The Life Giving Properties in the Structure of the *Ganjali-Khan* Square in Kerman based on Alexander's Theory of Order

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Abstract

In reviewing the case studies of traditional architectures according to Christopher Alexander's theory on "the nature of order" and the fifteen fundamental properties introduced, it is important to note that the ontology of the theory is based on human's indigenous feeling about architecture, which subsequently implies these kind of studies to be based on people's cognitive images induced from architecture. In this regard, this paper has examined fifteen properties that make structures alive, in *Ganjali-Khan* square in Kerman. The presence of the fifteen properties of the living structures in the square and their mutual relations were studied along with the generalizability rate of alexander's theory to the square, with a quantitative approach and a comparative study method, based on the formal and structural analysis.The purpose of this study is to evaluate the generalizability rate of this theory on the urban public space from the observers' perspective present in the square to find out its life giving features leading it to eternality. The results show that the fifteen properties of the living structures are visible in the square. However, the feature of roughness is less visible, due to its restoration process. Hence, the *Ganjali-Khan* square is an urban public space in conformity with Alexander's theory on the nature of order with all its structural and formal features and their mutual relations in the observer's eyes; which make it consistent of the properties that define it as a high quality living structure.

Keywords: Nature of order, Living structure, Generalizability rate, *Ganjali-Khan*, Kerman.

1. Introduction

Alexander's theory on the nature of order which is mainly based on the two concepts of "wholeness" and "strong centers", is developed in compliance with the formation of desirable, or alternatively described as alive or eternal, architecture. Despite some critical views from some theorists, this theory provides a strong basis for designing or redesigning buildings. Fifteen properties which are in mutual relationship with each other, are introduced in this theory that are consistent for all living structures and yet take different appearances due to different time and place related conditions. Therefore, it is necessary to study these properties and their manifestation in architecture of every city and country in different periods of time. This work will also act as a theory testing in different grounds and will evaluate the ability to extend and apply the theory to other sample cases. This test and evaluation is important, specifically for case studies from traditional architecture built in the pre-modern period; due to their high desirability in respect to other buildings.

Therefore, by inspecting Alexander's theory about the nature of order, this study analyzes the ways and means of the presence of these properties in architecture of a city space, focusing on the Ganjali-Khan square in Kerman. Subsequently, conformability of the square with the theory is put to test by studying the mutual relation of these properties in the square and their strength or weakness of presence. This study will be finally lead to determination of life-giving properties which can make the square perpetual.

2. Literature Review

Seamons (2007) presents a commentary on Alexander's theory of order based on the view of theorists like Henri Bortoft. He declares that Alexander's theory of order should be acknowledged as based on significant; that is because it's authored on the basis of seeing and feeling. Yet, the fifteen properties sometimes fail to be generalized to architecture, being more reflected in other arts such as carpet or handmade crafts. Besides these critiques, there are others that believe Alexander's theory of order could be generalized to all natural and artificial existence such as architecture and he city itself. However, the study of the fifteen properties discussed in the order theory are rarely considered in the case studies of the researchers and analysts of the theory; and the little existing studies have hardly considered all of the properties in their case study. The most inclusive case studies in this regard are carried out by Alexander himself. However, as mentioned, all the cases are not assessed by all of the fifteen properties together, but are rather evaluated by the most prominent feature. Amongst these studies, Hedayatnia (2013) has evaluated the presence of these properties in the physical and spatial evaluation of Qurtan Castle. The results of this research shows that the Iran desert traditional architecture match Alexander's theory of order. Hatefi Shoja (2015) has studied the conformity of Chahar Bagh and other Isfahan's gardens with this theory. This research is mostly based on the plans of the case studies which has led to ignorance of some properties which could not actually be

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conceived by plans only. The research comes to this conclusion that from the fifteen properties, the levels of scale, strong centers, boundaries, positive space, alternating repetitions, echoes, and good shape are the most prominent features in Isfahan's gardens including the Chaharbagh type. Focusing on the plans in such an analysis of the samples, results in the failure of the study of the properties according to Alexander's theory. This is because, due to this theory, the environmental perception and experience of the observers from the fifteen properties is of high importance and it may not be able to be fully considered in the plan-based analytics. The importance of this issue has been discussed by Bauer (2014). Evaluating the fifteen properties and their capability of giving life to the structures, he believes that the ways and means of designing a living work needs generalizing these properties from the structural space to the cognitive space by which the correct use of this theory would be made possible in perception, memorization, assessment and evaluation. According to this, Bovill (2012) has evaluated the tile work of Mirza Akbar, with this notion that these properties should be conceived by all audience of artworks. Although Alexander has used different examples to explain these properties and their indications and has studied them in detail, a researcher may still face ambiguity in their inspection. On this account, Takashi and Shingo (2014) have represented these properties in graphical charts using correspondence analysis, a statistical technique providing graphic representation which provides more clarity for related studies. In this regard, Petrusevki (2012) studies this theory in accordance with the generative design methods, such as fractals and cellular automaton. He believes that the fifteen features, although not all the same, have reflections in these methods.

The present research, being in line with these kind of studies, evaluates the Ganlali-Khan complex by the aspect of life and order; aiming to fill in the gaps of the studies in this field in its approach. For this aim it addresses an urban space as a case study and focuses on the observers' perceptive and cognitive space to assess the fifteen properties that are noticeable by the audience in their experience of the different dimensions of space.

3. Methodology

The purpose of this research is to study the fifteen features discussed in Alexander's theory on "the nature of order" in Ganjali-Khan square in Kerman. Being based on a case study, and with a focus on meanings the researach has a qualitative approach. This approach is the most appropriate attitude, for research works, such as this one, that relate to the human behavior and his perception and impression from the urban and architectural space around him. The research also has a structuralist attitude towards Ganjali-Khan square according to Alexander's approach in his theory of order. By such an approach, and based on the definitions and examples that Alexander presents in explaining the fifteen properties of order, the Ganjali-Khan square is studied by formal and structural assessments. The purpose of this assessment is to evaluate

the rate of the conformity of the square with the theory of the nature of order. Hence, the research is a comparative analogy between the theory of order and the square, by which the discussion and conclusion about the questions towards the mission of the research would be made possible.

4. Theoretical Structure

The ontology of the theory of "The Nature of Order", presented in 2003-2004, is based on the combination of two thoughts. First, the neglect of pluralistic values, integrated with subjective or objective phenomena; and second, lack of correspondence between Alexander's worldview and alternate experiences, and social, political and economic facts. Hence, the proposed ontology of Alexander is based on these two assumptions and indicate that the timeless way of building in architecture is the one route to build a beautiful environment. Although, the epistemological aspect of his theory is also based on reasonable scientific method (Dawes, Ostwald, 2017: 5) The lowest level of abstraction in this theory is based on Alexander and his group's observations in twenty years, from nature, living things and manmade artifacts that haven't lost their attractiveness and immortality thorough time. (Akbari, 2012: 3) The reason that the theory is based both on living beings and lifeless artifacts is basically rooted in a common feature which Alexander defines as "livingness". More explicitly, the basis in the beginning of alexander's studies in defining the best way of design in architecture and urban design which results in a longstanding work, include what he calls alive, different from the definitions of the empirical sciences. In Alexander's definition of the feature of "living" it is noted that the terms "living" and "not living" should be distinguished. The words "living" in this theory goes beyond an empirical definition and actually relates to coherence between "the inner forces of any entity". This is exactly why lifeless beings, can be called alive if they have come to a degree of balance on their inner forces, which would evoke the sense of life and vitality in human's livings. Naturally, the more balanced the inner forces, higher would be the degree of livingness, and consecutively, the deeper the feelings evoked. (Alexander, 2004: 25-32) All human beings, regardless of any conditions, and merely because of this feeling evoked in them, can distinguish the living entities from the others. This happen regardless of that entity being biologically a living species or not. Therefore, the assessment of a manmade artifact being alive is settled for all humans, but there are disagreements on the calculation of the degree of livingness. However, this disagreement does not reach an extent by which one thing could be called alive by one and lifeless by another. (Alexander, 2004:50-58). According to Alexanders views, the stimulation of this deep feeling which indicates a deep objective quality and not a subjective one, is the reason to designate the phenomenon of life to them. On this basis, it can be concluded that the degree of livingness for the structures are in correlation with men's inner feelings; because, in alexander's terms, ten percent of human feelings are

personal and ninety percent are intrinsic and common. (Rahmani, Nadernejad, 2012: 9-13) The next stage in studying whatever is counted as alive, is where alexander proposes the two concepts of "Wholeness" and "centers". These two concepts are brought up with the aim of answering this question that: What is it that makes one to find a thing to have "life". In the first concept, wholeness, Alexander notes that these things are presumed alive and able to support life because they act as a whole. This wholeness has actually two meanings. First, that is the item itself is not an independent entity from the world that surrounds it, but rather a part of the surrounding world system that acts as a whole for it. Second, this item, being a part of a whole, is itself a whole two. In a simpler expression, it is itself a whole that is made of the combination of other components and it is very likely that each of these parts are a whole made of parts within. (ibid) This wholeness has three important features: 1- The whole is not divisible and separable to its constituent parts. 2- The relation between the parts does not have any limits and is continuous. 3- The behavior, character and structure of every component follows the whole. The second concept is "centers". This concept can also be defined as a constitutive feature of the concept of wholeness. (Alexander, 2004: 84) Alexander calls these parts "centers". The main reason for this suggestion is that every one of these parts are a focus point in a bigger whole and every center is actually an indication of a

designed area in space. (Alexander, 2004: 80-85). Alexander then tries to answer what pattern or patterns lead to formation of a center and what turns these centers in correlation to a whole that its main feature is livingness. These patterns basically express the relation of elements within a system. Additionally, they provide the appropriate means for production and organization of a structure. (Salingaros, 2017: 12-13) This stage, and the two questions above, can scientifically provide a structure or criteria which could help to evaluate the strength of the relationship between the components and thus, the degree of balance between the inner forces and the degree of the item's livingness. These are introduced as "fifteen structural features" consistently "appeared in things which do have life" by alexander and are as follows: "1- (The simultaneous presence of the) levels of scale, 2-strong centers, 3- boundaries, 4- alternating repetitions, 5- positive (or well-shaped) space, 6- good shape, 7- local symmetries, 8-deep interlock and ambiguity, 9- contrast, 10- gradients, 11- roughness, 12-echoes, 13- the void (or negative or empty space), 14- simplicity and inner calm and 15-not-separateness." (Alexander, 2004: 144) The theory of Alexander is basically aimed at finding a solution to a beneficial, yet lasting and eternal architecture. Thus, based on his views, it could be claimed that a building is lasting and eternal when it has the feature of "livingness" and this is not achieved unless the building is designed by the nature's rules.
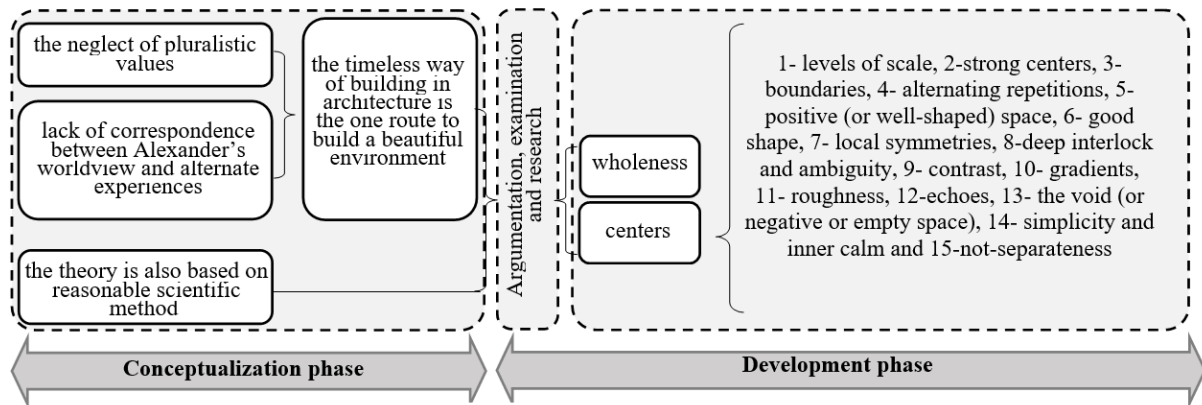

Fig. 1. The Graphical Representation of the Theory of the Nature of Order

5. Case study: Ganjali-Khan Square

The Ganjali-Khan complex consists of a wide and rectangular square with 50*100 m dimensions which is also famous as Khan's square. At the four sides of this square are important public or semi-public buildings such as a caravanserai in the eastern side, a mosque in the north-east side, bathhouse in the south, water reservoir and school in the west and a mint in the north. (Pirnia, 2008: 327-329) The square is surrounded in three sides by the Bazaar's passages and a *chahar suq*.
The position of the square between the north-east and the east-west passage, has made it one of the most important city centers at the intersection of crossroads from the city's main gateways. Additionally, the documents show that this complex was developed aiming at expansion of the bazaar to the east and the connection of the old section

of the city to the northern newly built section. (Javadi, 2008: 38, 167) This complex is all part of the endowments of Ganjali Khan, the governor of Kerman (between the years 1005 to 1029 Ah), and has been designed and built by Soltan Mohammad (Memar) Yazdi by his command. (Shayestehfar, Khaleghzadeh: 2015: 96) The Ganjali-Khan complex was also the third biggest city square at its own time. Its approximate area was 1.17 times bigger than the Naghshe Jahan square (Bastani Palizi, 2008: 193) and it is simpler. Yet, it counts as one of the biggest projects of the Safavid government outside the city of Isfahan. (Shayestehfar, Khaleghzadeh: 2015: 95) The date of formation of the square is 1005 A.H. (equivalent to 975 Hijri and 1597 A.D.) which is approximately equivalent to the time of the construction of Bazaar. After the square itself, the school is the oldest building in the complex

(1007 A.H., equivalent to 977 Hijri and 1599 A.D.). Nearly thirteen years later, (1020 A.H., 990 Hijri, 1612 A.D.) the Ganjali-Khan bathhouse was built. Then in one year later the caravanserai and the water reservoir were added. Generally, it can be claimed the Ganjali-Khan complex has been made throughout the years 1005 to 1029Ad. (Bastani Palizi, 2008: 167). The general form of the square is a four-porch plan in which the porch (Eivan*)* belonging to the caravanserai is deeper and taller. The other three Eivans belong to the entrance of the mint, school and the bathhouse which have little difference in height with the roof line of the other facades. What distinguishes these three Eivans from the surrounding arcades is the tile work ornaments. The three northern, western and southern facades of the square are one storey building facades, but the eastern wall of the square which belongs to the caravanserai's facade is a two storeys facade; which explains the elevated height of the Eivan in this side. According to the mentioned information, the main axis of the square is the east-west axis and the secondary axis is the north-south axis which almost crosses over the main axis. The northern side of the square is a one storey facade which its central arch being wider and taller than the others and decorated with tile work defines the entrance to the mint. The other significant element in this wall is a windcatcher (*badgir*) which is also the tallest element of the square. This windcatcher is four-sided and the stalk is decorated with brick and tile work. The eastern wall is the highest facade of the square which is built in two storeys and the opening in the central arc signifies the entrance to the caravanserai. This facade, like all the other ones is covered with brickwork and the spandrel in all arcades are decorated with tile work. The western facade of the square is built in also one storey and its connection with the two northern and southern facades is made with an arch with a forty-five degree angle. The southern facade also has rows of arcades which their central arc is higher and wider than the others and distinguished with tile work and defines the entrance to the water reservoir. Another significant element in this façade is the brick dome which shows the location of the bazaar's Chaharsuq to the one standing in the square. The southern façade of the square can be called symmetrical to the northern façade by the main (east-west) axis of the square, which does not include the windcatcher. The intersection of this facade with the western facade of the square defines the bazaar's *chaharsuq* by which the intersection point of the two sides is built as a forty-five degree bevel.

6. Fifteen Main Properties of Living Structures in Ganjali-Khan Square and their mutual relations

These fifteen properties can be described as "fifteen ways in which centers", as focusing points within a bigger whole, "help each other come to life". (Alexander, 2004: 145). These properties are as follows:

6.1 Levels of Scale

By this feature, the living structures have a variety of different scales. In simple words, one can observe all four well-marked levels of scale as big centers, middle-sized centers, small centers and very small centers within them. (ibid) So, for the centers to be alive, it is not preferred to merely have a wide range of different sizes; but rather to have a continuum of big scale centers with big dimensions to small scale centers with small dimension. This spectrum of scales brings continuity between the components making a whole. This continuity should be caused by the contribution of it defines center with a specified scale in defining centers with bigger or smaller scales. So it is very important for having different levels of scale that the difference between the various scales not to be too much. (ibid, 146) This feature is also discussed by Salingaros (2006). He acknowledges the necessity of the use of hierarchy in the scale and measures as originated in the necessity of the existence of environmental data for the observer in any distance of location with the environment. (Salingaros, 2008: 50-51) On this basis, the Ganjali-Khan square is in the biggest scale, a central open space with four rectangular cube blocks which are in similar heights in the three northern, western and southern facades and taller in the eastern side, and with four significant elements defined in it as the portal to caravanserai (east), windcatcher (at the north), and chaharsuq's dome (southwes) . This is the image of the whole which is visible in the macro scale and at distant points from the square. In a closer distance, what is visible through the middle scale is this image that the arcades in the three similar faces and the two storey arcades in the eastern face has made them closer to human scale. Additionally, in this scale, details such as the color change in the bricks by the portals and at the forehead of the arcades in the eastern side is recognizable. A slight view of the domes used as the roof cover in the three similar sides can also be acknowledged as the skyline. After this middle scale, in the small scale, the details of brickwork, subtle differentiation of colors, specially, in the tile work and most important of all, is the recognition of the patterns and designs used in the decoration of the square walls. These details include very small scale dimensions; examples of which can be seen in the decorations of the entrance portal to the caravanserai. Table 1

6.2 Strong centers

"We find that the various wholes which exist at different levels appear not merely as centers or "wholes" or "blobs", but rather as *strong* centers". (Alexander, 2004: 151) The living structures are not alive just because they have centers, but it is their feature of having strong centers which turns them into a living whole. These centers are not called strong, just because of their shape or form, but rather depending on their located position and their geometrical qualities. Additionally, the relation of the centers in a living structure is very important; because each center should help to define the other center or centers for all to be able to enroll as strong centers in the structure as a whole. There are conditions for recognition and development of strong centers in living structures which symmetry is one, not as a necessity. But the most

feature which makes strong centers can be defined as such: The ability of these centers in defining an area as a delineated boundary. By this definition, the Ganjali-Khan square has centers with various scales which define each other. These centers act as the strong centers of the square, due to their bigger height, symmetrical layout, the use of material that are different from the ones used in the context, and specially, defining distinguished functions such as an entrance or an intersection in the complex. The strongest center in the square, featured by the position of location and its formal traits, is the portal of the caravanserai. This portal is the strongest center of the complex due to its height, decorations and the position in the main axis of the complex which is also defined by the other three portals in the northern, western and southern faces. Although, the windcathcer in the northern side and the dome as the roof cover of Chaharsuq in the southwest of the square should also be counted as strong centers due to their formal traits.

Between these two elements, the Chaharsuq dome is in more compliance to the definition of strong center because of its position and being defined by the smaller domes as roof covers of bazaar. The windcatcher is only defined as a center by height and being located next to the portal of the mint. Thus, these two outstanding elements are in second line of importance because of their location and also the portal being marked as the entrance to the caravanserai. Besides these elements, in the third level, are two portals with tile work in the northern and southern facades are also counted as strong centers of the square, which in turn define the position of the mint and the bathhouse. Additionally, these two centers also act as strong centers because of their difference, although little, in height in comparison with the other facades, the greater height of the dome covering the related span and also because of the difference in their facade materials. Besides to these portals, the domed space in the northwest side, which is the point of intersection of the two northern and western passageways of the bazaar, also count as strong centers of the square, due to the distinguished height of the dome as it is viewed from the observer in the square. The fountain pool (*howz*) in the middle of the courtyard is also another observable strong center in the square, due to its location and definition as the approximate central point of the square. Based on these observations, the strong centers defined in the Ganjali-Khan square is depicted in the image below which shows the important physical and functional positions. Figure. 2

6.3 Boundaries

The boundaries of centers follow two purposes: It helps concentrating on the center and it separates the center from the world beyond. (ibid: 158-159) boundaries surround, enclose, separate and connect the centers by a variety of geometric ways, having one vital common feature which is being "of the same order of magnitude as the center which is being bounded." (ibid: 159) This general definition of a feature lets us to recognize it in different scales in the living structures. Generally, each boundary can include one or more boundaries within its

subsets. By this feature and its definition, the largest scale of boundaries developed in the square, is bounding the limits of the square as a strong center and an open urban space with four walls. The second boundary which separates the centers from their surrounding walls, is the boundary shaped by the material difference. Thus, the four portals are separated and distinguished from their context as strong centers, due to the change of materials used in them. This is the kind of which has smaller boundaries within. Examples of these boundaries are observable in the images below. Table 2
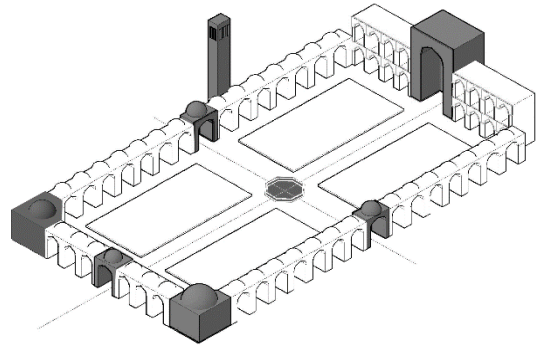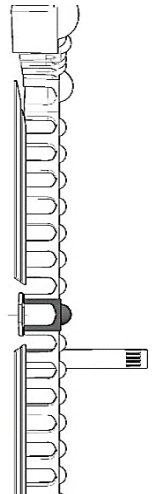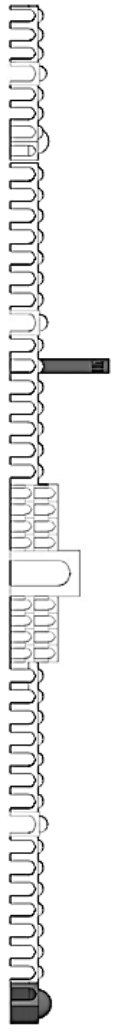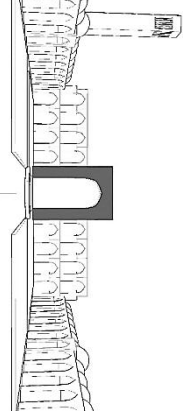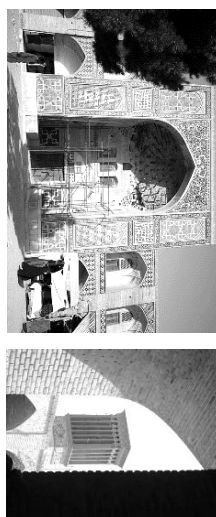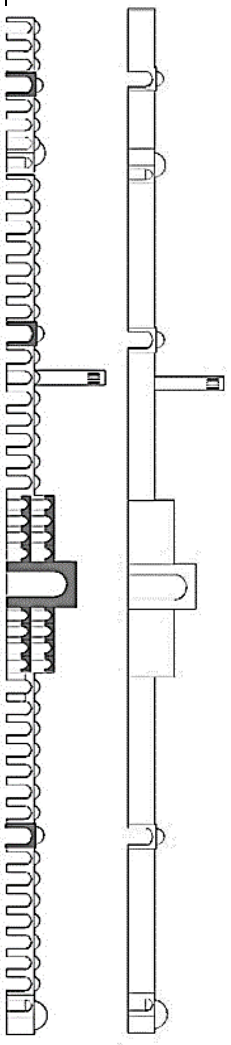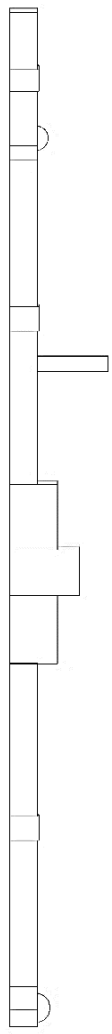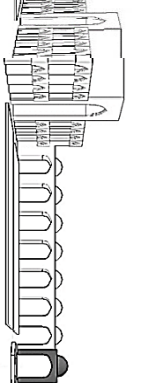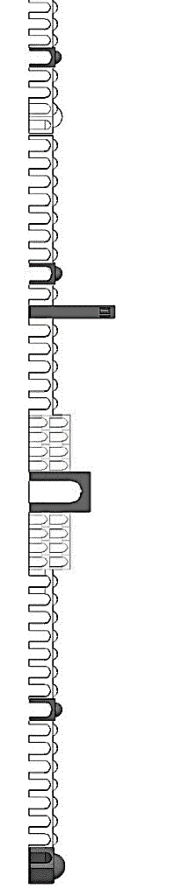

Fig. 2. Strong Centers in the Square
(Source: authors)

6.4 Alternating Repetition; Rhythm

Centers help each other by repetition. (ibid: 165) But what brings life to the overall structure in this repetition, is the correct suggestion of a center by definition. The method of repetition is also important here: repetition and alternation should happen in the same direction; that is horizontal or vertical. Simultaneous repetition in two direction lowers the strength of creating a rhythm which annihilates the feature giving life to the structure. (ibid, 169) In other words, in case of repetition in two directions, there is little opportunity for bringing the structure to life, because it debilitates the possibility of defining a strong center is. On the other side, the shapes which are created in the process or by the rhythm itself can be defined as communicational or social forms which are complete and autonomous. (Frey, 1999: 8) The most important element repeated in the Ganjali-Khan square is the row of arcades that each define a center. The same event has happened in its interior space and in a way in the three northern, western and southern facades. Although by the definition, the repetition of the arcades in the eastern facade provides a weak presentation of rhythm which has less power in defining centers, specially the entrance portal of the caravanserai. The same rule works for the covering domes of the northern, eastern and southern sides which are only perceived through the inner space: because they can't be observed at the height of the observer's sight standing in the square. Table 2
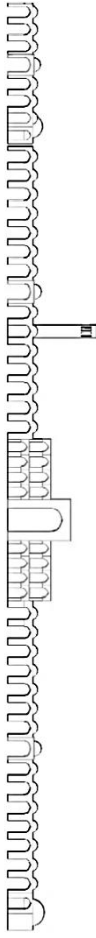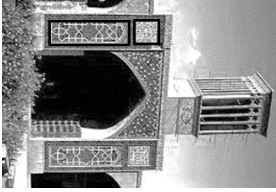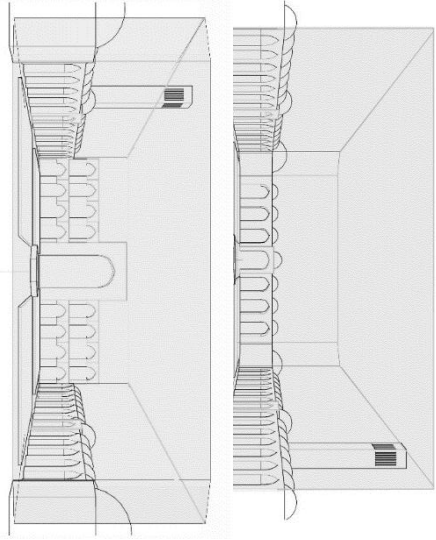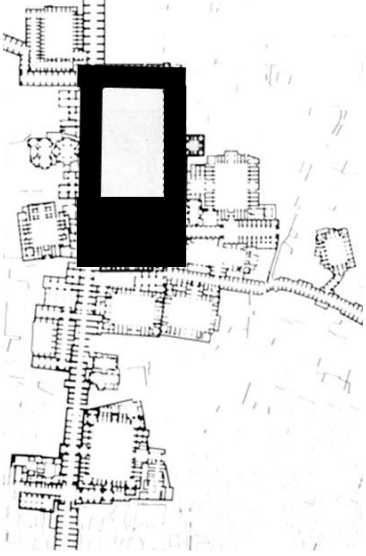
Table 1
The Formal Analysis of the Properties of Levels of Scale and   Strong Centers in the Ganjali-Khan Square

Strong centers[3]			Levels of Scale[2]		
Portal of the mint, Bathhouse,reservoir and the domed *chahartaq*[ʾ]	Windcathcer, Chaharsuq	Portal of the caravanserai	Small	Medium	Macro
Portal of the mint / Portal of the Bathhouse / Portal of the reservoir and the domed water reservoir		The strongest center / Defining strong centers by the other centers			

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[1] an architectural unit consisted of four barrel vaults and a dome.

Table 2
The Formal Analysis of the Properties of Boundaries and Alternating Repetition in the Ganjali-Khan Square

Alternating Repetition[5]	Boundaries[4]	
	details	square
Alternative repetition in interioe and exterial spaces		

6.5 Positive or well-shaped space

By Alexander's definition, the positive space is an empty space which is defined by full space. By this definiteness we mean the buildings designers' thoughts about the features, shape and the form of this empty space; because this is the only way to present a living structure by a positive space in the building. (ibid: 173, 175) This feature is also explained by Salingaros: "The built structures partially surrounding an outdoor space, be it rectangular or circular, must define, in its wall elements, a concave perimeter boundary, making the space itself convex overall." (Salingaros, 2017: 14) According to Alexander's explanations, all the spaces between the arcades in the Ganjali-Khan square are a definition of positive space, because the elements of the arcades as filled space defines the empty space between them. Some

of these definings are shown in Table 3. Furthermore, all the spaces defined by columns, arcades, and domes in the bazaar passageways, the domed Chahartaq, Chaharsuq and even the portals are examples of empty space. That is because they are defined by filled spaces and are also introverted spaces in line with the principles of Iranian architecture, due to which the spaces are designed from inside and the empty space between the spaces is of high importance. Hence they can be explained as definable spaces. Table 3

6.6 Good shape

Good shape is a shape that is built up of "multiple coherent centers." In other words, if each corner of a shape has coherent centers, the shape can be defined as a good shape. In another view, the good shape is a set of shapes that have good shapes within. (Alexander, 2004:

179) What is important here is that despite the degree of complexity of the overall shape, its constituent centers are made up of simple elementary figures. (ibid: 181) The quick understanding and analysis of regular shapes makes us feel confident with them. (Frey, 1999: 7) Alexander defines seven features which build up living structures as "having a high degree of internal symmetries" and a bilateral symmetry, "a well-marked center (not necessarily at the geometric middle)", creating positive spaces next to itself, being "very strongly distinct from what surrounds it", relative compactness (the overall outline scale being about 1:1 and 1:2 and not higher than 1:4), and finally having closure and "feeling of being closed and complete."(Alexander, 2004: 183) Understanding a good shape by the observer is only through looking at facades and perspectives; although some of its requirements may have been considered by the designer in the plan and sections, but since they would not be perceived by the observer it wouldn't be discussed in this research.

The Ganjali-Khan square, can then be acknowledged as having a good shape due to having internal and external symmetry in the facades and also in the inner space of the square, the definition of the strong centers; the caravanserai's portal and the fountain pool in the middle of the square, the emphasis towards the positive space as discussed before, and its proportions. The analytical study of this is appeared in table 3.

6.7 Local symmetries

Symmetry is one of the repetitive features in the living structures. Further than the existence of the symmetry axes, this implies the existence of centers which symmetry plays an important role in their formation. Table 3

6.8 Deep interlock and ambiguity

Another prevalent property in the living structures, is the correlation of centers with their surroundings, in a way that they couldn't be separated from their surrounding environment. This correlation is mostly created by a structure which belongs simultaneously to the center and its environment. In simple words, they interact both with the center and the environment. By this, they create an intermediate space between the two. The definition of Salingaros from a living courtyard is very close to this feature. He believes that a courtyard plays an important role in giving life to architecture if it has many entry points, and imply a feeling of enclosure. (Salingaros, 2017: 14) The intermediate space mentioned is present in architecture and subsequently in the Ganjali-Khan square in two ways: First, there are the four portals in the four sides which act as an interface between the square and bazaar, caravanserai, bathhouse and the mint. Second, although weaker, is the arcades in the north, west and south which act as a connective element between the square and the bazaar passage. This intermediate space is also present in connection with the surrounding urban context, where the Ganjali-Khan square acts individually

and independently as a center. It also acts as a center for the historical bazaar or even the neighborhood. Table 3

6.9 Contrast

Another property, is the existence of significant contrast within the living structures. Life cannot be obtained without contrast. (ibid: 200) Contrast also has a stimulating manner for the visual senses and emphasizes the concept of contraposition. (Frey, 1999: 11) On this basis, every center is constituted of interpretable contrasts. These contrary forces represent life as it is by providing a dynamic balance between themselves. (Bayes, 1994: 23-24) two prevalent contrasts are the use of black and white colors and the qualities of darkness and light. Other examples are filled and empty, opaque and transparent, or crowded and quiet spaces. On this basis the Ganjali-Khan square can be counted as an empty space in contrast to the filled space due to its surrounding four facades. Additionally, we have the definition of this square, together with the spaces and elements such as the portals in the four sides, as a halt and interim space in contrast to the in-move spaces created by the passages of bazaar. The existence of contrast in the square can also be related to the difference in the colors between the bricks and the tile work and in the difference in the material choices in the square. These contrasts are also visible in the composition of the designs and patterns of tile work and the shadows made. Table 4

6.10 Gradients

This feature looks on the softness of the living structures and generally points out the changes in the center caused by the change of its conditions. This change of conditions implies the adjacency of the centers and their effect on the changes in the center's neighboring. The most important manifestation of this feature in Ganjali-Khan square can be seen in the eastern side; where because of the caravanserai's function, the height of the arcades has been lowered and matched with the usage. There is a similar type in the portals of the other three sides which is specified by the difference in height, material and even the height of the covering dome. This feature has also been considered in the intersection point of the northern and southern facades to the western façade, which has resulted in shaping a 45degree angle, which has caused change to the centers due to their positions. Table 4
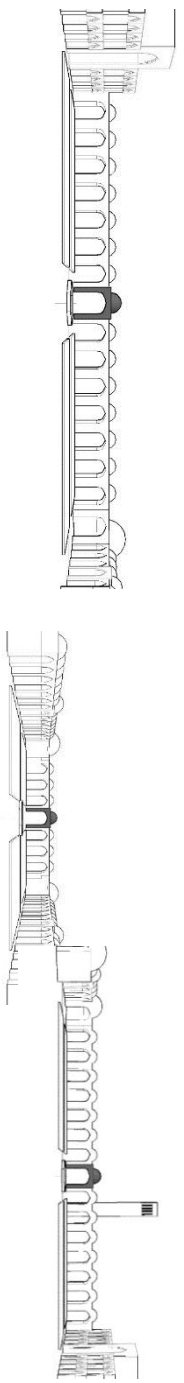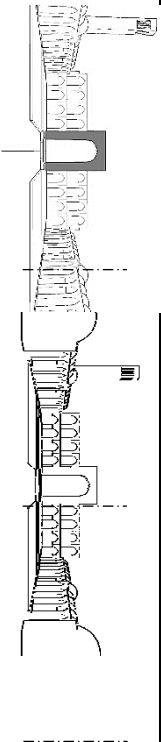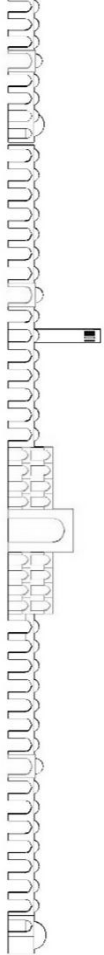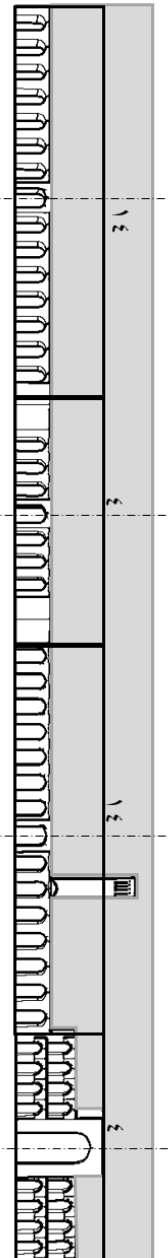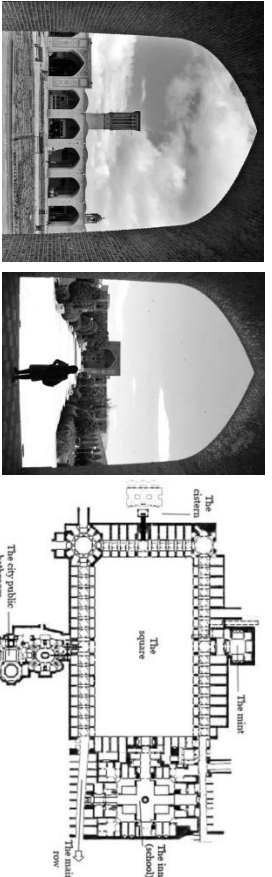
6.11 Roughness

This feature should not be known as originated in requirements of manual construction techniques in handicraft industries. This property is independently one of the features which exist consciously in the living structure and indicates minor differences between similar elements by which, each element has its own specific design, although being part of a group. It is exactly like

the parts of the human body which are all exclusive, still being similar. These partial differences between the elements belonging to a group mostly depends on its function and position of location. This feature has a faint role in the Ganjali-Khan square. An important reason for this is due to the process of its restoration which has brought the differences to minimum. Still, this feature can be observed in the patterns and the designs of the tile work in the square facades. Table 4

Table 3

The Analysis of the Features of Positive Space, Good Shape, Local Symmetries and Interlock and Ambiguity

Deep interlock and ambiguity[9]		Local symmetries[8]	Good shape[7]	Positive space[6]
Architectural scale	Urban scale			

6.12 Echoes

Echoes implies the formal signs and shapes between the elements constituting the living structures by which they can be grouped in a collateral group. Conceiving these elements in the whole and the larger context is made possible subsequent to this similarity. One of the most significant examples of this feature is the consonance between the arcades and the covering domes of the bazaar passages. This feature is also present in the decorative patterns. Table 4

6.13 The void

Void or empty space shows itself in the living structures in two ways. The first is that the space is visually empty. In other words, a sense of depth and emptiness is induced. The second state is where the space is physically empty, as the courtyard in the middle of a building. In the Ganjali-Khan square, the greatest and the most important empty space physically is the square itself. In addition to this space, all of the arcades, the bazaar passageways around the square and the windcatcher partitions are also physical empty spaces. Furthermore, in the decorations of the portals' tile work, the use of dark colors in the background induces a feeling of depth and visual empty space. Table 4

6.14 Simplicity and inner calm [15]

The feature of simplicity and inner calm in the living structures is mostly induced by simple and appropriate geometry in the design of the structure and the neglect of accessories. In simple words, the more a structure is enough, not more or less, this feature would be present. This property is one of the most evident features of the square. Minimum decorations, little variation in material used and simple geometry has provided the square to be perceived in simplicity and inner tranquility.

6.15 Not-separateness [16]

This feature looks on the connection of the new structure with its surroundings; in a way of being as part of a whole and acting as such. The study of the Ganjali-Khan square by this feature is not possible; because it has a sort of inwardness in its design which makes its comparison with its surrounding environment in the observer's eyes practically impossible. Although this property can be clearly seen in the bird's eye. Figure. 3

Fig. 3. The correlation of the square with its context and the surrounding setting (source: www.dome.mit.ed).

The fifteen properties discussed in the structure of the Ganjali-Khan square should be in mutual relations according to Alexander's theory. In other words, Alexander believes that these features shouldn't be counted as independent and separate from each other; because the existence of one feature can be effective towards the presence of another. Alexander presents this mutual relation with the study and analysis of these features in numerous case studies. In table 5, the mutual relations of the properties have been inspected, trying to answer this question that whether the "A" index depends on the "B" index and whether the presence of the B index is necessary to understand the A index. The table number5 represents Alexander's table on this basis. The gray cells in this table define the existence to mutual relations between two properties. Hence, the relation between the two features is definite in these cells, but the strength and weakness of the relation could depend on the variable case study.

For example, we want to find whether the definitions of the levels of scale in the square depends on the definition of the strong centers and have the strong centers been effective in the perception of the levels of scale? In this case, by formal analysis in the related tables we can see the role of the strong centers such as the portal of the caravanserai, mint, bathhouse, water reservoir and the two domed Chahartaq in the definition of the levels of scale in macro and middle scales.

The alternating repetition of the arcades in the sides of the square facilitated the enrolment of the centers of each facade like the portals of the caravanserai, bathhouse, water reservoir, mint and even the domed Chahartaq's as a center from both the aspects of function and form.

Table 4
The Formal Analysis of the Properties of Contrast, Gradients, Roughness, and Echoes
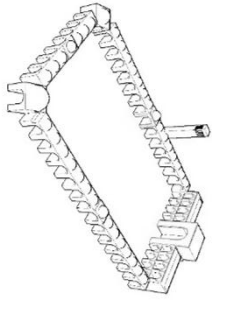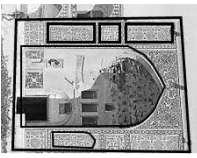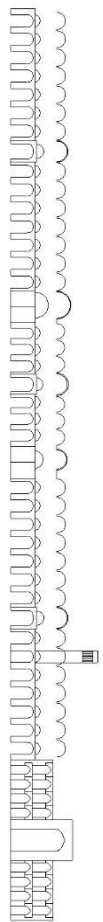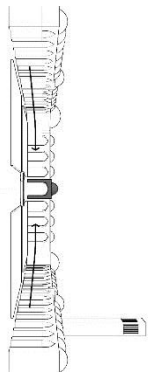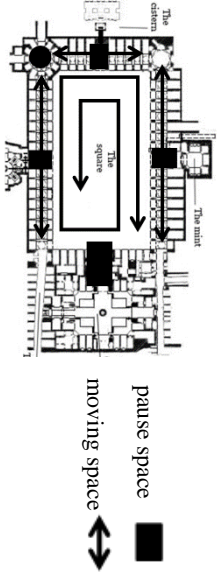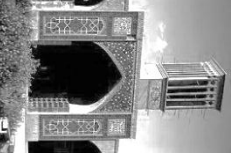
The void[14]	Echoes[13]	Roughness[12]	Gradients[11]	Contrast[10]
Void in urban scale Void in architectural space		Roughness in chaharsugs dome	Shifts in angles nearby connections transformation in the joint of walls	Contrast based on full-empty spaces, materials, colors and shadows Contrast based on opaque and transparent space moving space pause space

Table 5
The mutual relation between the properties of living structures in the Ganajali-Khan square and the strength of each property

Prosperities A

Prosperities B	levels of scale	strong centers	boundaries	alternating repetitions	positive space	good shape	local symmetries	deep interlock and ambiguity	contrast	gradients	roughness	echoes	the void	simplicity and inner calm	not-separateness
levels of scale		■		■			■								
strong centers				■									■	■	■
boundaries	■		■									■			
alternating repetitions	■		■												■
positive space	■			■			■			■			■		
good shape	■			■						■					
local symmetries	■												■		
deep interlock and ambiguity				■			■			■					■
contrast		■													
gradients	■				■										
roughness	■				■				■					■	
echoes	■			■			■			■			■		
the void	■			■			■								
simplicity and inner calm						■		■			■				
not-separateness		■	■					■			■		■		

(source: Alexander, 2004)

7. Discussion and Conclusion

This research aimed at the study of the features of Ganjali-Khan square in Kerman by Christopher Alexander's theory of order. The purpose is the structural and formal analysis of an urban space and the study of its conformity due to the properties named for a living architecture in the theory. Furthermore, what is the focus point in this research is the emphasis on the formal analysis from the viewpoint of an observer in the square. On this basis, elevations, sections and inner and outer perspectives were used in the analytics which provide more human viewpoint than the plan. In a few cases that the plan has been used, the purpose was the better graphical presentation of that feature and the observer's perception in the square has not been studied through the plan.

The formal analysis from the fifteen properties of living structures and their mutual relations in the theory of the nature of order, shows that all of the features, excluding roughness, are present in the structure of the square. It seems that the weakness in the feature of roughness is due to the restoration process which has faded the partial differences in similar elements.

The structure of the square beholds the following properties: 'levels of scales' from the macro scale at the level of architectural structures to small scales at the level of ornaments and their design; 'strong centers' due to the portals, the domes of the western façade and the fountain pool in the courtyard; 'boundaries' due to bounding the limits of the square and its separation from the city by the walls, bounding the limits of the portals by the use of tile work and the material change from brick in the background, and the boundaries made by the tile work designs in the square.

Furthermore, the alternating repetition can be seen in the structure of the arcades; positive spaces in the structure of inner spaces and the arches; and good shape in the right proportions, symmetry, centers and the defined positive spaces. Local symmetry can be spotted in the design of

the plans and their facades; and interlock and ambiguity is provided through the creation of mediate spaces between the square-bazaar, square/bazaar-caravanserai, bathhouse; water reservoir and the mint which are definable by the portals of each façade. Moreover, the feature of contrast is provided through the cast of shadows, filled and empty spaces, difference in the types and color of the materials and the interim/in-the-move spaces; the feature of ingredients by the formal change of the structure of the square in the facades intersections by creating corners and variation of the skyline in the centers; and the feature of echoes by the use of elements similar in form in the ornaments and the inner/outer spaces in the structure of the square. The empty space can be explained at urban scale by the creation of the square as an open urban space, and at an architectural scale by the openings in the arches and the indents in the portals in the square. The little use of ornaments, little variation in the materials and the simple geometry in the design of the square imply simplicity and inner calm. At the other hand, the consonance of the square with the context, geometry and the structure of the city of Kerman could be seen as a manifestation of the not-separateness of square from the city.

Thus, the structural and formal features of the Ganjali-Khan square and the mutual relations between them as witnessed by the observer, show that this urban space is in conformity with Alexander's theory of the nature of order and comprises the properties that define it as a high quality and living structure.

Notes
1. Geoffrey Broadbent believes that Alexander's work is a result of a mechanical view towards design and an effort towards formulating the creation of an eternal work of art. Lawson also believes that, all requirements and needs shouldn't be of equal values for simplification and the original and eternal ideas don't basically have equal relation with all requirements. Mozayyani also claims that the issue of interest and norms are not as definite as Alexander says.
2. The graphical expression if the levels of scales, (Takashi and Shingo 2014, 437)

3. The graphical expression of the strong centers; source: ibid

4. The graphical expression of boundaries; source: ibid
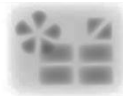
5. The graphical expression of alternating repetitions; source: ibid

6. The graphical expression of positive space; source: ibid

7. The graphical expression of good shape; source: ibid

8. The graphical expression of local symmetries; source: ibid

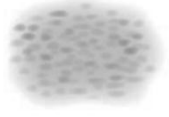9. The graphical expression of deep interlock and ambiguity; source: ibid

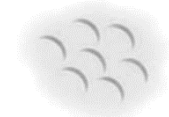10. The graphical expression of contrast; source: ibid

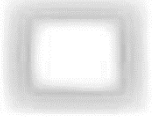11. The graphical expression of gradients; source: ibid

12. The graphical expression of roughness; source: ibid
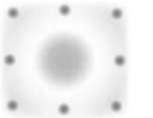

13. The graphical expression of echoes; source: ibid

14. The graphical expression of the void; source: ibid

15. The graphical expression of simplicity and inner calm; source: ibid

16. The graphical expression of not-separateness; source: ibid

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