

Geometry at work: Re-reading the Persian bazaar

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1 ABSTRACT

The paper focuses on three issues concerning the Persian bazaar¹: (1) considering the bazaar as an interiorized urban environment; (2) the way the bazaar achieves this interiority while obtaining such a large scale and; (3) how this interiority affects the experience of the bazaar. The subject of the Persian bazaar first came to my attention through research I conducted during the first year of my studies at the Staedelschule Architecture Class. During this year I discovered the main elements of this Persian archetype and analyzed the underlying geometrical principles that gave rise to them while focusing on specific examples. The second motivation that led to this subject was the current body of texts on the Persian bazaar. Almost all of the texts that have been published on this subject are merely descriptive and historical; this paper attempts to offer a more subjective reading of the bazaar in the hope of not just raising awareness of the subject but also opening up new possibilities for its interpretation.

It has been tried to keep the main focus on answering questions of “what” and “how” instead of “why”. Architectural elements have been analyzed cut off from their symbolic meanings and/or their religious attributes in order to consider them as elements with the capacity to produce purely spatial architectural effects. Despite the fact that there are strong connections between the material form of the bazaar and the climate, religion and culture of its surroundings, these issues have not been taken into account for such subjects stretch far beyond the scope of this paper.

The grand bazaar of Isfahan was chosen as a reference example. The main reason for this choice was the location of the bazaar, its accessibility, and the availability of materials related to it. Due to the scarce references that offer a more in depth study of the bazaar, the personal documentation and experience of the bazaar of Isfahan, through film and photography came to be of great help.

2 A BRIEF INTRODUCTION ON THE GRAND BAZAAR OF ISFAHAN

“The first evidence of a bazaar in Isfahan is based on Hamze Isfahani, who wrote that in the bazaar of the city which is close to Yahoudiye² there are some squares for businessmen, craftsmen and workers (750A.D.). After him Moghadasi, a famous historian in the tenth century, described it into a long street with some roofed quarters and some non-roofed quarters”(Gharipour, 2003). The bazaar of Isfahan was formed over centuries. The bazaar was developed in two parts, each corresponding to different time periods. First the organic growth of the bazaar that was completed in the Saljuqid period (11th century); during this period the bazaar had a linear (the linear bazaar³) development that took many years. Secondly the predesigned growth of the bazaar occurred during the Safavid period (16th century). At this phase the

¹ “Originally, a public market district of a Persian town. From Persia the term spread to Arabia (the Arabic word *suq* is synonymous), Turkey, and North Africa. In India it came to be applied to a single shop, and in current English usage it is applied both to a single shop or concession selling miscellaneous articles and to a fair which such miscellany is sold.” (Brittanica, 2011).

² “The ancient Isfahan was divided into two areas, named *Jey* and *Yahoudiye*. *Yahoudiye* was the settlement of the Jewish in Isfahan...”(Gharipour, 2003).

³ “Most of the Persian bazaars, specially the permanent ones are linear, because they are formed in line with paths and streets. The linear bazaars are divided in to two types of organic and designed. The organic bazaars are the ones that have been gradually formed along with the streets of the city that are not designed, with the development of the city new spaces have been created alongside them[...].The main parts of the bazaar of Isfahan have been formed in an organic way that is not designed. A small number of Persian bazaars, in other words parts of these bazaars have been created in a straight and designed pathway. These bazaars have been formed when someone (a ruler or one of the influential persons of the city) decided to build a passageway of bazaar.” (Ministry of Housing and Urban Development, 2009).

bazaar was developed into a gridded structure (the multiple axis bazaar⁴) and was better ordered in less time compared to the first phase. This part was eventually spread around the enormous *Naghsh-e-Jahan* square (measuring 165×510 meters). The bazaar acted as a connector between the two main centers of the city, the old square (which was formed in the first phase, in the *Saljuqid* era) and the new square (*Naghsh-e Jahan*) (Fig.1). The city of Isfahan flourished during the *Safavid* period when it was the capital of Persia under the ruling of Shah Abbas. During this time (1501 to 1721) many architectural masterpieces were built in and around the grand bazaar. Although they have been damaged or destroyed over the years many of them still remain under the protection or are being renovated by the cultural bureau of Iran. The bazaar was host to a multiplicity of functions, ranging from commercial to socio-religious. This hybrid nature of the bazaar made it the most important economical, social, and religious heart of the city. The grand bazaar of Isfahan and its surrounding buildings remain one of the main tourist attractions in Iran.



Fig. 1: Plan of the bazaar showing the old square on the bottom right and the new square (*Naghsh-e-Jahan*) on the left. Image from (Ministry of Housing and Urban Development, 2009).

3 THE BAZAAR AS INTERIORITY

To consider the bazaar as interiority means that the experience of the bazaar is similar to the experience of an interior space. We know that every building has an interior and an exterior and in fact the existence of one depends on the other, but that does not necessarily mean that we are experiencing it as an interior space when we are inside the building. When walking through the bazaar we do not encounter any evidence that would lead us to obtain an understanding of its external expression as a material form. All the information that we receive with our five senses is focused on the inside; in fact we are surrounded with so much of it that we feel that we have stepped into a wonderland. The following sections offer the main clues as to why the bazaar is considered to be as interiority.

3.1 No exterior

If we look at existing documents on a Persian bazaar we will notice that one conventional architectural document is missing: the external elevation. The only architectural documents at hand are the plans and sections, each giving crucial information on the understanding of its architecture. The plan shows the central spine of the bazaar running through the city fabric and the diversity of functions that are attached to it. However, the interesting thing happens at the peripheries of this central spine: the borders of the bazaar seem to dissolve as they move towards the surroundings (Fig.3). It is difficult to say exactly where the bazaar ends and where the residential units start. The structure of the bazaar is integrated with the neighboring houses to such a degree that it seems as if they are functioning as prosthetic features of one another, literally grafted. There is no wall or any other architectural element that cuts the connection of the corridors of the bazaar with

⁴ “A vast grid of parallel or crossing passageways that incorporate a series of caravansaries. Compared to the other types of bazaars this kind has more vitality and attraction. In Tehran, Isfahan, and Shiraz the central part of the bazaars has been mostly developed in multiple axes” (Ministry of Housing and Urban Development, 2009).

the alleys of the city; the corridors become alleys and streets without any interference. If we look at the section, we begin to realize the existence of two important architectural elements of the bazaar that are in fact the only external expressions that it has: the entrances/exits and the roof. The main entrances of the bazaar have been emphasized through their height, width and surface articulation. At these places the surfaces have been accentuated through the ornamental use of bricks and tiles in such a way that they are clearly distinguishable from their adjacent walls. Take into account that most of the city was constructed with the use of ordinary mud- bricks and only places holding special value (cultural, religious, political) were treated with the use of such materials. Moreover, surface articulation techniques such as *Kar-bandi* (the term will be introduced later on in this paper) and *Muqarnas*⁵ add to the visual distinction of the main entrances and attract viewers from the outside (Fig.2).

By looking at the section diagram of one example of such entrances (Fig.2), the shift in scale from exterior to interior is clearly visible. The height of the entrance arch dramatically decreases as the viewer enters. The surface articulation that was mentioned before exists between these two arches. The first arch corresponds to the exterior conditions of the bazaar, acting as a signifier; the second arch relates to the interior scale and condition of the bazaar and is the starting point of the interior.

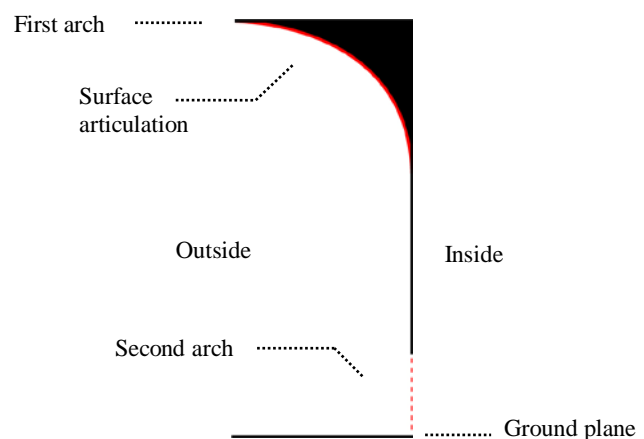


Fig. 2: The section diagram on the right and the *Ghveysariyeh* entrance of the bazaar of Isfahan on the left. Left image from (Ministry of Housing and Urban Development, 2009).

The roof of the bazaar takes the shape of a series of connected domes. The main passageway of the bazaar is found under these domes. The section of the roof reveals that at certain points the height and radius of the domes differ, making them stand out against the domes that come before and after them. This happens at two points: one is called *Chahar-Su*⁶ the other *Timcheh*⁷ (Fig.4). Despite the fact that at these two points the structure of the bazaar stands notably higher than its surroundings, still the domes are not very visible from a distance. Hence they do not act as landmarks or signifiers for the exterior (compared to the mosque which was visible from all parts of the city). In other words they, are actually relating to the interior conditions of the bazaar. The only way that the roof is visible from the outside is if one stands at the roof of another house or by aerial photography. The second revelation concerning the roof section is the double layered skin of the roof.

⁵ “*Muqarnas* is a type of corbel used as a decorative device in traditional Islamic and Persian architecture. [...] *Muqarnas* takes the form of small pointed niches, stacked in tiers projecting beyond those below and can be constructed in brick, stone, stucco or wood. They may then be decorated with painted tiles, or paint on wood or plaster. They are often applied to domes, pendentives, cornices, squinches and the undersides of arches.” (Wikipedia, 2009).

⁶ “*Chahar-Su* is the crossing of two main passages of the bazaar.” Sometimes the *Chahar-Su* was formed in line with the main passageway of the bazaar or at the entrance of certain buildings connected to the bazaar that where of special importance, such as Mosques or Caravansaries.[...]The *Chahar-Su* is usually eight sided in plan. In each corner there are one to three chambers, occasionally a staircase is also situated. Because of its exclusive spatial location and its height it is a unique opportunity for the performance of the architect. In its architecture techniques such as *Karbandi*, *Yazdibandi* and *Moquarnas* have been used and in more details works of stucco and paintings act as ornamentations.[...]In the past the *Chahar-Su* was also used as a place for the management of the bazaar in order to keep the general order and the prices of the goods in balance.” (Ministry of Housing and Urban Development, 2009).

⁷ “*Timcheh* (covered halls) is an economic complex. In *Timcheh* shops are located around a courtyard. These *Timchehs* act as shopping complexes for special products.” (Gharipour, 2003).

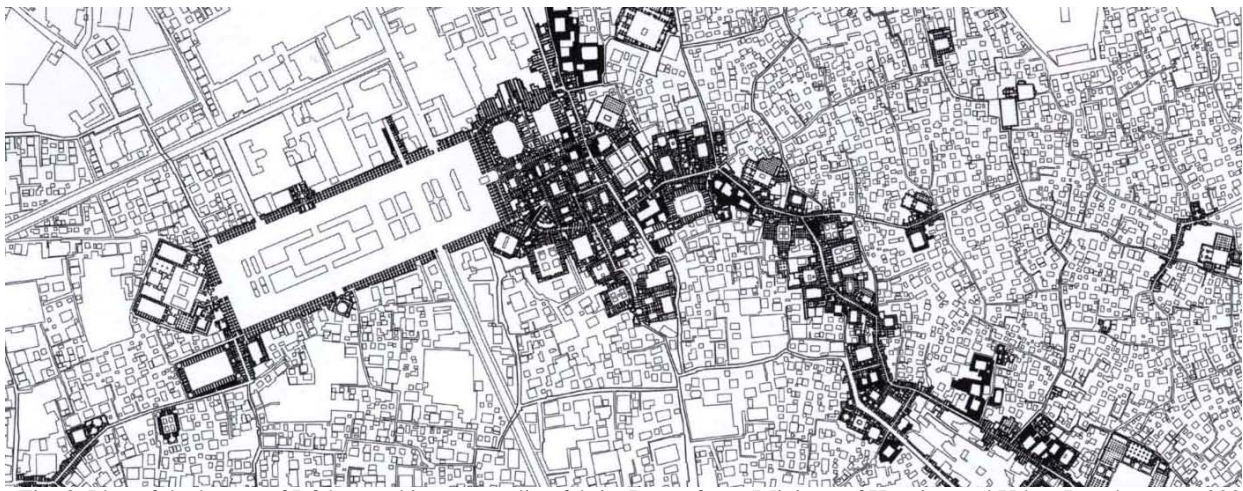


Fig. 3: Plan of the bazaar of Isfahan and its surrounding fabric. Image from (Ministry of Housing and Urban Development, 2009).

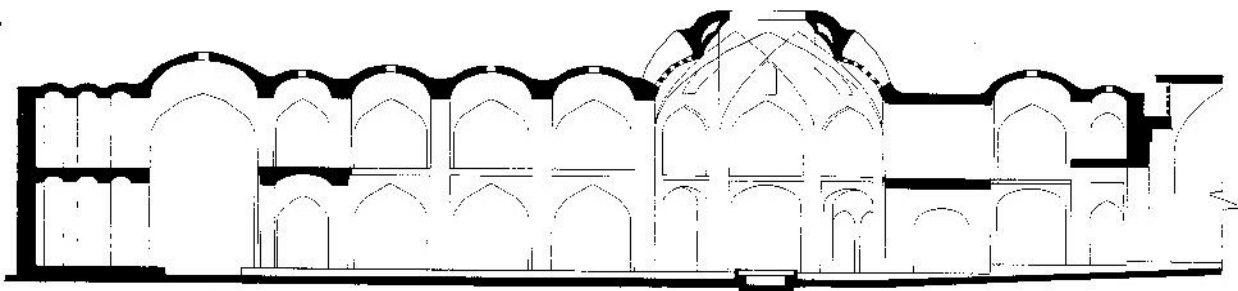


Fig. 4: The highest dome here is the dome of a *Timcheh*. Image from (Shahid Beheshti university faculty of architecture and urban planning, 2007).

3.2 The double layered skin

The structure of the roof consists of two major layers. The inner layer is constructed using specific geometrical principles that are visible to the eye; the dominant material that is used here is the brick. The outer layer of the roof which has a main function of protection and insulation, is covered with plaster made of clay and straw, giving the outer surface a smooth look (Fig.5). Despite being joined together, these two layers relate to different conditions and each serves a different purpose. The inner layer is carefully constructed, and at points such as the *Chahar-Su*, *Timcheh*, and the entrance, it is partly articulated with the use of tiles as ornaments. The techniques that have been used for the construction of this inner layer are made to be visible by the eye; therefore, they have been constructed having great attention to the experience of the viewer from the inside. On the contrary there is no sign of any kind of surface treatment other than trowel ling on the outer layer. No effort has been made in order to make it stand out from its surroundings. When seen from above the color and the material of the outer layer blends with the city fabric. Only the circular shape of the dome makes it distinct from the flat roofs of the neighboring houses (Fig.6). This layer does not reflect the geometry of its inside; the surface curvature and geometry is, to a large degree, independent from the inner layer. The exterior of the roof remains somewhat indifferent to the viewer's eye; hence, it is merely functional and not made to be gazed upon.

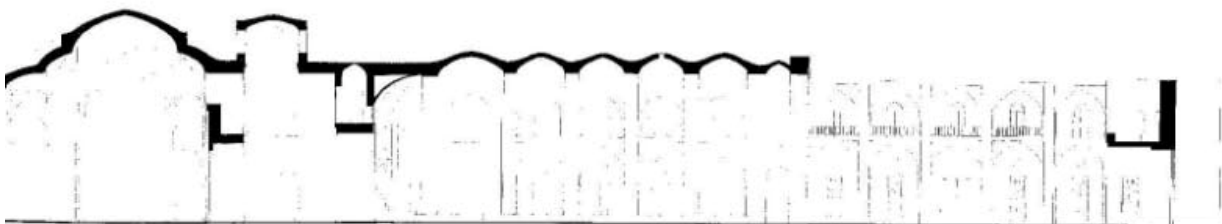


Fig. 5: Section of the roof of the bazaar. Image from (Shahid Beheshti university faculty of architecture and urban planning, 2007).



Figure 6: Aerial view of the bazaar of Isfahan and its surrounding fabric. Image from (Encyclopedia Iranica Online, 2007).

4 CONTINUITY AND DISCONTINUITY

If we consider the bazaar an interiorized environment with the scale of a district, we begin to understand that it is also functioning as a landmark without possessing the necessary formal and monumental characteristics of a landmark. A building that is acting as a landmark does so by distinguishing itself from its surroundings; this distinguishing often occurs at the level of formal language and scale of the building. Take the mosque for example: in addition to its unique architectural language; the minarets of the mosque which are its tallest features make it visible from a distance. The way we approach and perceive a building like a mosque, or any other landmark building, is essentially different from the way we approach and perceive the bazaar. Usually we develop an understanding of the building before we enter it; we see the building from a distance, and as we approach it, our perception of the building becomes clearer, we begin to see the details and then we enter. The bazaar of Isfahan is approached either through its main entrances or the secondary ones that branch out from the central passageway at multiple points. In Fig.7, a series of stop shots show the way we approach the bazaar from an adjacent neighborhood. Before entering we are unable to take a much of a guess as to what is happening on the inside; the only visible element is the arch that marks the starting point of the bazaar. After passing the arch there is a visual shock. This cinematic experience could be compared to the element of suspense in the cinema when the viewer is left in a moment of uncertainty not knowing exactly what comes next. On the other hand entering from the main entrances brings together another experience. Because of the characteristics of the main entrances of the bazaar that were mentioned before, entering from these points results in a rather smooth transition from the outside to the inside. While these two experiences stand at two poles, there is also a range of in between experiences that result from the diversity of the secondary entrances that are spread out along the central corridor, each having different angles and offering unique ways of approaching the bazaar. The affects of such experiences move between the two poles of continuity and discontinuity.

The bazaar is not a single building and it cannot be experienced through single fixed viewpoints, yet this characteristic does not result in the formation of a fragmented perception of the bazaar; it remains a continuous interconnected spatial environment. One must physically occupy the space in order to grasp its spatiality, reminiscent of the works of the American sculptor Richard Serra. Yve-Alain Bois describes this aspect of Serra's work in his essay titled *A picturesque stroll around Clara-Clara* where he refers to Serra's comments about the Rotary Arc peace: "no one who circumnavigates this sculpture, whether on foot or by car, can ascribe the multiplicity of views to a Gestalt reading of the arc. Its form remains ambiguous, indeterminable, unknowable as an entity" (Bois, Shepley, 1984), which further on leads to the notion of the sublime instead of the beautiful, "and while in the beautiful totality is immediately apprehended, the feeling of the sublime comes from the contradiction between apprehension (which "can go *ad infinitum*") and comprehension (which reaches a maximum, beyond which the imagination cannot go)" (Bois, Shepley, 1984). When moving inside the bazaar we realize that the passageways of the bazaar are connected without any interference of walls. We move about in open continuous corridors but in these linked passageways, there is also discontinuity, separation, and independency. The architectural element that makes this possible is nothing else than the arch.



Fig. 7: Entering from a secondary entrance to the bazaar.

4.1 The arch

The arch which is present almost everywhere in the Persian architecture holds the continuity of the geometrical language of the bazaar. It is the gene that gives rise to the subsequent geometrical complexities. The arch starts from the tip of the columns but because of its direct connection with the column it is seen as a continuous line rising from the ground and creating the tip of the arch at the roof (Fig.8). Therefore the arch is giving an emphasis on the wall and the roof, and at the same time connecting them together without introducing breaks. Thus, without arguing about the metaphorical meanings of such an element in Persian architecture, it is safe to say that the effect of the arch is continuity between the wall and the roof. The same arch repeats itself with rotation in each dome, and as a result, the center of the dome (which is left open for the penetration of light) is heavily present in visual terms. The center implies the affect of stability as opposed to movement, but when the dome is repeated along the way a tension occurs between the dynamics that the repetition generates and the stability that is produced by the center of each dome. This tension exists throughout the entire circulation route of the bazaar. The open connection of each dome to the other and its repetition creates a continuous sense of movement while at the same time the geometrical independency of each dome makes us feel that we can stop at any point of this passageway. Each dome is in itself a complete entity that is being composed of part to whole relationships. The arch forms the dome, the dome forms the bazaar. The rotation of the arch which is the main operation generating the geometry of the bazaar is expressed through the use of a specific geometrical technique: the *Kar-bandi*.

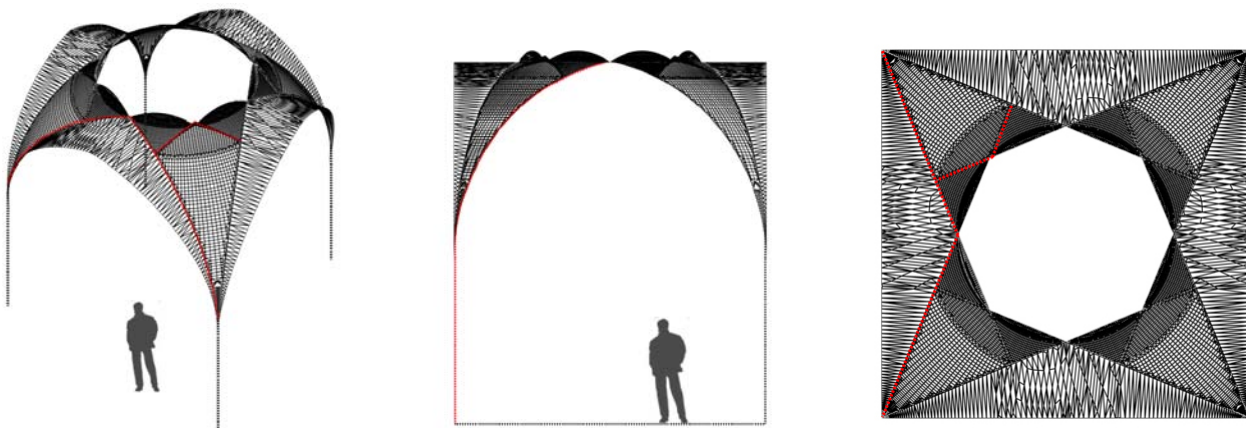


Fig. 8: 3D model depicting the arch and its rotations as continuity between the ground, the column/wall, and the roof, in perspective, elevation, and plan.

4.2 The *Karbandi* technique

“The *Kar-bandi* comprises a series of arches that intersect each other. A vault is constructed with the use of the intersecting points” (Bozorgmehry, 2006)(Fig.9). This technique is used in order to make a transition between a polygonal plan (with four or eight sides) to a circular dome. By increasing the number of arches and their intersections the sides and faceted surfaces of the *Kar-bandi* increases, and as a result, the transition from a polygonal plan to a circular dome becomes smoother. The *Kar-bandi* can be adjusted and modified in order to be used for different places. Through its modification it has been used in a variety of buildings in the Persian architecture such as the mosque, the *Hammam* (Persian baths), the house, and of course the bazaar. It is because of this flexibility that the diverse functions around the bazaar are able to attach to it without introducing eruptions. The same geometrical language has been used, but when modified, it obtains independent yet connected identities. “The distribution of loads along the surface of the *Kar-bandi* dome embeds it with an optical affective property of crystallinity and

stalactiformity that remains consistent within any space it defines. The variations in curvature, faceting and ribbing all add diffusion which often dominates focusing.” (Moussavi, 2009). The *Kar-bandi* technique consists of different types, but the one that will be demonstrated here is the Plumb line *Kar-bandi*. “The mould of this type of *Kar-bandi* is held perpendicular to the ground plane; hence, most of them are able to take on loads. In the case of the bazaar, where the arches are the main covering of the vault, this type of *Kar-bandi* is used.” (Moussavi, 2009).

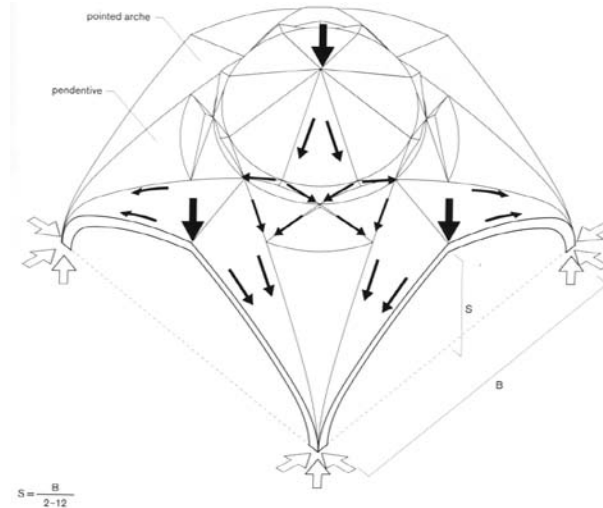


Fig. 9: 3D Model of the *Kar-bandi* system with a square plan and the resulting vault. Arrows show the transmission of loads from the oculus to the foot of the arch. Image from (Moussavi, 2009).

4.2.1 Geometrical principles

“The number of sides of the *Kar-bandi* not only depends on the desire of the architect but it also relies on the dimensions of the given plan. If we have a rectangle with the length of A and the width of B the following formula indicates the sides of the *Kar-bandi* that results from it: $2(A+B-2) =$ the number of sides of the *Kar-bandi*”¹¹. For example a rectangle with the dimensions of two and three would give us a *Kar-bandi* with six sides. “It should be noted that these proportions are not fully accurate and in practice the architect might need to make minor adjustments through trial and error.” (Raiszadeh, Mofid, 2006).” Let’s say that we have a rectangle with the length of four and the width of three (the ABCD rectangle) (Fig.10). According to the given formula we would have a ten sided *Kar-bandi*. In order to draw the plan we must do the following: first we will draw the circle that governs the rectangle, then we will divide the circle into ten segments from its center. At the length of the rectangle the circle has been divided in to three segments, the division points on the circle will be connected to each other with intervals of three. What remains in the rectangle is the final plan of the *Kar-bandi*.” (Raiszadeh, Mofid, 2006). The most frequently used arch in the *Kar-bandi* that is present in the bazaar is the *Panj-Do-Haft* arch. The principles that govern this arch are shown in Fig.11.

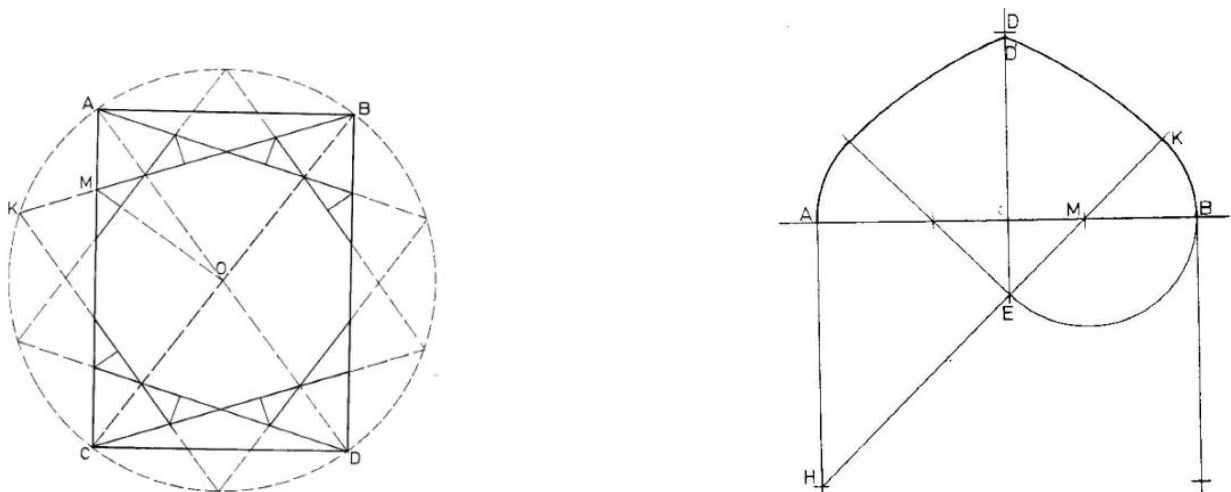


Fig. 10: Geometrical principles of the *Kar-bandi* technique (left), and the geometrical principles of the *Panj-do-haft* arch (right). Image from (Bozorgmehr, 2006).

4.2.2 Building principles

“To build the *Kar-bandi* we need the plan and the mould. First the plan is drawn on the ground plane with a one to one scale. The mould of the type of arch that is going to be used will be made using wood or stucco with a one to one scale. On the plan the intersecting points are marked (in Fig.12 they are shown as numbers one, two, three), using a plumb line (or any other tool that would have the same function), they are converted to the mould. This procedure is repeated for all the arches of the *Kar-bandi*. Some of the moulds are a full piece and some contain a part of the arch. The moulds that contain a full arch are the ones that will carry the main loads and transfer them into the columns.”(Raiszadeh, Mofid, 2006). At the end, by putting the moulds on the exact lines of the plan and erecting them perpendicular to the ground plane they are joined together.

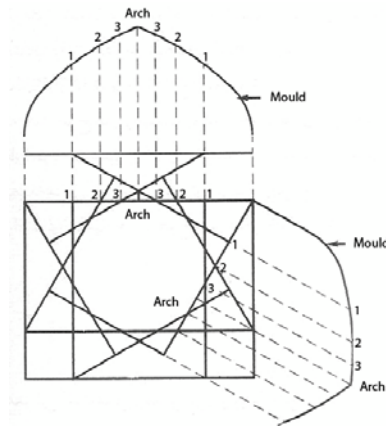


Fig. 11: Conversion of intersection points from the plan to the moulds. Image from (Raiszadeh, Mofid, 2006).

5 CASE STUDY

To bring up an example of the use of the *Kar-bandi* technique in its material form, the space of a *Chahar-Su* will be analyzed here. As an example a *Chahar-Su* in the grand bazaar of Isfahan has been chosen. The *Chahar-Su* functions as a knot in the infrastructure of the bazaar. Because of its unique location at the crossing of two passages, it hosts special functions that add to its distinction. Therefore, in the *Chahar-Su*, the idea is not only to connect two crossing passages but to have the connection itself become the main subject.

The *Chahar-Su* of *Gheysariyeh* is located in the passageway of *Gheysariyeh* which is the most important passageway in the bazaar of Isfahan with a width of approximately 6.5 meters. The *Chahar-Su* of *Gheysariyeh*, approximately twenty meters high, is situated in line with the main passageway of the bazaar and in between the *Shah* caravanserai (on its left) and the *Zarabkhaneh*⁸ (on its right) (Fig.13). The principles of the *Kar-bandi* that have been used in this *Chahar-Su* are shown in Fig.14. This *Chahar-Su* is at the same time connecting and separating the two elements that exist at its sides. These two elements offer entirely different spatial experiences. The *Shah caravansarie* starts from a rather narrow passageway that leads to its central courtyard; at this point a vast opening is introduced. In contrast to this open and bright space, the *Zarabkhaneh* is a more compact and dim space that further on divides into its subspaces through multiple corridors. In between these two contrasting spatial experiences is the *Chahar-Su*, a buffer zone that presents a moment of pause in the movement of the viewer inside the main passageway. At this point one can decide to continue the journey through the main passage, enter either neighboring spaces or linger at the connection space itself which hosts four chambers (shops) at its corners. The increase in height of the ceiling, which is almost doubled at this intersection point (from about 10 to approximately 20 meters), helps in creating its static experience. In addition, the central oculus of the dome which the arches converge around creates a central focus point. “This *Kar-bandi* assemblage transmits an optical affect of crystallinity, faceting, and rotundity, and an acoustical affect of focusing and diffusion.”(Moussavi, 2009). The effects that are being produced in this space are directly relying on a base unit (the arch) and the operations that take place on it (rotation, projection, and intersection through the *Kar-bandi* technique).

⁸ *Zarabkhaneh* is a place to develop coins, what is now a bank.



Fig. 12: Plan showing passageway and *Chahar-Su* of Ghaysariyeh. Left Image from (Ministry of Housing and Urban Development, 2009), Right image from (Firooze 4, Isfahan Multimedia Encyclopedia, 2011)

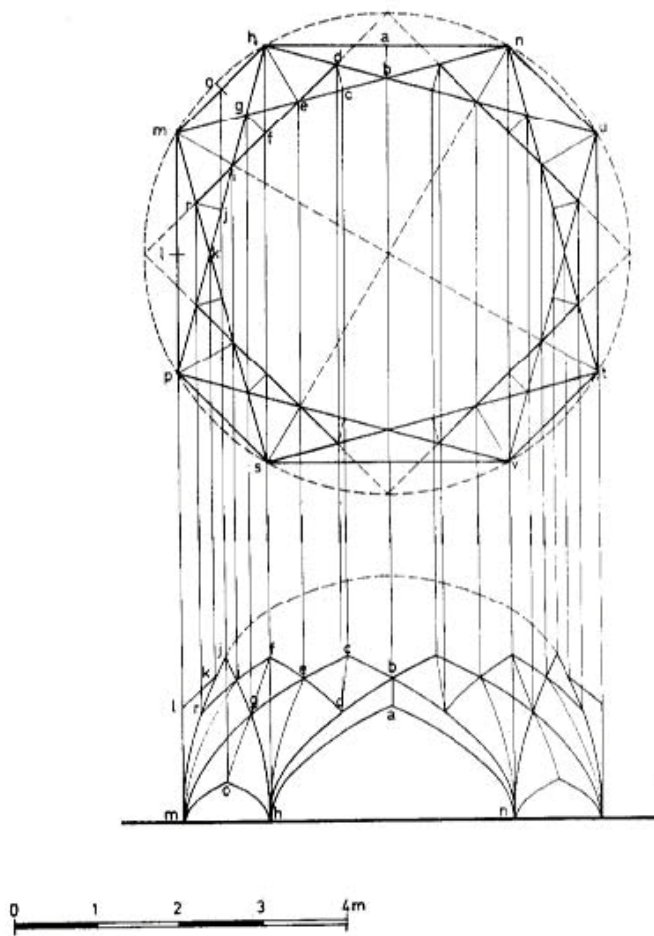


Fig. 13: Image from (Bozorgmehry, 2006).

6 CONCLUSION

This paper demonstrated how the bazaar is considered to be an essentially interior environment and the main effects it produces if it is considered to be one, and the geometrical principles and techniques that enable it to do so. It has shown that special attention has been paid to the experience of the viewer in the bazaar and that it has been designed and built not as a single building, but as an environment. Although the geometrical principles of the bazaar are strict and specific, at crucial points they tend to demonstrate a flexibility that enables them to function at both macro and micro scales, ranging from the main circulation routes to subspaces such as the *Chahar-Su*. It should be noted that the geometry itself does not form the overall structure of the Persian bazaar, but contributes to its creation; issues such as the program, climate, and context of the city all have vital roles in its overall form and structure.

One of the other key issues that the paper brings forth is the question of interiority in the architectural and urban scale. We tend to think of the city's public realm as an exterior environment, meaning that the single buildings generate private interiors and what remains outside is the public exterior; the study of the bazaar suggests an alternative to this perception, that it is possible to have an entirely interior experience at the scale of the urban context. However, this is not necessarily achieved with the insertion of single buildings and by emphasizing inside/outside relationships, but rather by adding another layer of spatial articulation to the existing city fabric. In other words the exterior of the surrounding buildings become the interior of this new layer (in this case the new layer being the bazaar). This new layer brings the possibility of creating intimacy in a formerly extrinsic environment. With the rapid growth of cities in the vertical and horizontal axis this possibility of creating intimate zones within an existing city fabric can be of great value. This characteristic offers the chance of establishing a closer relationship between the users and the surrounding built environment. Furthermore such a perception of architectural space implies a shift from considering the buildings as objects inserted into the urban context to a grafting of spatial conditions within the city fabric. In this understanding of space, the superficial façade that conventionally contributes merely to the creation of an exterior image gives way to a more internalized organization of space which is directly related to the experience of the building by the human body as it occupies it. The notion of the interior can also be understood as the internal logic that underlies a spatial organization. In the analyzed example the specific geometrical techniques orchestrate this spatial organization, thus an internal logic is provided which responds to external conditions such as the site and the changing of programs over time. Being tied to its context as if it has always been there, the internal logic enables the bazaar to adapt to change to a large extent⁹ while maintaining its coherent organization. In this sense we can witness the coexistence of two radically different ideas: being siteless and contextual at the same time. If we consider the fast and ever-changing landscape of the contemporary city today we can realize that such characteristics are not only outdated but well fit in response to the design problems that we face as architects today.

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⁹ Although the bazaar faces many problems today such as the passage of cars, the increasing population, and the demolition of the surrounding fabric, yet still it has managed to adapt to many changes overtime. The development of the bazaar has been through the accumulation of different architectural styles over time, by maintaining its internal logic; this archetype has primarily relied on evolution instead of destruction.