redesign these neighborhoods and pay attention to the mix of functionalities. Also, in this matter, people living in the neighborhood must contribute to creating a desirable, safe and efficient environment. Therefore, in the proposed methods and the final design, all cases are expressed in terms of the research approach and can be reconstructed with canals and squares. Attractive and joyful which also affects the basic needs of the neighborhood and its activities which, in addition to creating dynamism in the neighborhood, can bring more people into the neighborhood and eliminate unnecessary trips. In Fig 13 and 14, this proposal is presented in the form of three dimensional images.

Fig 13 Proposed design neighborhood squares of Ellyadoran

Fig 14 Proposed design neighborhood squares of Kohanestan

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Spatial Hierarchy in Iranian Mosques (Case Study: Jame Mosque of Yazd)

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Abstract

The principle of hierarchy is one of the fundamental principles that dominate the universe. This principle is considered in the Muslims architecture and in Islamic thought. In this research, initially the position of hierarchy in Islamic art is explained in order to find out its importance and necessity. Afterwards, study the various spatial hierarchies through sample analysis of Iranian mosques (Jame mosque Yazd). The main research question is how the hierarchy of space is understood in the field of architecture? And how this meaning was manifested in Iranian mosques architecture? The research process is based on descriptive-analytical techniques and the required data is collected through library and field studies. The research and inference process is based on a case study analysis, and the extraction of qualitative and quantitative data. The research results show that "proportions" and "shape and form" are the most important factors in creating the spatial hierarchy in architecture of the Jame mosque in Yazd and to create a spiritual preparedness to enter the building and to understand the correct conduct from one space to another space in architecture.

1. Introduction

The significance of hierarchy according to the Holy Qur'an perspective can be pursued in two ways: one from the point of view of the verses and other the meaning and interpretation of the verses. As it is seen from the eleventh verse of Surah al-A'raf, it indicates the existence of sequence in the stages of human creation and the prostration of the angels upon him. It is also possible to

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study the family verses, which shows significant differences in the order of the mentioned relatives in Quranic verses. For example, due to their status and respect, parents have been considered superior to other relatives (Naghibzadeh, 2008: 167). But the meaning and interpretation of some verses can be found that type of sequence has been mentioned as hierarchy of human existence in Islamic teachings. The purpose of the hierarchy existence is that all the creatures of the universe, such as the chain loops or ladder stairs are interconnected from pure existence to non-existence in a regular order, and the position of each in this hierarchy depends on the degree of intensity and its weakness existence level (Nasr, 1980: 114). The degree of existence itself is a kind of inner hierarchy that the spiritual value increases from bottom up (Mirhosseini, 2018: 125), and creates two modes of divine and supremacy in mankind, which in the first state, the body is without soul and in the second state the spirit is without body (Naghizadeh, 1999: 276). The footprint of this principle can be seen in Iranian mysticism. The mystics know the main aspects of existence on five occasions, and they are called as "the divine goddess". Islamic scholars have accepted the same division from Suhrawardi onwards, but generally have used other terms to describe and express each hierarchy (Nasr, 1996: 175). In epic literature closely related to mysticism, we open the story of seven cities, or seven houses, love in the form of seven chamber (meaning seven houses) (Ellahi Qamshahi, 1997: 336).

This sort of personality is not specific to the Iranian-Islamic geography, but throughout the cosmopolitan people, the theme of fixed universe has been revealed hierarchically (Nasr, 2001: 167). In order to clarify the connection between the hierarchy of existence and the hierarchy in which human beings deal with it in life, one can say that "... human as a minor world is the mirror of the whole façade of the great universe, so the human soul also has a similar hierarchy and correspond to the Great Universe. That is, each potential level of human soul, if it can be achieved, can lead to the recognition and perception of its corresponding existing hierarchy in the great universe" (Mohammadian Mansour, 2007: 62).

What has been said about the principle of hierarchy from the view point of Iranian-Islamic studies is the expression of human beings acquaintance to the traditional society of the various aspects of hierarchy. This understanding in the traditional society has determined color and has significant effects in the field of human artifacts, including architecture and urbanization. In a mosque, there is no arc that induces a transcendent meaning that, by replacing it the hollow of the concept disappears, but the geometric design, light proportions, spatial order, and access to hierarchy which gradually shift the individual from daily routine to a quiet place for prayer (Zargar, 2006: 115), which expresses the importance of the issue of hierarchy in human life and its function in his works.

2. Literature Review

2.1. Types of Hierarchy

The hierarchy defines the relationship between the components of a set to create a whole unit. An environment as a set has components that are defined by the hierarchical relationships. Naghizadeh (1999) divides the hierarchy of the environment into the following categories: regional hierarchy, neighborhood hierarchy, passage hierarchy, functional hierarchy, and spatial hierarchy.

Grötter (2011) states in the definition of space: the closest definition is to consider space as a void, which can accommodate an object or fill it with something. Space is not an entity that has a definite definition, but it is measurable. Also, space in its existing concept alone cannot offer any particular features, but as soon as a human group places an activity, the symbolic meaning of space

emerges. Henceforth, space is the base to express human activity and behaviors; a place for imagination and reality (Habibi, 2003). Hence, in general, it can be said that space is the essence of architecture. Space in architecture protects human beings from natural factors and encompasses all his personal and social activities. In other words, human beings in space provide their material and spiritual needs. According to the above definitions, space can be divided into form and function, where form is geometry and structure, and its function consists of people and activity (Fig 1).
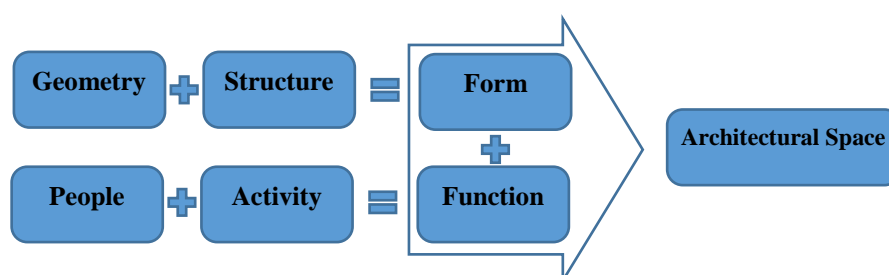

Fig 1 Factors forming space in architecture (Source: Author)

Hence, space hierarchy was chosen as evaluation criteria to incorporate the main factors of the architectural space (i.e. structure, form, people, and performance) among other types of hierarchy. The spatial hierarchy addresses the inside connection of the building (as a private space) and its adjoining spaces (as the public space) and clarifies the details of this relationship (Naghizadeh, 1999). Its observation in architecture has been the factor of the emergence of many concepts in the artistic environment. Hence, we explore the factors for creating a hierarchy of space in architecture, and then, based on the obtained factors, we will examine and analyze the case study.

2.2. Factors Creating Spatial Hierarchy

Tabasi and Jami (2006), by the definition of space, consider many factors in construction of effective space, which are called as the main factors of form, function, structure and materials. Also, time, light, color, decoration, and proportions are considered as secondary and effective factors in strengthening the expression of architecture and space perception. Meaning of proportion is relative in architecture which expresses the relationship between two or more dimensions. In architecture, this ratio corresponds to our spatial perception. In other words, change in the proportions of an emotional space that one has in relation to that space changes or actually the space changes. The change in proportion creates a new atmosphere that is not associated with the cognitive background for the audience. Therefore, although the respondent emotional percept at the moment of confrontation with the effect, but the mental perception of the new space requires time for thinking, this is the moment that is the goal of the Muslim architect (Tabasi and Jami, 2006: 84).

A form is conceptually subjective and in order to be able to exist, it needs something that can represent that form. The forms have a variety of rules (circle, square, triangle, etc.) and non-rules each due to their characteristics creates a special atmosphere. Experiments have proven that in determining position in space, form plays an important role than color. For example, for children of a certain age, color is more important than the form. The perception of color depends on the light and color of the environment (Grötter, 2011: 449).

Light is the first condition for any kind of perception. In darkness, one cannot percept form, color, and space. Light in addition to practical use has always been of symbolic values. In religious architecture, using appropriate lighting creates a visual phenomenon that is not perceptually precise

and gives a mystical mood to human (Grötter, 2011: 449). Light is effective in creating prominent spaces and extends the scope of imagination. By considering the relation of light with decorative elements and combination of space can reach to a wide range of possibilities in visual art (Haji Ali Mohammadi, 1993: 13). Muslim architects by using skylight bring in the light to the interior dome space.

Shekari Niri (1999) about the decoration in Islamic art, especially mosques architecture says: Eslimi designs in Islamic architecture, especially in the mosque's elevation are widely used, which are abstracted from plant designs and symbol of the tree of life and the paradise garden. In the role of the knot, whether on tile, engraving, or mogharnas, all designs finally lead to the shamseh, which reminiscent of unity. Light and water are important components of Islamic decoration, as they can create more layers of designs and patterns and change the space (Edrisi Khosroshahi, 2007: 44). Ahmadi Maleki (2008) refers to the forms and symbolic roles of Iranian architecture that creates the spiritual environment. The Iranian mosques are a manifestation of visual aesthetics and a clear example of the combination of symbolic forms with deep beliefs. Hyacinth is the visual level that descends from their rank in order to express a transcendental meaning. Among these symbols are blue, cyan and cobalt blue colors that symbolize immortality. The tiles patterns originate from plant motifs associated with life. In mosque architecture lie the cosmic meanings. The shape of the squares at the bottom of domes associate the earth and the place, and the top circle associate with the sky and the time. The octagonal base of the dome is the interface between the earth and the sky and the symbol of the universe of angels (Ardalan and Bakhtiar, 2012). In addition to the shape, color and texture of space, the change in the floor level relative to its adjacent surfaces determines the severity of space limited by that surface and the intensity of creating a base against other elements in space in order to be seen (Mortazai, 2002: 37).

Urban form and architectural space are understood through the incomplete means of the human eye that can get a limited level at a glance. Understanding the urban form and space by human is proportional to the human distance. For example, human from long distances can only understand the general form of the city or the architectural space, and at further longer distances, the image of the city replaces the urban form, which consists of visual elements of the environment such as activity centers, signage, borders and synchronous movement systems. On smaller scales, forms can only be understood by pedestrians. The combine arrangement of spaces and architectural elements should be considered (Tabibian et al., 2011: 71).

According to the above description, which is a summary of library studies by the researchers, the factors for creating a hierarchy of space in architecture can be summarized in Table 1.

Table 1 Factors creating a spatial hierarchy in architecture (Source: Author)

No	Factors	Description
1	Balance	Change in floor balance
2	Decoration	Brickwork, tiling, Chinese knot, mogharnas, etc.
3	Proportion	Change in relation to length to breath and length to spatial height
4	Sight and landscape	Create and change of visual frame and different views from space relative to its surrounding
5	Atmospheric condition	Change in atmospheric condition including radiation, temperature, rain, humidity and wind
6	Shape and form	Change in shape and geometric patterns of plan and section
7	Acoustic	Occurrence of acoustic phenomenon like resonance and echo, etc.
8	Material	Change in cladding material and texture and color of space
9	Symbolization	Use of symbol of beliefs and culture, etc.
10	Light and lighting	Change in the light intensity and natural lighting of the space

3. Research Methodology

In order to answer the research question, first the domain of research and explanation of the statistical society (Iranian architecture) as well as the statistical sample (Jame mosque Yazd) are introduced as the dependent variable. Also, to make it possible to measure the impact of the hierarchy for the case study, the factors of its formation in the architecture are explained. The data collection is based on library studies and the analysis of information and decision making about independent and dependent variables is by logical reasoning method. In order to reach the goal of the study, a case study was carried out in the research methodological framework. Data collection was done by field method and data analysis in a comparative way. Finally, in order to understand better and analyze more precisely, qualitative analyzes to quantitative have been discussed.

3.1. Study Area

The height of glory in architectural work is the mosque. With accurate study we will notice that at any time period the variety of decorations used in the mosques are not obvious. Dynasty and Islamic governance since beginning till date has been involved in the evolution and progression (Chitti, 2000). Therefore, among various land uses of the Iranian traditional architecture, among the mosques the Jame mosque has been selected as a symbol of the Islamic city and the most important public building of the city, which was formed mainly at the core of the city and is accessible till the present day. The Jame mosque of Yazd was built for more than 800 years, and the structure has remained intact for years. The mosque structure has been added with decorations in such a way that it spreads to its fullest extent and brings it to its peak of glory and is available to the author in order to visit and for field analyzes, as a case study.

4. Discussions and Findings

In this section, the Jame mosque of Yazd was analyzed based on the factors creating the hierarchy of space in architecture. This analysis was performed on the basis of the main parts of the mosque and, accordingly, the movements of the audience from the outer element namely courtyard to its interior that is the altar. Due to the limitation, only the two parts, the gateway and the dome area has been analyzed, and the findings related to the analysis of the parts are presented in tables and charts.

4.1. Gateway (Entrance)

The high gateway of Jame mosque was built in the Azeri style, and two minarets were added in Esfahani style to prevent the collapse of the arch. It is one of the tallest entrance gateways with a ratio of 1:3 (Pirnia, 2008: 233). The gateway has indent part that defines the empty space of gateway and the gathering location of the mosque; and strengthens the invitation to the interior of the mosque. This indent is due to a step from the courtyard to a higher level, which reminds the audience of the change in space and the consequent change in behavior. On the two sides of the indent, there are two high-rise platforms as a resting place for the pedestrian, along with other horizontal lines dividing the surface, which helps to make the scale more human. The materials and decorations of the gateway are completely different from the courtyard, which draws the attention of the audience. The use of beautiful tiles with motifs and colors are taken from the nature and Quran inscriptions around the entrance gateway, creates a sense of calmness and reminiscent the beauties of creation and creator. Change in the proportions of the gateway to its adjacent walls is

one of the important aspects in designing this section and creates a hierarchy of space in the building. The stretched proportion and the vertical movement of the gateway emphasizes the entrance and mosque's privacy, and converts the horizontal motion of the courtyard (symbol of the material world), toward sky vertically and acts as the sign of the Islamic city causing legibility of the mosque in the city's surroundings and motivates the movement in the city at different intervals.
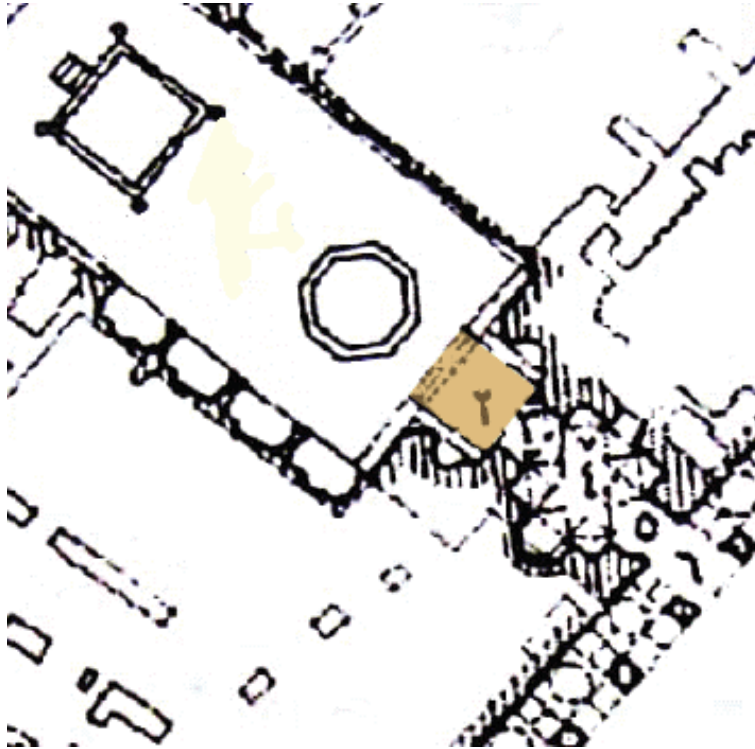
Fig 2 Entrance gateway plan of Jame mosque of Yazd (Tavassoli, 2007, edited by the author)

Table 2 Spatial hierarchy analysis of entrance gateway of Jame mosque Yazd (Source: Author)

No	Factor	Analysis
1	Balance	+
2	Decoration	+
3	Proportion	+
4	Sight and Landscape	+
5	Atmospheric condition	-
6	Shape and form	+
7	Acoustic	-
8	Material	+
9	Symbolism	+
10	Light and skylight	-
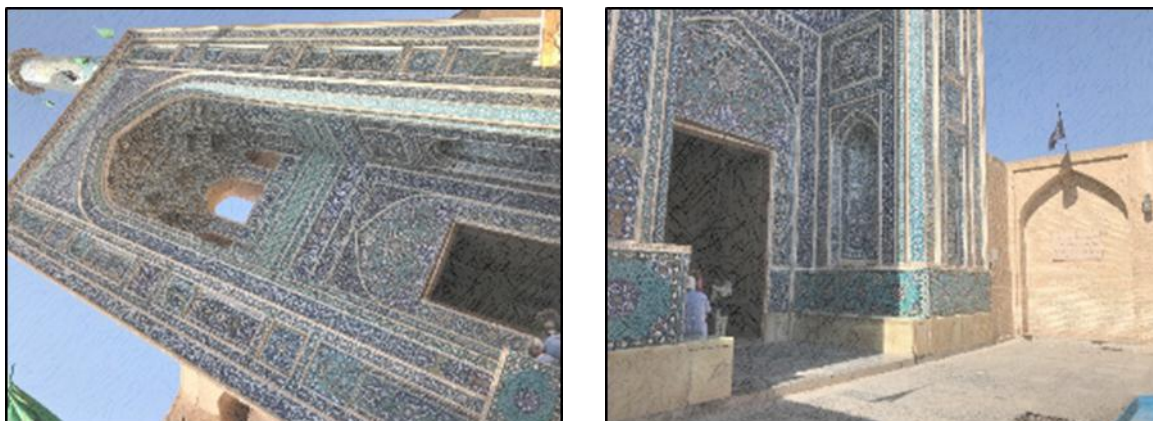
Fig 3 Entrance gateway of Jame mosque of Yazd (Source: Author)

4.2. Dome Area

The stretched porch space leads to the dome. The porch and dome are at a level and in terms of decorations and materials used in the walls are close to each other which covers the space. Brick knot with lacquer tile and tangled knot with turquoise color is one of the most important decorations of the dome space. As mentioned in porch, the change in geometry, form, and proportion of space relative to its perimeter spaces, especially porch, is an important point to be considered in designing this space and creating a spatial hierarchy in this part of the building. The square proportions and strong vertical movement of the dome area emphasize the presence of the audience at the focal point of the building. The center, because of the symbols used in geometry and its decorative motifs guide the people from earth to heaven and it reminds them that although it has reached to an end, it is just the beginning, a way that its destination is a point in the sky.

Fig 4 Dome plan of Jame mosque of Yazd (Tavassoli, 2007, edited by the author)

Table 3 Hierarchy analysis of dome space of Jame mosque Yazd (Source: Author)

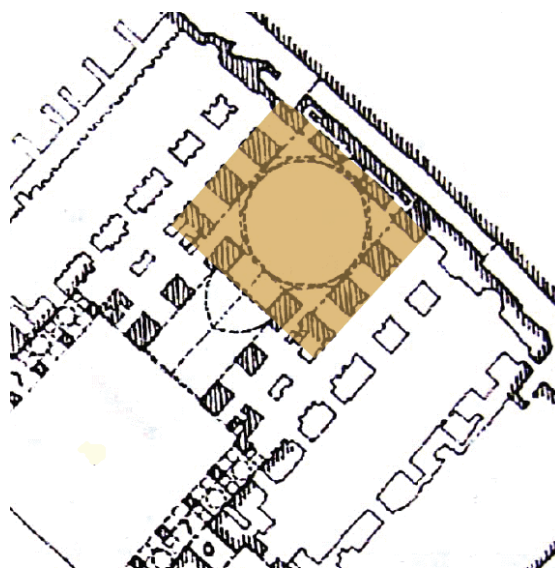| No	Factor	Analysis
1	Balance	-
2	Decoration	-
3	Proportion	+
4	Sight and Landscape	+
5	Atmospheric condition	+
6	Shape and form	+
7	Acoustic	+
8	Material	-
9	Symbolism	+
10	Light and skylight	+

Access to the interior of the dome area is possible through the corners and porches. The dome space is illuminated by brick lattices on the east and west sides of the building and above the corners are embedded, as well as through the openings on the curves of the dome. The sun movement throughout the day and sunlight from these openings entering to the interior space and its movement on the floor and walls of the dome increase the sense of space and signs of the presence of the creator are reminded to the creature. The high double shell dome causes the coolness of the space in summer, and its relative enclosure makes the transfer less frequent in porch and the presence of more deities'. The eastern and western walls of the dome due to the columns that transfer the dome load to the ground are divided into three openings at two levels, which make it possible, while creating a human scale and reducing the mass and fluidity of space, ventilation, visibility and accessibility to the corners.
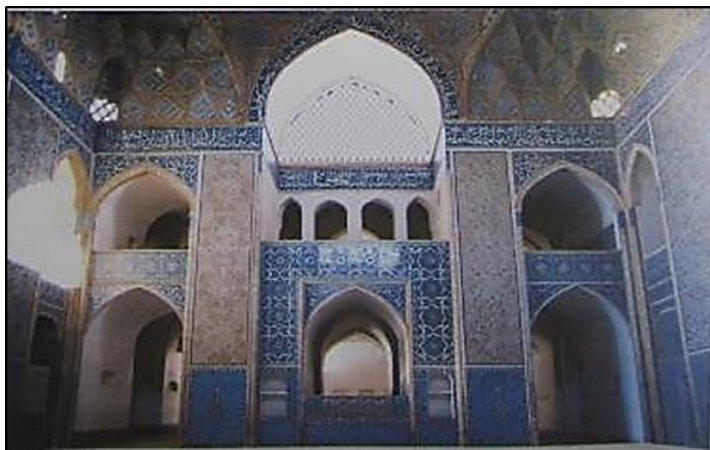
a.   Under the dome area

b.   Dome

Fig 5 Jame mosque of Yazd (Source: Author)

Further, in order to understand better and precisely analyze the Jame mosque of Yazd from the viewpoint of the spatial hierarchy, an attempt have been made to code and transform qualitative analyzes into a quantitative one, the output result is presented in the tables and diagrams.

Table 4 Parts, code and analysis of spatial hierarchy of Jame mosque Yazd (Source: Author)

No	Space name	Associated space	Period built	Code	Percent available
1	Counter	Gateway	Esfahani	1, 3, 4, 5, 6, 7, 10	70
2	Gateway	Counter, vestibules	Azeri	1, 2, 3, 4, 6, 8, 9	70
3	Vestibule	Gateway, porch, hall	Esfahani	2, 3, 4, 5, 6, 7, 8, 10	80
4	Porch	Vestibule, court, hot area, hall, Ivan	Qajar	1, 3, 4, 5, 6, 7, 9, 10	80
5	Court	Porch, Ivan	Qajar	3, 5, 6, 9, 10	50
6	Lighting	Court	Qajar	1, 8	20
7	Eastern hot area	Porch	Pahlavi	2, 3, 4, 5, 6, 7, 8, 9, 10	90
8	Western hot area	Porch	Qajar	3, 4, 5, 6, 7, 10	60
9	Hall	Vestibule, porch, Ivan, corner, dome area	Azeri	1, 3, 4, 6, 7,	50
10	Ivan	Porch, court, hall, dome area	Azeri	2, 3, 4, 5, 6, 8, 9	70
11	Corner	Hall, dome area	Azeri	1, 3, 4, 6, 7, 10	60
12	Dome area	Hall, Ivan, corner	Azeri	3, 4, 5, 6, 7, 9, 10	70
13	Altar	Dome area	Azeri	1, 2, 3, 6, 8, 9	60

As shown in Table 4, the porch area and hall has the maximum relation to other spaces of the mosque, while the spaces such as the courtyard, the skylight space, the hot areas and the altar have the least connection with other spaces. Also, there are all major construction periods, as well as changes in the structure of the mosque between the parts of the mosque.
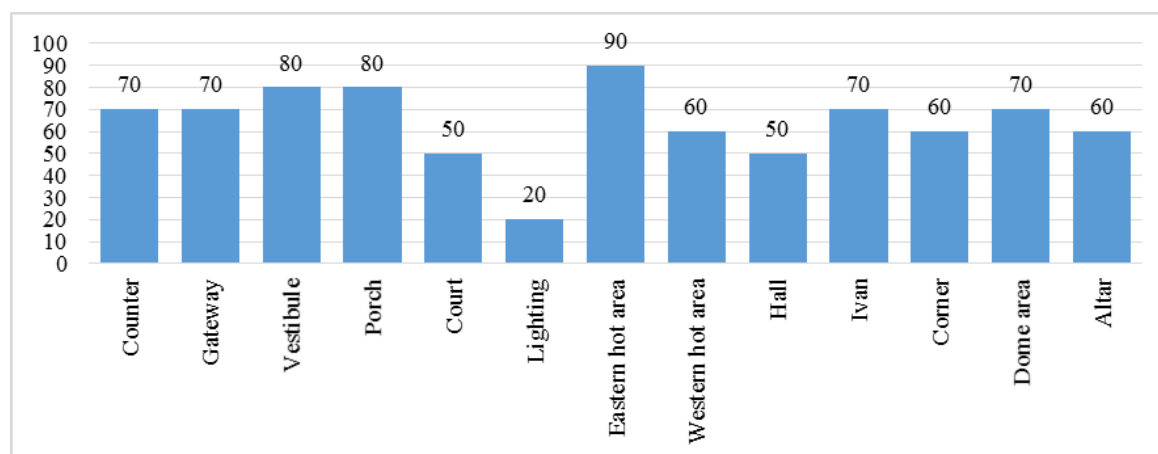
Chart 1 Frequency of spatial hierarchy in the parts of Jame mosque of Yazd (Source: Author)

As shown in Table (4) and Chart (1), eastern hot area with the highest code and the highest use of spatial hierarchy creation factors has the highest frequency (90%) among the mosque spaces. After eastern hot area, the vestibule space and the porch of the mosque with frequency of 80 percent, as well as the courtyard spaces, gateway, porch, Ivan and dome area with the frequency of 70 percent are most used to create spatial hierarchy. In contrast, the skylight space with the lowest

code and the least use of spatial hierarchy creation factors has the lowest frequency (20%). After that, mosque courtyards and halls with a frequency of 50% has the least use of the factors creating a spatial hierarchy. Hence, it can be said that the hierarchical quality of a space or the use of factors creating hierarchy in a space with the number of spaces associated with it, has no significant relationship. So the eastern hot area, which only has a porch connection, has the maximum frequency and the hall spaces that are connected with many spaces such as vestibule, porch, Ivan, and dome area has the lowest frequency.

On the other hand, by ignoring the skylight area, it can be seen that the spaces and corresponding parts in terms of hierarchical quality of space has frequency of 50 percent. Therefore, it can be said that architects of Jame mosque of Yazd, (during 800 years), in designing and constructing all the major spaces of the mosque in terms of hierarchy, from the outer space to the inner space has utilized at least half of the factors in creating the spatial hierarchy and in the set of spaces and parts more than two-thirds of these factors (total frequency 67.5 percent). This shows the high importance of the hierarchy criteria in designing and constructing of mosque spaces, religious spaces and even other environmental spaces in Iranian architecture.
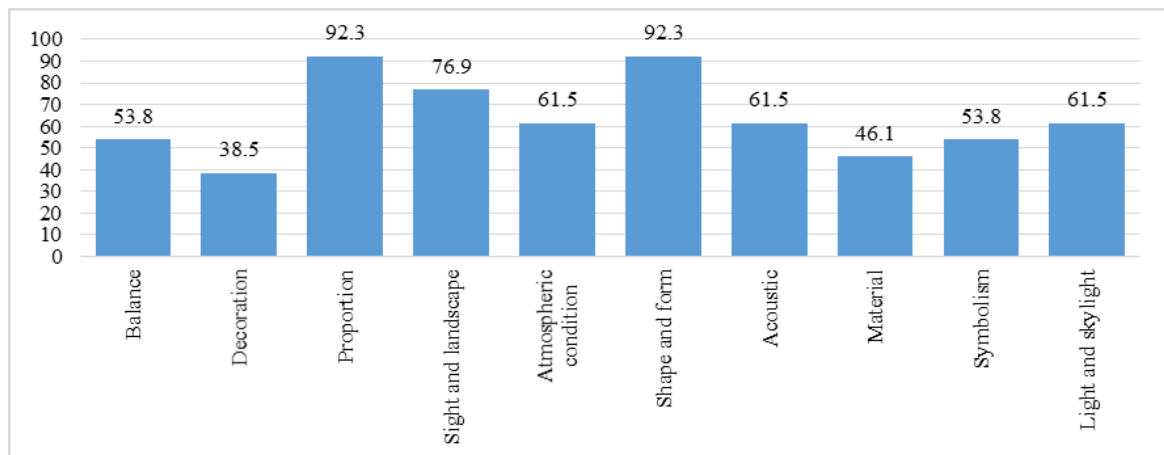
Chart 2 Factors frequency for creating spatial hierarchy in parts of Jame mosque Yazd (Source: Author)

As shown in Chart (2), all factors creating hierarchy are used in the mosque vicinity. Of course, factors such as shape and form and proportions with the frequency of 92.3 percent and sight and landscapes with frequency of 76.9 percent had the most use in parts. In contrast, factors such as "decoration" with frequency of 38.5 percent and "materials" with frequency of 46.1 percent, has the least use by the parts of the mosque. But the overall frequency of 63.7 percent indicate that architects in designing and constructing more than half of the main parts of the mosque have used these factors to create hierarchical quality, which shows the importance of all parts of the mosque in terms of quality of hierarchy.

The main factors in creating hierarchy in the mosque's parts are shape and form, and proportion and not decorations and materials. In fact, it can be said that the architects are familiar with the form and proportions, and on a macro scale it has the tools to create a hierarchy of space, and has used decorations as a space supplement on a micro scale.

5. Conclusion

As explained, eastern hot area with the highest code and the highest use of spatial hierarchy factors has the highest frequency (90%) among the mosque's spaces. The skylight space with lowest code and the least use of factors creating spatial hierarchy has the lowest frequency (20%). Hence, it can be said that the quality of hierarchy of a space or use of factors creating hierarchy in a space does not have a significant relationship with the number of spaces associated with it.

On the other hand, by ignoring the skylight area, it can be seen that the spaces and corresponding parts in terms of hierarchical quality of space has frequency of 50 percent. Therefore, it can be said that architects of Jame mosque of Yazd, (during 800 years), in designing and constructing all the major spaces of the mosque in terms of hierarchy, reaching from the outer space to the inner space has utilized at least half of the factors creating the spatial hierarchy and in the set of spaces and parts more than two-thirds of these factors (total frequency 67.5 percent). This shows the high importance of the hierarchy criteria in designing and constructing of mosque spaces, religious spaces and even other environmental spaces in Iranian architecture.

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Simultaneous and Durable Design of Colourful Diversity and Protective Alarms against Ultraviolet on Child's Apparel

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Abstract

Sunlight has energetic radiations like ultraviolet that exposed to it for specific time limit causes making vitamin D and bone in body. On the other hand, prolonged exposure to ultraviolet energetic irradiations available in sunlight could lead to irremediable damages such as eye and skin diseases for human beings. In this research, it is tried to create durable design using photochromic dyes sensitive to light and printing conventional process in order to safety against ultraviolet utilizing coloured diversity. To do this, polyester fabrics were put under printing treatment and printed samples were exposed to different irradiations such as sunlight, fluorescent, and D65. Finally, coloured changes were measured and compared with each other by evaluating monochromatic compounds amounts (red, blue, and yellow) of each printed sample and under mentioned irradiations. One of the findings of research is durable and effective protective alarm against ultraviolet through created coloured diversity for child's garment that was successfully obtained by conducting this research.

Keywords: Garment; Photochromic Dyes; Protective Alarm; Ultraviolet Irradiation

1. Introduction

Ultraviolet irradiation effects on human body specially causing dangerous skin disease and also protective role of garment by their coverings are among central aims of research. Although sun irradiation is essential for all kinds of lives, but if it becomes prolonged it will be dangerous and its ultraviolet irradiations are harmful for human and textiles (De, 1998). Some of ultraviolet irradiations which reached earth surface are variant considering factors such as season, time,

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climate conditions, and geographical coordinates (Dawson, 2005). Yearly, in England, about 46000 new conditions resulted from skin diseases are reported which 40000 cases are related to skin diseases that are not cancerous and 6000 cases are cancerous skin disease that finally leads to death of 2000 cases (Pearson and Mullen, 2003). In South Africa, cancerous skin diseases were increased from 1 case from 1000 which was related to 40 years ago to more than 1 case among 75 individuals (Pearson and Mullen, 2003). Regarding the significance of protection against ultraviolet, it was attempted to deal with creating protection of different fabrics and garment against of ultraviolet using different methods and chemical agents like nano TiO2 (Alebeid and Zhao, 2014; Nazari, 2014; Nazari et al, 2013), zinc oxide (Merati et al, 2017), natural compounds (Alebeid et al., 2015), polymeric materials (Carnlibel et al., 2018), utilizing fabric structure and its statistical analysis (Azeem et al., 2017), and also length and twist of fiber (Wong et al., 2016).

Photochromic is technically referred to reversible colour change generated by special chemical compounds. Foresaid colour change is developed by different irradiations such as ultraviolet irradiation. In a way that, after ultraviolet omission, initial colour is appeared again (Barnfield, 2001). Colour changes resulted from photochromic phenomenon could be made because of different mechanisms (Pimienta et al., 1999; Bouas-Laurent and Durr, 2001). Photochromic phenomenon was firstly observed and reported by Fritzche in 1876 (Fritzche, 1867).

In this research, it is tried to attend child's garment durable design accompany with developing and enhancing protection and alarm announcement against ultraviolet available in sunlight using photochromic dyes. Therefore, conventional process of simple screen printing was applied and photochromic dyes were exploited in printing paste. In a way that target design was printed on fabric durably with capability of usage for several times. Afterwards, printed fabrics were exposed to different irradiations of sunlight, fluorescent, and D65 and unsuitable irradiation condition for the child worn that garment could be obtained by observing colour change and in fact simultaneous and durable design of coloured diversity and announcement of protective alarms against ultraviolet would be achieved.

2. Materials and Methods

2.1. Material

Photochromic dyes were prepared in three colours of red, blue, and yellow from HALI INDUSTRIAL CO., LTD.; in China. Dyes were appeared in the environment without sunlight irradiation as colourless (Fig 1-a) and under sunlight irradiation as colourful (Fig 1-b) and this change is reversible. Also binder and acraconz synthetic thickener were provided from Pervyj Ukrainskij Market Himicheskogo Syrya Company of china. Polyester fabric was prepared from Yazdbaf company related to Iran with technical specification of plain weave 100% polyester fabric with warp density 36 yarn/cm, 30/1 Ne, weft density 24 yarn/cm, 30/1 Ne, and fabric weight of 118 g/m2.

a.   before exposure to sunlight   b.   after exposure to sunlight

Fig 1 Photochromic dyes prepared from china

2.2. Equipment

To spread and pull printing paste on screen netting, squeegee (Figure 2), and silk screen (Figure 3) were applied. Basic piece in silk printing is silky net which had different mesh numbers and one scientific table based on printed object but it is utilized to number 50 for printing fabric in simple method, 50 to 90 for ordinary functions, 90 to 150 for elegant designs, and 150 to 200 for very accurate performances such as printing electronic circuits. There are very small pores in net to pass colour paste that should be immediately cleaned during and after finishing of printing treatment by thinner to remove any effects of colour in pores.

Fig 2 Utilized squeegee
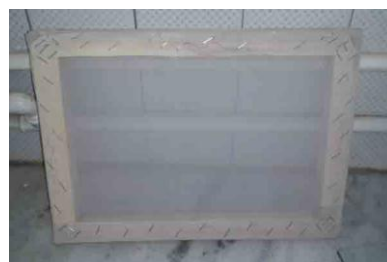
Fig 3 Utilized silk screen for printing

SX40 HS camera (Figure 4) was applied to xerography of printed polyester fabrics. SX40 HS camera exploited from CCD 14.1 megapixel image sensor. SX40 HS is equipped with 12.1 megapixel sensor but of backside illuminated CMOS type which presented higher quality and sensitivity former models sensor. Therefore, suffix of this kind of camera is HS that means High sensitivity. Full HD taking photography is a capability of SX40 HS.

Fig 4 SX40 HS camera

To conduct the research, light cabinet was used with different simulated irradiations of sunlight, fluorescent, and D65 that characteristics are presented in Table 1.

Table 1 Characteristics of irradiations available in light cabinet

Lamp type	Watt	Company name	Country
Fluorescent	**40**	**SIBALEC**	**Indonesia**
D65	**18-20**	**Pars**	**Iran**
Sunlight	**20**	**GE**	**America**

3. Discussion on Results

3.1. Photochromic Red Colour Component Measurement in Printed Polyester Fabrics

Printed polyester fabrics were set under printing treatment by utilizing acraconz thickener and red photochromic dye and through silk screen conventional method. In continue, printed samples were exposed to different irradiations of sunlight, fluorescent, and D65 and also exposed to any irradiation. Images are illustrated in Fig 5.

Also red photochromic dye was broken up to basic colours through CS6 software and numerical amounts of each of them were measured and revealed in Fig 6.

Polyester fabrics	No irradiation	D65	Fluorescent	Sunlight
Red				

Fig 5 Colourful images of red spectra in printed polyester fabrics with photochromic dyes and under different irradiations

	Sunlight	Fluorescent	D65
CYAN	22	35	36
MAGENTA	98	47	34
YELLOW	51	29	23
KEY	5	1	0
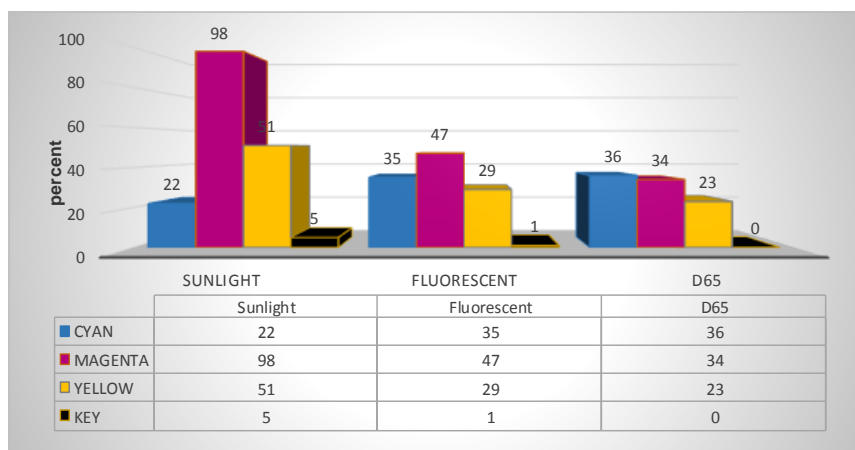
Fig 6 Amount of red colour component in printed polyester fabrics and under different irradiations

Also it is observed in Fig 6, highest amount of red colour (98) is occurred under sunlight irradiation and less amount of red colour (34) is occurred under D65 light source. Medium amount of red colour (47) is presented under fluorescent irradiation. Obtained results are in desirable accordance with shown images in Fig 5. In a way that part of sunlight involves ultraviolet irradiations and as long as printed polyester sample is exposed to it, red photochromic dye was more appeared and this could be appropriate warning for a child to prevent and hinder ultraviolet harmful irradiations.

3.2. Photochromic Blue Colour Component Measurement in Printed Polyester Fabrics

Polyester fabrics were put under printing treatment by using synthetic thickener and blue photochromic dye and in continue, printed samples were exposed to different irradiations of sunlight, fluorescent, and D65 and also exposed to any irradiation. Images are exhibited in Fig 7. Then blue photochromic dye was broken up to basic colour through CS6 software and numerical amounts of each of them were evaluated (Fig 8).

| Polyester fabrics	No irradiation	D65	Fluorescent	Sunlight
Blue				

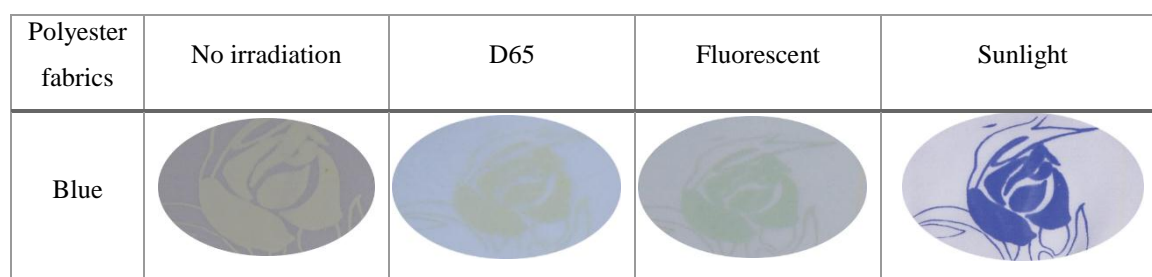**Fig 7** Colourful images of blue spectra in printed polyester fabrics with photochromic dyes and under different irradiations

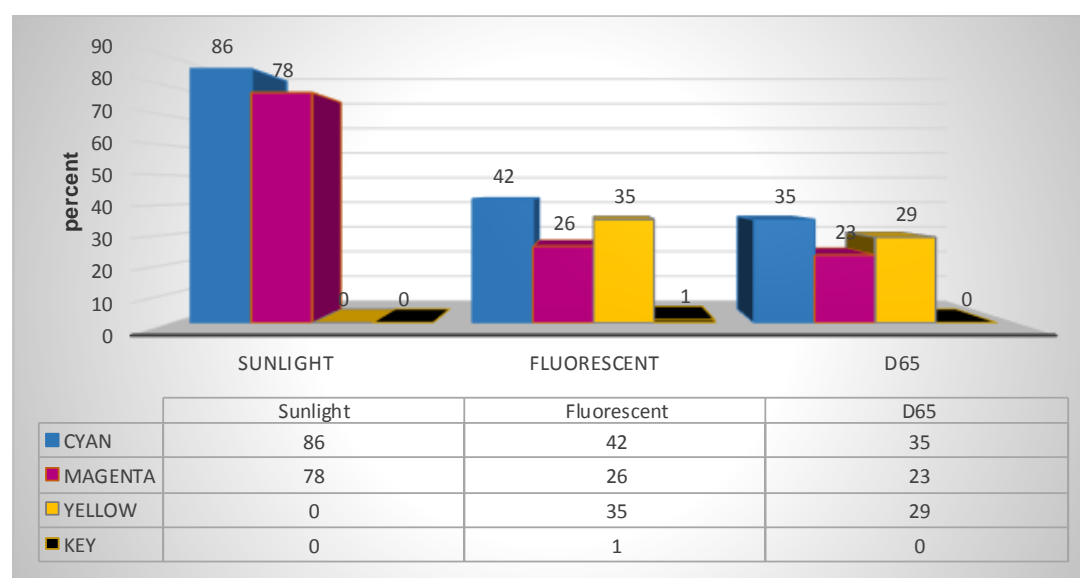|	Sunlight	Fluorescent	D65
■ CYAN	86	42	35
■ MAGENTA	78	26	23
□ YELLOW	0	35	29
■ KEY	0	1	0

Fig 8 Amount of blue colour component in printed polyester fabrics and under different irradiations

Also it is implied from Fig 8, highest amount of blue colour (86) is happened under sunlight irradiation and less amount of blue colour (35) is happened under D65 light source. Medium amount of blue colour (42) is emerged under fluorescent irradiation. Resulted findings are in suitable adaption with images illustrated in Fig 7. Some of sunlight includes ultraviolet irradiations and since printed sample is exposed to it, blue colour photochromic dyes are more appeared and this could be acceptable warning for hindering ultraviolet irradiation and also desirable colourful diversity is made because of different irradiations.

3.3. Photochromic Yellow Colour Component Measurement in Printed Polyester Fabrics

Polyester fabrics were printed with acraconz synthetic thickener and yellow colour photochromic dye, then were exposed to different irradiations of sunlight, fluorescent, and D65 and also exposed to any irradiation (Fig 9). After that, yellow colour photochromic dye was broken up to basic colour and numerical amounts of each of them were reported (Fig 10).

Polyester fabrics	No irradiation	D65	Fluorescent	Sunlight
Yellow				

Fig 9 Colourful images of yellow spectra in printed polyester fabrics with photochromic dyes and under different irradiations

	نورخورشید	نور فلورسنت	نورD65
CYAN	6	28	24
MAGENTA	38	22	16
YELLOW	100	28	15
KEY	0	0	0
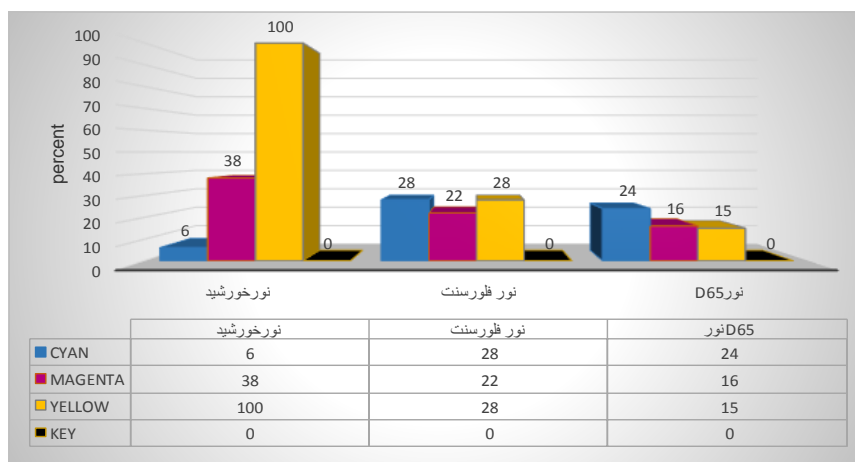
Fig 10 Amount of yellow colour component in printed polyester fabrics and under different irradiations

Based on conclusions obtained from Figure 10, it is implied that highest amount of yellow colour (100) is presented under sunlight irradiation and less amount of yellow colour (16) is emerged under D65 light source, and medium amount of yellow colour (22) is appeared under fluorescent irradiation. Acquired results from illustrated images in Fig 9 confirm that ultraviolet irradiations available in sunlight could more effectively reveal yellow colour exists in photochromic dye than other applied irradiations and are further warning for a child that used aforementioned apparel.

3.4. Children's Apparel Design

After conducting experimental and investigative researches, it was identified that the photochromic dyes have dominant characteristics of colour change and sensitivity against ultraviolet irradiation which could be applied to achieve aims and progress in culture of clothes usage specially children's apparel. Injuries consequent from ultraviolet irradiations are serious threats for children. Therefore, providing stable garment for a child holding protective characteristics against ultraviolet with considering various designs are prominent necessities and impressive challenges that are attended in this research. In a way that prepared clothes resulted from this study could avoid skin damages and are well timed warning for a child and his/her parents to made child leave the place. Based on obtained conclusions, effective role of utilizing photochromic dyes could be announced in order to alarm and warn dangerous and energetic ultraviolet irradiation. Specifically since experimental equipment are not accessible to inform presence ultraviolet in environment, it is possible to use stable designed garment colourful with photochromic dyes. In design section of this research it is attempted to regards child's apparel with attractive and update design by applying photochromic dyes in printing process in parts of clothes such as upon of hat and back of clothes which do not place ahead of child's eye and exhibit a suitable display for others and specially parents to be a punctual alarm to change child's location. As a consequence, both matter of protective alarm announcement and developing colourful diversity are presented in designs of Fig 11-15, thus remarkable variety and creativity are provided for child's garment designs. Toy like printed designs were located on back of children parka (Fig 11) and also on the parka's hat (Fig 12). If the eyes of created designs were observed colourful (Fig 11-b and 12-b), it would be demonstrator and warner of child's exposure to ultraviolet energetic irradiations and it is required to change child's location. In fact, the conception of leave of unsuitable position is conveyed to other through made innovative and ingenious designs.

    a.   Far from   b.   Under sun ultraviolet irradiation

Fig 11 Design 1 printed and designed apparel for a child

a.   Far from   b.   Under sun ultraviolet irradiation

Fig 12 Design 2 printed and designed apparel for a child

Printed designs on masculine shirt are illustrated in Fig 13 and 14 using photochromic dyes. Warning and clear changes are observed for a child (Fig 13-b) and other (Fig 14-b) when exposing to ultraviolet irradiation of sunlight that could be instantly hindered from damaging child's skin.

a.   Far from   b.   Under sun ultraviolet irradiation

Fig 13 Design 3 printed and designed apparel for a child

a.   Far from   b.   Under sun ultraviolet irradiation

Fig 14 Design 4 printed and designed apparel for a child

Spotted designs are devised for girly clothes in Fig 15. It is tried to use photochromic dyes on fabric to print each spot. Since a child is exposed to ultraviolet, white spots are turned into colourful spots (Fig 15-b). As it is perceived from created designs on child's clothes, simultaneous design of colourful diversity and warning announcement were clearly developed for the presence of ultraviolet dangerous irradiations. This means that attractive and creative designed garment for a child not only satisfy aestheticism desires in children but also, in upper level, play significant and cautionary role in protecting child against ultraviolet.

a.   Far from   b.   Under sun ultraviolet irradiation

Fig 15 Design 5 printed and designed apparel for a child

4. Conclusion

In this research, simultaneous and stable design of colourful diversity and announcement of protective alarms on child's garment against ultraviolet utilizing photochromic dyes are considered. Hence, it could be possible to declare the concept of dangerous and energetic ultraviolet presence through printed attractive and creative designs applying silk screen current method on child's

apparel. To do this, photochromic monochromes of red, blue, and yellow were used during printing process, and then printed polyester fabrics were exposed to different irradiations. An effect of sunlight irradiation was further and more obvious than irradiations of fluorescent and D65 and develops more efficient and warning notifications through child's apparel. This is related to significant existence of ultraviolet irradiations in sun light. Results from research imply achievement of stable design for a child's apparel. Therefore, when printed clothes with photochromic dyes are exposed to ultraviolet, they became colourful and they loss their colours after removing ultraviolet irradiations. This characteristic could be emerged with high numbers of repetitions and several times of exposures to ultraviolet irradiations. The reason could be related to chemical structure of photochromic dyes and their reversible aspect to primitive chemical structure.

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Green Environment Advertising to Reduce the Environmental Pollution

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Abstract

One of the problems that our communities face is the issue of environmental graphics in the cities, with respect to the pollution of environment is one of the concerns of the authorities. It is based on empirical-descriptive research. The graphic design of environmental billboards and bus stops are designed in a way that visually the design can create a sense of attraction for the audience. On the other hand, Titanium nanoparticles were used so that it can remove the colors and designs from the billboards after few days and to create new designs on them. Therefore, fabric base has been used to create the design, and the spectrophotometer was used to determine the amount of color evaporation. The results showed that the fabric used can eliminate the colors and designs created on them after some time; and prepare the base again for new advertisement with colors and designs. Therefore, the green environment advertisement was implemented.

1. Introduction

Graphic design is a type of language that has unspecified commands and is in the process of inventing extensive literal meaning. The unclear nature of its principles means that it can only be studied and not taught. The graphic work of art can be understood at times when one can percept its language (Hollies, 2002: 21). Graphic design means creating and organizing a series of visual factors to express a concept or message or information in a direction with specific purpose (Mesghali, 2011: 23). The graphic design has three types of function which are a) identity (introduction and recognition like poster design and company signage); b). Information designs

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such as chart diagrams and landmark signage; and c). Arena graffiti and advertising such as posters and city advertising (Hollies, 2002: 10).

With the expansion of urban life and the agglomeration of inner-city spaces, more problems occur. Living in big cities, especially metropolitan areas is in a way, that people spend most of their time in the outdoor space. Therefore, they are more influenced by the external environment. Hence, such type of spaces offers the best opportunity to the environmental graphic designers who can act based on the aesthetic principles of different issues. This opportunity is sometimes as a short pause, but can deeply affect the viewer (Ilukhani, 2009: 17). Environmental advertising has an effect on the customers and viewers while moving from place to place and conveys the everyday message advertisement in their places of living, work, shopping, recreation and travel (Sadr Mohammadi, 2008: 15). Historical research has shown that the consumers' attitude is influenced by advertisement. Accordingly, most of the companies have invested lot in the field of advertisement. Today, green advertising has a vital role in the field of shaping the attitudes and behavior within and outside the organization related to environmental issues (Leonidou 2014).

Green product: Green product are environmentally friendly product or products obtained from the environment, designing a product that requires less natural resources and has the least opposition with the environment and throughout the life cycle of the products (Mohtasham and Moghadamnia, 2016).

Environment means the combination of different knowledge in science, which includes a set of environmental factors in the framework biological and non-biological environment (physical, chemical) that affects the life of individual or species and gain influence from it. Today, this definition is related to humans and its activities. The environment can be summarized as a set of natural factors of the earth such as air, water, atmosphere, cliffs, plants, etc. (Ravanshadnia, 2013).

The nanostructured material referred as a material that at least one of its dimensions is nanometer scale (below 100 nanometers). This definition includes types of structures, such as man-made or nature. The study carried out here is related to new technologies or those developed through deeper understanding of the science of Nano. So, the subject of discussion is the structures of nanometer with the dimension of nanoscale. The textile industry dates back to the age of human civilization, and great clothes or relatively stable ones are their main core, but these products ranges from room curtains to recreational kite. Nanotechnology has huge potential for the production of fiber-reinforced materials with new qualities, cosmetics and sports materials. Nano-pipes may one day be as a woven nano-fiber with high strength and durability.

Titanium dioxide is also known as Titanium dioxide IV or Titanium with TiO_2 chemical formula. When this is used as a pigment, it is named as white Titanium, white pigment 6, and CI77891. Its application ranges from cream to food colors. Photocatalyst is a substance that by absorbing light causes a chemical reaction in the environment. When the UV rays of the sunlight or the room light hits the surface covered with photocatalyst, the surrounding organic material decomposes through oxidation. In this way, dust and organic contaminants, the material with odor and bacteria are removed and brings about a good cleaning property (Fili, 2008).

2. Results and Discussion

In this paper, cotton fabrics are used with the following specifications given in Table 1, and useable chemical substances are used and shown in Table 2 respectively.

Table 1 Specifications of the fabrics used

Weave type	Manufacturer	Fabric type	Weight (gm/m2)	Warp density (1/cm)	Weft density (1/cm)
Tafteh	Yazd baf	100% cotton	100	21	13

Table 2 Specifications of useable chemical substance

Substance name	Manufacturing company name	Chemical formula
Titanium Nano-Dioxide	Degussa p-25	TiO2

To cover the cotton fabric with nano materials the crosslink method was implemented and test were conducted. To cross link the nano material with cotton fabric the following steps were carried out:

After washing the cotton fabric with distilled water it is dried to remove wax and waste materials. The Succinic acid with Sodium Hypophosphite was stirred for 20 minutes to obtain a suspension. The cloth was then placed in the suspension at 70 ° C for one hour and later removed. Then the cloth was kept in the oven at 85 ° C temperature for 3 minutes, and later the temperature was increased to 180 °C and the cloth was stirred for 2 minutes to be cooked. Then the material with 1.5% nano material was prepared and the cloth was kept in it for one hour and after that put in the oven to dry. Then the fabric containing the nano material and it was prepared for subsequent test to be carried out. The range of the color fading of the fabric was measured under ultraviolet light so that the fabrics were cut in 4*4cm size and stained with Reactive Orange (Fig 1-4). The staining method was done by initially synthesizing the color with 0.1% weight. Then two drops of color was dropped on the surface of the specimens and kept for 5 minutes for the stains to dry. It should be noted that the stains uniformly covers the surface of the fabric. The specimens were exposed to ultraviolet light (UV A type) with 400 watts for 30 hours. Subsequently, samples were prepared for the experiment of reflective spectrophotometry testing to obtain a degree of color evaporation (ΔE). The results of the reflective spectrophotometer show that the ΔE of the specimen are incomplete and is lower than the completed specimen. In other words, the range of ΔE of the fabric was the most containing 1.5% of titanium nano-dioxide. The ΔE of the completed and incomplete samples is 1.78 and 18.63, respectively. Therefore, according to the test results, the poster designing for the Diety factory began and the following designs were implemented on the fabric.

These advertisements are for the billboards that are quickly read and there is much time for its analyses. So the more simple, beautiful and not complicated are designed which are more powerful and successful. To convey message or product advertising the use of attractive images with brilliant colors can be effective and help to achieve our goal.

Fig 1 Advertisements for the billboards

3. Conclusion

This paper, was carried out for designing the graphics of the city by using fabrics that were completed by Titanium nanoparticles and urban furniture (billboards and bus stops advertisement) was designed for Diety food product. The fabric was prepared by nanoparticles with dimension less than 100 nm and then tested by ultraviolet rays. The spectrophotometer was used to determine the amount of color evaporation. The results showed that the use of this fabric for advertisement can eliminate the colors and designs created on them after some time, and again prepare the base to provide new advertisement with colors and designs. In this way, plastic materials that harm the environment are not used for environmental advertising, and only one base was used for the presentation of several designs.

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Content Validation of a Checklist to Evaluate Therapists' Competency in Delivering Magic Tricks

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Abstract

The aim of this study is to describe the development and content validation of a magic performance evaluation checklist. Content validation process consisted of two stages. Stage 1 was item generation and stage 2 was item evaluation where 16 professional magicians evaluated items generated from stage 1 for relevance. In Stage 2, each magician independently rated the relevance of each item in the checklist. A content validity index was used to determine the percentage of agreement among the ratings. Stage 1 resulted in a 5-item checklist which included essential skills needed to perform magic. Each item was rated on a three-point scale. The scale content validity index of the checklist was 0.99, which was well above the set criterion of 0.8. Content of the magic performance evaluation checklist was considered relevant to evaluate the ability of rehabilitation therapists to demonstrate magic tricks which provides a benchmark of competency for them to teach magic tricks to children.

Keywords: Magic Tricks; Content Validity; Teaching; Rehabilitation Therapists

1. Introduction

Magic, a form of performing art, has been used as a therapeutic modality since early 1980s (Lam, Lam, & Chawla, 2017; Spencer, 2013). Children with disabilities have been shown to benefit from participating in learning and performing simple magic tricks (Spencer, 2012). Rehabilitation therapists have incorporated teaching magic as therapeutic activities for these children (Spencer, 2013). A recent scoping review (Lam et al., 2017) revealed that magic arts have been used

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clinically to improve upper limb function in children with motor disorders through repetitive action of practicing the magic tricks (Green et al., 2013), enhance interpersonal and communication skills of children with autism through development of appropriate social interaction skills (Spencer, 2012), improve psychosocial health of children with developmental disabilities through enhancement of self-esteem and self-confidence (Ezell & Klein-Ezell, 2003), and improve cognitive skills through planning and sequencing in executing magic tricks (Spencer, 2012).

2. Literature Review

Performing a magic trick is not simply about knowing the secret or executing the moves. Learners are required to utilize and integrate a variety of skills that result in a masterful performance to create the desired illusion (Lyons & Menolotto, 1990; Rissanen, Pitkanen, Juvonen, Kuhn, & Hakkarainen, 2014). The learner may be able to verbalize the secret of the trick and correctly execute the moves required to create "the magic"; however, it is also important for the learner to develop his/her performance skills, enabling him/her to enhance the presentation and capture the attention of the audience (Lyons & Menolotto, 1990; Rissanen et al., 2014). Therefore, learning magic tricks demands (1) motor skills to perform the trick (2) communication skills to explain the trick, (3) social skills to engage the audience, (4) cognitive skills including memory, sequencing and judgment, and (5) creativity and adaptability according to specific conditions (Spencer, 2012).

Teaching magic to children with disabilities requires a significant time commitment. Most professional magicians either do not have access or cannot afford to volunteer their time to teach these children on a regular basis. Training rehabilitation therapists to teach children with disabilities simple magic tricks is feasible. However, before teaching magic tricks to their clients, rehabilitation therapists themselves must learn the tricks and be skilled in their delivery. In order to ensure rehabilitation therapists are competent to teach magic tricks to their clients, rehabilitation therapists need to achieve a certain level of proficiency in delivering the magic tricks. Currently, no assessment tool exists to evaluate rehabilitation therapists' skills to deliver magic. The purpose of this study is to develop an evaluation checklist of magic trick performance skills for rehabilitation therapists. An important step for the development of this checklist is to validate the content of the checklist. The process involves seeking professional magicians' opinion to establish the content validity for the performance evaluation checklist.

3. Method

3.1. Study Design

The study used a cross-sectional survey research design to establish the content validity of a performance checklist to evaluate rehabilitation therapists' competency in delivering magic tricks. Content validation was completed using a two-stage process: Stage 1 is item generation and Stage 2 was item evaluation. The Institutional Review Board of the University XXX approved the study.

Stage 1: Item Generation

A magic performance evaluation checklist was generated by the first author to evaluate the rehabilitation therapists' competency in delivering magic tricks. Items generation for the checklist was based on the first author's practice and teaching experience of magic, as well as recommended principles of magic delivery in the literature (Lyons & Menolotto, 1990; Rissanen et al., 2014). The

author has more than 35 years of experience in performing magic arts and has taught magic to children with various disabilities for more than 20 years. The checklist consisted of 5 items which included essential skills to perform magic. Each item was rated on a three-point scale with 2 = Pass; 1 = Borderline; 0 = Fail. A rehabilitation therapist received either a borderline or a fail score on an item that needs to be retrained and reevaluated. The checklist was slightly modified and endorsed by the second author whose expertise is in psychological instrument development. The items in the checklist were then evaluated by a panel of professional magicians in stage 2.

Stage 2: Item Evaluation

Participants

Twenty professional magicians were recruited to participate in this stage to evaluate the items on the magic performance competency evaluation checklist. These magicians were selected by the first author from the database of the two largest organizations dedicated to the art of magic -- the Society of American Magicians and the International Brotherhood of Magicians. These organizations represent approximately 7,500 individuals. Since the recommended number of judges / raters for content validation was within ten, the first author selected 20 magicians from the database and invited them to participate in the study. All 20 magicians are acquaintances of the first author.

Procedures

The purpose of this stage was to assess the relevance of each of the five items on the newly created performance checklist to evaluate rehabilitation therapists' competency in delivering magic tricks. A cover letter explaining the purpose of the study with the performance checklist and a short survey was sent to 20 professional magicians via e-mail that requested them to evaluate the relevance of the five items in the checklist. The survey consisted of six questions that sought descriptive information regarding magicians' demographic information (gender, city and country of residency) and professional background (magic training background, years of experience as a magician and teaching magic experience). Completion and submission of the evaluation checklist and the survey back to the investigative team indicated consent for participation in this study.

Magician respondents (i.e., panel members) were requested to independently rate the relevance of each of the five items in the magic performance evaluation checklist using a four-point rating scale: 1 = not relevant, 2 = unable to assess relevance without major revision, 3 = relevant but needs minor alteration, and 4 = very relevant and succinct. Panel members were encouraged to highlight words or portions of the item descriptions that were unclear and use the comment column to suggest alternate phrasing. Panel members were also asked to appraise the rating scale for the checklist including the number of response options and verbal qualifiers.

Data Analysis

The data were analyzed for item relevance by determining the percentage of agreement among the ratings of the magician respondents using the content validity index (CVI) (Lynn, 1986). The formula to compute the CVI for item relevance was: the number of experts giving a rating of 3 or 4, divided by the number of magicians in the panel. The criterion to retain an item was set at 80% which required 13 of the 16 magician respondents to provide a rating of 3 or 4 on the item (i.e., item-CVI $\geq$ .80).

4. Results

The response rate was 80%. The sixteen magician respondents were from various geographical regions in the United State: Northeast (1) Midwest (5) South (6) and West (3), as well as one from

Canada. The mean and standard deviation (SD) years of the panel's work experience as a magician was 31±13.5 years, median = 35 years (range: 6 to 50 years). Eleven (69%) of them were male, 13 (81%) learned magic through self-taught, and the same number of magician participants reported that they received some informal mentoring such as from other magicians, and/or learning magic tricks in conventions and/or club meetings; and half of them also reported to receive some formal training such as attending (online) courses. Fourteen (88%) had some experience in teaching magic, and their years of experience in teaching magic ranged from none (1 respondent), a few months to 27.5 years (with the mean and SD = 7±9 years, median = 3 years).

Main findings

Using the CVI ≥ .80 criterion, the scale-CVI of the magic performance evaluation checklist, which is the average of the item-CVI of the 5 items (Polit, Beck, & Owen, 2007), was .99; four items achieved unanimous agreement (CVI = 1), item 3 had a CVI of .94 (see Table 1). The panel members also provided suggestions, though minimum, on the wording of the items and the rating scale or response options of the checklist. For example, one participant suggested adding the phrase "in a natural way" at the end of the item 3 statement.

Table 1 Item evaluation of the magic performance evaluation checklist by professional magician participants (n=16)

Items	Task	No. of members given a rating of 4	CVI
1	The rehabilitation therapist recalls the sequential steps without delay.	13 (81%)	1
2	The rehabilitation therapist performs each step correctly.	14 (88%)	1
3	The rehabilitation therapist performs each step smoothly.	11 (69%)	.94
4	The rehabilitation therapist performs the magic trick without exposing the secret.	13 (81%)	1
5	The rehabilitation therapist presents the trick with some finesse.	14 (88%)	1

CVI = Content Validity Index

5. Discussion and Implications

This study employed a two-stage process to establish the content validity of the magic performance evaluation checklist. The process used professional magicians to review the checklist to establish the veracity of its content. The checklist achieved an excellent scale-CVI value of 99. The number of judges (i.e., magicians) used to establish content validity for the magic performance evaluation checklist exceeded the 10 recommended in the literature (Lynn, 1986). Several participants commented on the rating scale or response options and verbal qualifiers of the checklist. They pointed out that the intent of this checklist was to evaluate magic delivery competency of the rehabilitation therapists who teach children magic tricks, and these rehabilitation therapists were not professional magicians; therefore, even if they achieved a borderline in items 3

and 5, it would not affect their competency to teach magic. However, the counter argument was that it is essential for the rehabilitation therapists to display competency in these two areas (i.e., items) to earn the respect of the student. After considering all comments, it was decided to keep the rating scale as it was originally developed. The diversity of the magician participants in terms of gender, professional and teaching magic experiences, as well as broad range of geographic location, make this sample more likely to be representative of the whole magician population.

The findings of this study have the following implications for magic training practice of rehabilitation therapists who wish to use this activity as a therapeutic modality:

- The five items in the magic performance evaluation checklist reflect essential skills that rehabilitation therapists should achieve before teaching their pediatric clients.
- Preliminary evidence supporting the content validity of the checklist confirms that the content is suitable to evaluate the rehabilitation therapists' competency in delivering magic tricks.

One limitation of the study was that the process of content validation did not include a pilot testing stage in which professional magicians observe rehabilitation therapists deliver the magic tricks and evaluate their competency. However, construct validation of the checklist is underway which aims to establish the psychometric properties of the magic performance evaluation checklist, which will involve inter-rater reliability, factor analysis to evaluate the structure validity to ensure the items in the checklist are consistent with those originally envisaged in the content validation phase.

6. Conclusion

This study used professional magicians' input and review to establish the content validity of the magic performance checklist for evaluating the rehabilitation therapists' competency in delivering magic tricks. The 5-item checklist included essential skills needed to perform magic, and each item was rated on a three-point scale. The scale content validity index of the checklist was 0.99, which is deemed to be excellent. In conclusion, content of the magic performance evaluation checklist was considered relevant to evaluate the ability of rehabilitation therapists to demonstrate magic tricks which provides a benchmark of competency for them to teach magic tricks to children.

Key findings:
- Preliminary evidence supporting the content validity of the magic performance evaluation checklist which is used to evaluate the rehabilitation therapists' competency in delivering magic tricks.

What the study has added:
Develop an instrument to evaluate the rehabilitation therapists' competency in delivering magic tricks.

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