

Spatial Analysis of Khaju Bridge As An Urban Element, In The Context of Space Perception Through Senses

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Abstract: *According to the experimental studies of spatial meanings and architectural features of urban elements, the relation between senses and human perception occurs in spatial preference. With this relation it is possible to reach the preferred qualities of the places frequently used. When the perceptual features combined with time and historical knowledge it becomes a new perceiving methodology in terms of "spatial perception". Spatial perception is a kind of point of view that interacts with all senses and memorial accumulation. Because of this it is very important to understand the relation of senses and space in terms of spatial perception. In this study the spatial analysis of Khaju Bridge which is a major sample of spatial preference has done in the context of perception with senses.*

As a result, it is identified that, the factors that determine the quality of space are senses, perceptions and past experiences. These factors analysed in the context of Khaju bridge as a social space. By the interaction of all factors determined the quality of space, the spatial preference occurs. In this study, it has been proved that individually all senses and the interaction of them are important in designing the bridge and also in the user satisfaction.

Keywords: *Spatial Perception, Khaju Bridge, Senses, Spatial Analysis*

I. INTRODUCTION

From past to future, the artifacts and structures undertake important tasks by maintaining our bonds with past and carrying the universal values of cultural heritage. Historical structures are vital elements, that carries indications from past via their social, cultural and physical meanings and they transfer them to future by adapting these indications to the city's identity. One of the most important structures, which undertake the duty of transferring cultural heritage to next generations are bridges. A bridge can be defined as an element which maintains a bond and a relationship between two things. However a bridge possess environmental and lexical datas beyond this explanation. Bridges are not only architectural structures that bonds two places or only a transition element, but also sometimes the symbol/token of the city which they located, sometimes common ground of civilizations and sometimes the elements which undertakes the duty of embodiment/concretisation of identity and culture.

Khaju bridge has been selected as a case study because of its physical, cultural and social qualities. Khaju bridge is not only a social and historical space it is also a preferable place with its psychological, spatial and aesthetical values. The aim of this study is analysing the relation of spatial senses and physical characteristics.

II. CONCEPT OF SPACE

Space is perceived by senses, get meaning and content with time and have relations with our memories. In determination of spatial qualities of a building or structure the kind of relation with senses is very important. to understand the qualities of space it is necessary to understand the term of spatial perception.

Even the concept of place and the concept of space have similarities between each other substantially/fundamentally they contain many different meanings/contents. In general, place, is a part of space which is a convenient place for people to maintain their actions in it and partly separate people from environment that its space and borders are perceivable by observers. On the other hand the word "space" —even though by its meaning and content mostly used in philosophic texts— a word related ot architecture in the context of human relationship with place. when examining the dictionary meanings a concept of space described as;

- Qualities of perceived objects,
- A place which an object occupies in space, breadth
- Occupying space; the basic quality of perceived solid objects; quality of objects that settled in space and filled a part of space.
- Solid entity/presence (Web message 1).

Descartes, identifies solid entity as space occupying reality (*res extensa*) in the presence of soul which is considering asset (*res cogitans*). According to Descartes space contains not only evolvment on ground but also length, depth and width like space. According to him holding space is the quality of substance, in other saying its own self, oppose to that quality of soul and its own self is consideration/notion/idea. Idealistic understanding of holding/occupying space and understanding of space is isolation of space from substance-action-time synergy/togetherness (Yıldırım Ö.).

Human, holds space in place, and moves in it. In that case human belongs to the place as a spatial substance. This belonging is not only physical/substantial; human sentiment and thoughts are also bounded and dependent to the place. Hence, existence is spatial both physical/substantial and spiritual patterns, because human is not a body and a soul on contrary "a body with a soul. Because human body is practical, bodily/physical reality is understandable and reaching to soul—which is known and sensible but not understandable—is only possible via body/physical substance. This habit of existence is a good example for understanding the bond/link which place setup with space that place and space contains different meanings by their own but only produce meaning when they are together as a whole. Space is the soul of the place, and this description become known as a relationship system which contains persona, time, place and action togetherness. Space described in phylosophy as "existed in time and occupying space in place" (Cevizci, 2000) and in Ottoman Turkish situated as space (*hayyiz*) qualified by Orhan Hançerlioğlu as "the situations of space occupying objects about the place where they located from" (Hançerlioğlu, 1999). In other words space is immaterialized version of place or if place provides a spiritual transformation to a person who is located in it is a space (Web message 1).

Field-place-space anthology explained in Semiotics Dictionary by this means (Greimas, Courtes 1979:32): "Field filled with natural and unnatural objects with integrity and continuity which we perceive by our sense organs. Field turn into space upon human changes on field; by this way space identified as a constituted object." In other saying, who attributes a meaning to space is human, and with the same way human existence and also motions gain meaning/make sense as part of space. "In this circumstances space, is a enunciation of the peoples location on earth. This location, indicated with all objects, natural, unnatural, living, inanimate".

III. THE RELATIONSHIP BETWEEN SPACE AND TIME

The relationship between place, time and space is defined by Selim Tuncer as: Space elucidates a limited and measurable/finite place in infinite space. As period is a measurable part of time, so space is a part of infinite space which departed from it but also in it. However, the main factor that distinguish space from space which is an infinite void and what makes space space is it is filled with objects, persons, events or facts. Filling a delimited space... or transformation of a void into space after filling... (Tuncer S. 2009)

"Every work of art also moves in a time and space. Our World is a dynamic horizon as long as there is someone who still perceive it; it's the World that we perceive or design, it's not an objective and stable World: Perhaps there is no World that nobodys' World. Hence we can say that every knowledge about the World has at least three factors: the World itself (space), the subject(a specific person) who deals with it and the time(a specific moment) which they both appear in. If one of all these three factors changes even a bit/a little, the World is not the same World anymore. "Whether the topic is the real universe that surround us or a pictured or imagined narrative universe, if something is true for one of these three factors it's also true for the other two, and the location replacements in space will require time wise structure to re-regulated, in the same way every replacement in time will also obligate spatial and personal structures to re-regulated" (Yücel T., 1979)

At the Near East University 4. Photograph Day which held in 27-30 March 2005, Assoc.Prof Dr. Şefik Güngör, emphasizes in his memorandum "The Space in Photographic Vision" the importance of time and space in the process of understanding the outer World: " One of our basic necessities is to position ourselves in the universe that we are living in. According to the famous German philosopher Immanuel Kant, people looks at the World with a pair of glasses which has time categories on one glass and place categories on the other glass" ... On our three dimensional universe object and space are in a dialectical relationship. They are the complementary pieces of a whole. There is no space where the object is, and there is no object where the space is... The couple concepts of emptiness and packness, existence and absence are rise from this relationship. It is natural that this way of understanding universe reflects on the artistic creations as it is: There is also 'empty' and 'full' fields in the representative universe of visual arts. These could be sculpture or real as on the theatre stage or picture, photograph or could be nominal as in cinema. Eventually, they subserve observer to setup a relationship with the work of art similar to the relationship the observer setup with outer world, and to make up for a basic requirement of our detection mechanism. In the visual arts, objects finds their meaning as shapes that represents them. As for what makes shapes existed and determines their borders is the space that they contain or they are in. As it is seen/understood shape and space are strictly bonded and as it is stated above they are the shapes of a whole. Hence artists creates the meaning they want to create with/through not only designing shapes but also designing the space (Tuncer S. 2009).

IV. THE SPATIAL PERCEPTION OF SPACE

Architecture is the science and art of construct and design the necessary places for to facilitate people's life and to continue their actions such as sheltering, entertainment, study etc. The architect Vitruvius who lived in 1st Century B.C. defines architecture in his work 'De Architecture' as "Utilitas Firmitas Venustas". Architecture is a type of art that depends on social structure, necessities of society, economical datas and technological developments.

Perception has a great role in the existence of place that is the main objective of Architecture. Perception is the interpretation process of experience knowledge through senses. The factors that have influence on perception are divided into three as; perceiver, perceived and situation.

Perceiver; Interests, expectations, experiences, motives, manner

Perceived; Innovation, movement, sound, size, proximate, background.

Situation; Period/Time, working conditions, social conditions (Web message 2).

According to Lang perception consists of two process, these are "sensory process" depending on our senses and "mental process" depending on knowledge.

While, sensory process is the process that we commentate knowledge's and data's we receive form environment through our senses, the mental process is the process that we conceptualise the environmental knowledge which we obtain by our senses or that we cannot distinguish, depending on our life experiences and with this way constitute on our minds (Lang P.J.1977). With combination of these processes the spatial perception of place comes true.

V. THE IMPORTANCE OF SENSES IN SPATIAL PERCEPTION

Perception skills that collects initial datas about perception could differ according to the person's physiological capacity. We see, hear, taste, smell and touch via our sensorial organs and then correlate and associate the collected senses together to feel and apprehend. While objects gains meaning with the skill of grouping or unbundling the received data with senses, place is perceived by all of the messages. As Aydinli stated: "the spiral mesh relationship between sentimental, intellectual course of actions of physical specifications of place and the functional process of life gives the concept of place open to change and new meanings"(Aydinli, 2008).

According to Ching: "Place constantly wraps up our existence, it moves throughout spatial volume, we see shapes/forms and objects, hear the sounds, feel the breeze and smell the flowers blooming in the garden. Place is a physical essence/core like wood and stone. However it has no shape/form as from its nature. Its visual shape/form, the quality of light, its dimensions and it's scale totally depends on to the borders that defined by elements of total form. As place apprehended and surrounded and inserted in a mould/pattern and corrected by formal elements, architecture gains meaning"(Ching F.D.K, 2002).

While Leland commentating architectural perception; he explains the process of perceiving place and apprehend this way: "The pleasure we get from architecture gains its value in our understanding/perceiving of it" and he continues; "This value is about how the eye and the mind (reason) perceive and interpret the image related to the architectural life. Perhaps the major concept/notion is the reason is programmed to seek meaning depending upon the communication between all the knowledge that send to the reason itself and senses. This is with no doubt related to the survival instinct. Reason endeavours to engraft the given knowledge in a reasonable template. When the given data is not reasonable, reason could not understand it. Even the reason is given totally random visual or aura/audio phenomenon's, reason add a pre-comment to them based upon its evaluation informatics that previously stored. Thus what we perceive depends on what we knew previously/before" (Leland, 2006).

Juhani Pallasma who gives importance effective role to senses in architecture and perception of space, describes sense of sight as below;

"Seeing separates us from the world but other senses combines"

Pallasma aims to create a short circuit between the suppressed sense of touch and dominant sense of sight. By doing this he tries to emphasizes that "in fact" feeling and perceiving occurs through the interaction of all senses (Pallasma J. 2014).

Merleau-Ponty says that: " My perception is not the total sum of visual, tactual and audio datas. With all my existence and with a integrated manner my perceptions; I apprehend a unique existence form, that simultaneously speaks to all my senses" (Ponty,1945).

In this context, physical place gains sight with images, it can be felt by its tissue, smell and taste, it can be heard by its sound, however, after passing through time filter it can be perceived with our senses and experiences and by this means it transforms into space. As a consequence, we can say that senses has a great role of perceiving rural space and collocation of senses is the contributing factor to determining the quality of space.

VI. THE RELATIONSHIP BETWEEN SPATIAL PERCEPTION AND SPATIAL PREFERENCE

When it comes to the quality of rural space, perception compounds and sense perceptions steps in. This quality as a multi dimensional concept is consist of the datas of social life and effects rural space and citizens social life within reciprocatively interaction. Perceptions and time determines the quality of rural space and produce user satisfaction. The factors that determines user satisfaction and living space preference in rural space, are determined depending on how various rural and common/public operations/services have done and how the user necessities are compensated (Rafieian, Khodaei, 2009). In this approach, according to Daneshpour; there has to be three basic specifications in the perception of place and user preference and satisfaction with environment and human relationship.

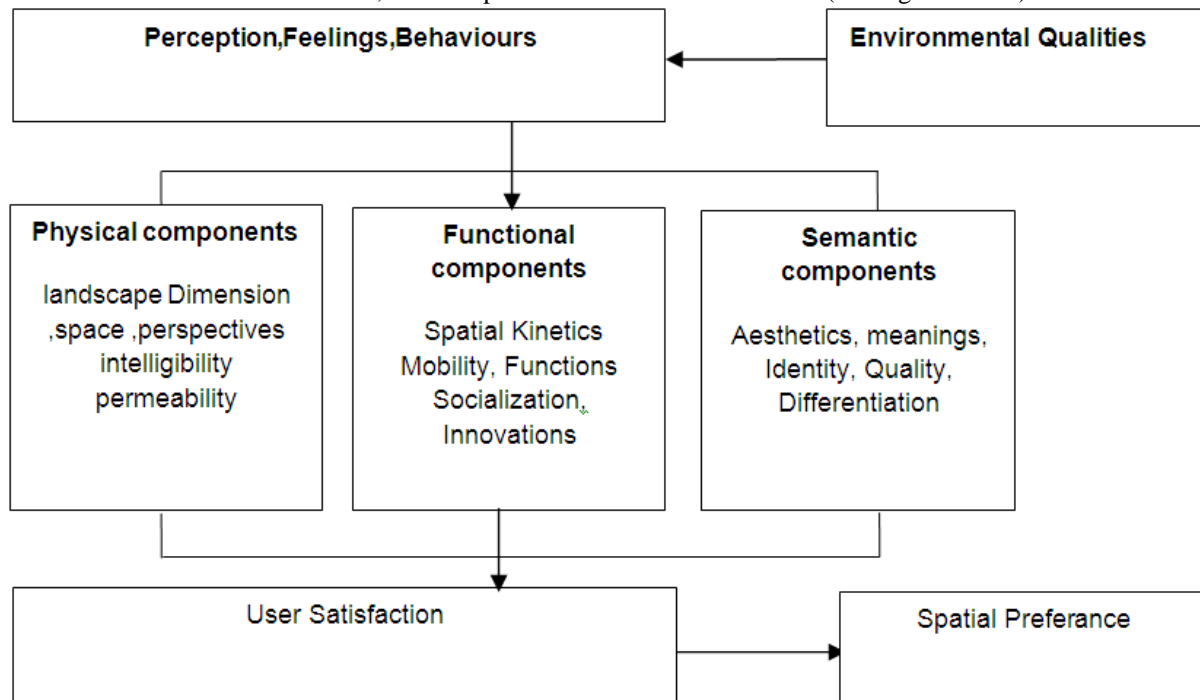
Physical Compounds: These are view, criterion, symbols, perspective, readability, permeability... e.t.c. According to Lynch these specifications are auxiliary specifications to determine the identification of environment and recognize it (Lynch K.2010).

Behavioural Compounds: These are users, activities, spatial liveliness and dynamism, peace, socialising and sounds... e.t.c.

Semantic Compounds: These are meaning, concept, attraction, aesthetics, identity, quality, discrepancy, perceptual functional, perception on qualities.

In this context, accessibility and integration of bridges, gates and roads, publicity holism, effects of peace and spectacle, various functions and areas of usage, privileged qualities and representation, discrepancy, control-security and the bonds they created with past, are important parameters on quality of space and user satisfaction/preference (1. Model).

Table1: 1st model, The components that effects satisfaction (Khaleghi N.2012)



In the earliest theories about the satisfaction and living space preference the importance of human and environment relationship has been stated (Motalebi, 2002), however it is gradually defended that environment and human behaviour are connected to each other, interactive and constantly transforming, and it is also defended that at the preference of living space this situation is important (Altman 1975). At the same time there held exercises about the bond between qualities of environment and personal perception and preference is based upon perception (Lang, 2004).

According to these approaches blue-ribbon environment is preferred in terms of living space by courtesy of its physical, social or symbolic features, and these features strengthened via personal perception.

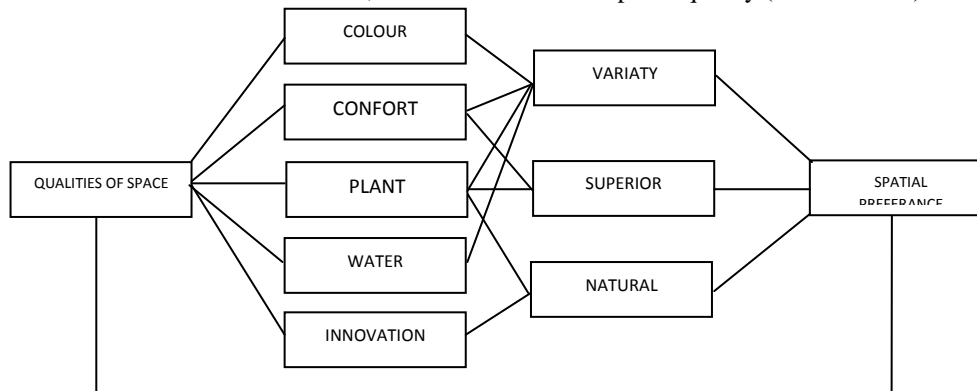
With this way we can divide people behaviour at the public spaces into three: Mandatory actions, optional actions (arbitrary) and social actions. Of all these three actions are in need of different features in environment and they could be affected with environments quality, they can be decline or grow stronger (Gehl, 1967). According to Jahn Gehl who researching and rewieving design at the open places especially arbitrary actions are affecting from environment and structures' spatial qualities mostly. (Table)

Table 2: Actions and the quality of enviroment(Gehl, 2007)

Quality of Enviroment: Weak	Quality of Enviroment: Strong	Actions
●	●	Mandatory
●	●●	Arbitrary
●	●●	Social

Egon Brunswik, has developed a special model in environment-behaviour relationship. According to Brunswik, psychology discovers the rules of behaviour and also ensures the comments and explanations of it (Neisser, 1967). The significance qualities as beauty cannot be perceived directly but measurable features leads perception and subjective senses perceives the beauty. For example water and plants shows the place natural and superior but being in, staying in and feeling in place increases the preference of space.

Table 3: 2nd model, Brunswik's model of spatial quality (Gifford 2000)



On the other hands, according to environmental preference theory by Stephan Kaplan and Rachel Kaplan, to have a strong spatial feeling, it should be a strong relation between communication, space and view. By this relation space or view would be preferable (Bell, 2001).

VII. CASE STUDY-KHAJU BRIDGE

A bridge can be stand for "which bonds two shores, that drawn apart by any reason, or a structure which made out of wood, masonry, concrete or iron, and maintains a traffic stream to pass above another traffic flow by not cutting each other. Also stand for: "the thing that provide a connection/bond or relationship between two things

Urban spaces are the realms where individuals live and which holds symbolic, nominal and lexical indications about the individuals' identities and who they are going to be. In this context, it's more preferable to use the concept of urban spaces instead of using concept of urban places. Because, to describe the relationship which constituted by human, between human and place/space and to find equivalents of this relationship in the context of movement, feelings/emotions and cognitive place, the word "space" comes into play. According to Burke 2008, Khaju Bridge is a bridge in the province of Isfahan, Iran, which has been described as the finest in the province. It was built by the Persian Safavid King, around 1650, on the foundations of an older bridge.



Figure 1: Painting older bridge Khaju.(Web İletisi 3)

Serving as both a bridge, and a dam (or a weir), it links the Khaju quarter on the north bank with the Zoroastrian quarter across the Zayandeh River. Although architecturally functioning as a bridge and a weir, it also served a primary function as a building and a place for public meetings (Burke A.2008). This structure was originally decorated with artistic tile work and paintings, and served as a teahouse. In the center of the structure, a pavilion exists inside which Shah Abbas would have once sat, admiring the view. Today, remnants of a stone seat is all that is left of the king's chair. This bridge is one of the finest examples of Persian architecture at the height of Safavid cultural influence in Iran. Khaju bridge is "the culminating monument of Persian bridge architecture and one of the most interesting bridges extant...where the whole has rhythm and dignity and combines in the happiest consistency, utility, beauty, and recreation (Chardin J., Ferrier R.W 1996).

Khaju Bridge has 24 arches and is 133 metres long and 12 metres wide. The pass way of the bridge is 7.5 meters wide, made of bricks and stones with 21 larger and 26 smaller inlet and outlet channels. The pieces of stone used in this bridge are over 2 meters long and the distance between every channel and the ceiling base is 21 meters. The existing inscriptions suggest that the bridge was repaired in 1873.

Khaju is one of the bridges that regulate the water flow in the river because there are sluice gates under the archways over the river. When the sluice gates are closed, the water level behind the bridge is raised to facilitate the irrigation of the many gardens along the river upstream of this bridge.

On the upper level of the bridge, the main central aisle was utilized by horses and carts and the vaulted paths on either side by pedestrians. Octagonal pavilions in the centre of the bridge on both the down and the upstream sides provide vantage points for the remarkable views. The lower level of the bridge may be accessed by pedestrians and remains a popular shady place for relaxing (Parsipour M.2010).

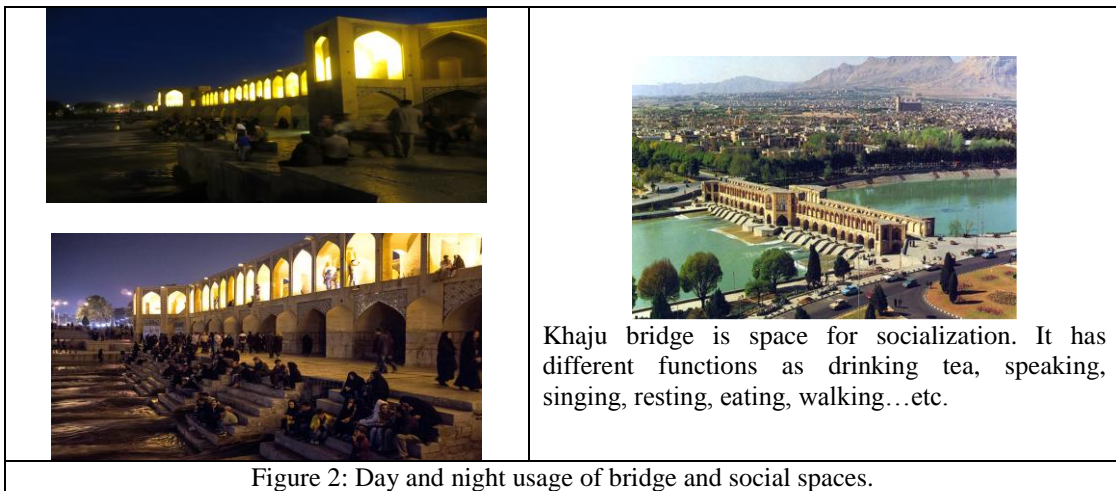
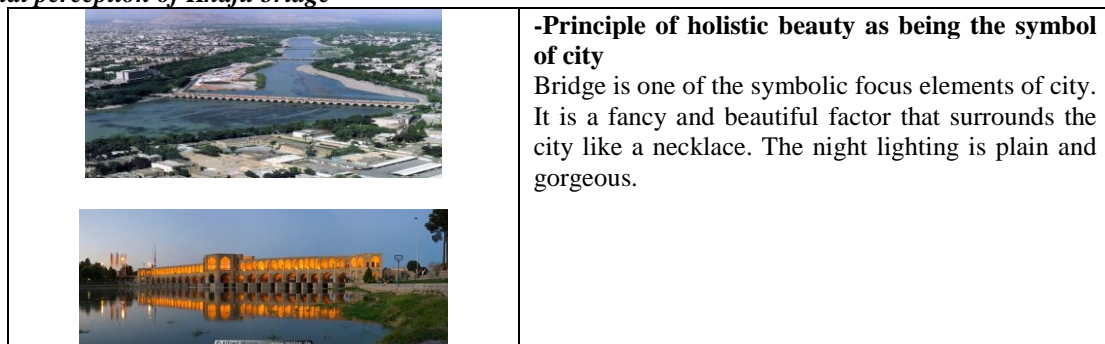


Figure 2: Day and night usage of bridge and social spaces.

Visual perception of Khaju bridge




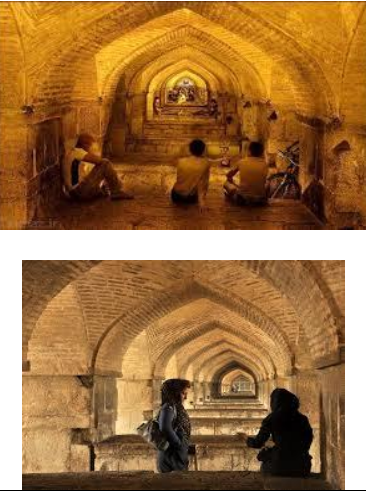
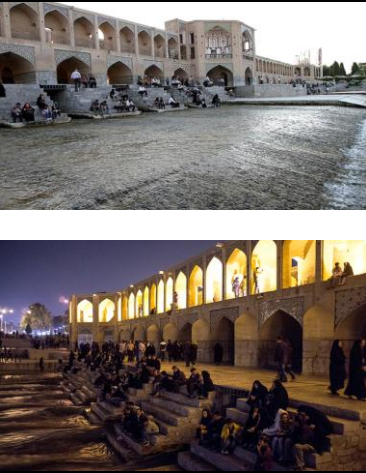

	<p>- The continuity and everlastingness effect in bridge The bridge is 133 meters long and it consists of 24 arched unit. The continuity and the everlastingness feeling of upper elevation walkway strengthens the visual effect.</p>
	<p>-Personal effect in the context of unit volume As a consequence of repetition of arch form and modules, continuity and depth effect was given in the interior place. These units that shows continuity of whole also allows for private place disintegration for groups.</p>
	<p>-Glance to the water over the bridge, movement/kinesis The waters of the river Zayende Rud jammed at one side of the bridge at the flow direction and set free at the other side of the bridge. This process cause the water to gain speed and get curvature in the arch form. It is also a visual feast to water to curvature in the arch form as much as the arched divisions of this bridge that its visual aesthetics are foregrounded.</p>

Figure 3: The visual perception of bridge

The aural perception of Khaju bridge

	<p>-The voice of the crowd in respect to person density Owing to the climates warm affect Khaju bridge is a social place where become intense at evening hours and a place that people of Isfahan comes as a family. Because of that the voices of children, chats along with the view and the sounds of people sings constitute the sound of crowd.</p>
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	<p>-Echo and acoustician the unit volume</p> <p>Khaju Bridge is consists of repetition of unit modules and pointed arches. This structure creates the specialized places in the unit volume and separate it from passing place.</p> <p>In the unit volume the voices are not scatters and stays inside of itself. As to the passing sections that link units the acoustic effect is getting higher and the voice that hits to the arches are disappearing by growing gradually. This situation gives courage to the people and the persons that effected by the view and special interior place started to sing.</p>
	<p>- The differentiation of sound volume at Ground Floor/ Upper Floor</p> <p>There is a sound differentiation at the Khaju bridge which consists of 2 floors. While The ground floor which held crowd and the water has rich environmental sounds and motile on the upper floor there are special and calm volumes, continuity and everlastingness effect and peace.</p>

Figure 4: The auditorial perception of bridge

Tactical perception of Khaju bridge



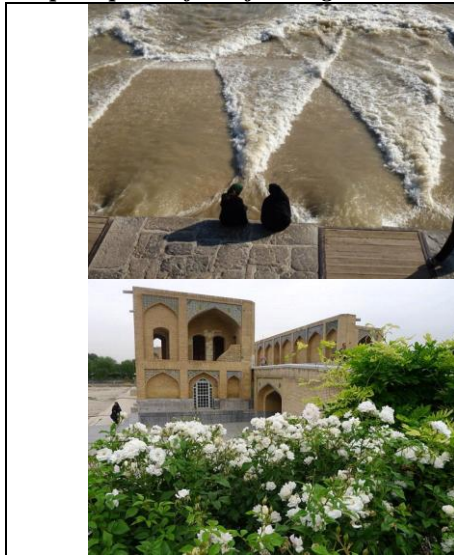
 <p>Because the colours and tissues depending on historical and lexical/semantic datas, it generates/creates antecedent indications and refers to the persons subconscious who look and touch it.</p>	<p>The feeling of wind/breeze, the tissue of stone/mud brick, touch point with water (visual and physical contact) and the stone tissue of the ground, they all create a sense of dependence/fidelity and strenghtens the tactual perception.</p> 
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Figure 5: The tactual perception of bridge

Olfactory perception of Khaju bridge



The refreshing smell of the water which is jammed at one side of the Zayende river and transferred to the other side gives a freshness to the place.

The scent of the flowers around combined with stone and mud brick gives the place liveliness and sense of naturality/naturalness.

Further to all these elements the scent of tea from the tea house is an important smell perception that strengthens the loyalty, family and feeling of warmness.

Figure 6: The olfactory perception of bridge

Taste perception of Khaju bridge



The sense of taste takes action with other senses took action and with the arousal of pleasure centres.

The physical and perceptual qualities of the place revives feelings like peace, liveliness, energy and happiness and hence the feeling of taste is also affected.

This mobility leads the people around to the dinning venues and provides inter-place flow.

Figure 7: The taste perception of bridge

VIII. CONCLUSIONS AND REVIEW

The quality of actions determined by senses, perceptions and past experiences. These determined qualities perceived on the spatial platform if they are in an interaction with each other and only in this circumstance we can talk about the concept of aesthetic and user satisfaction. As a consequence, spatial(living place) preferences steps in and the user prefers that place.

As a result we can say that Khaju bridge in a spatial context is triggering the user satisfaction and being preferred as it provides the criteria of physical elements that effects the satisfaction as view, dimension/size, symbols, perspective, place, legibility, permeability and functional elements as sound, liveliness, dynamism, novelty, peace and sociability and semantic elements as aesthetic, meaning, charm/appeal, identity, quality and differentiation.

According to the analysis it can be seen clearly that Khaju bridge is a rich sample with its spatial qualities. Visually, aesthetically, tactually, aural and olfactively, the bridge has deep and large impact factors for the people living in Isfahan and visiting tourists. These factors effects user satisfaction and user preference. Khaju bridge makes this affection by touching the peoples senses with acoustics, textures, smells, lighting, geometry and architectural qualities.

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