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Improvement Of Spatial Structure of Roodsar City Houses Using Space Syntax

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ABSTRACT

The variety of contemporary houses and overlooking the efficiency of traditional house patterns has required for the harmony with needs of dwellers and revision of space syntax in modern houses. The present paper aims to compare and analyze spatial organization of modern houses and to find inefficacies and then remove location- behavior stresses using revision in their space syntax. The current study takes analytical approach and is deemed as studies by empirical test. Thus, it employs empirical test method using UCL Depthmap software for the selected samples from the houses. In this regard, it proposes assessment indicators of qualitative analysis on houses at three levels i.e., space-function, space-behavior and space-form. Then, it utilizes three parameters of integration, connectivity and depth in quantitative analyses. The research findings show that Traditional house are created in adaptation to environment and behavioral system of inhabitants while modern house possesses single-purpose spaces and it is not clear whether it could meet the different patterns of modern space-behavior parameter or not. Although isolation of private and public spaces is properly seen in modern houses, it does not seem that any attention is paid to limits in ranking (hierarchy) for its entrance spaces. It is ignored to utilize special lighting conditions in geographical directions in configuration of house spaces e.g., kitchen and sitting rooms etc. in modern houses. Modern house versus traditional house has more connectivity in terms of space syntax, but at the same time it has not also proper configuration for semi-private and private space.

***Keywords**: Space syntax, Traditional housing, Apartment, Roodsar city, Depthmap*

1. INTRODUCTION

Doubtlessly, architecture always interacts with culture so that they may affect each other and both are influenced by them. The house architecture has served as one of fundamental symbols of social life and reflection of community culture in human settlements and it forms along with totality of social system governing over human culture within any ethnicity or nation. From another viewpoint, what makes the house as an important cultural and social dimension is that this phenomenon deeply interacts with individual and communal identity (Ileca, 2015: 167).

In other words, house does not only include form, but it is the space constructed for meeting of a complex group of needs. House construction is mainly intended to create friendly environment to human lifestyle. In addition to meeting of individual needs, house should be capable to satisfy social requirements for human as well (Poordeyhimi, 2018: 14).

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Theorists such as Rapoport have examined this significant role in creation of various architectural works including housing architecture (Peyvastehgar, 2017: 6).

The various spatial values of a location were analyzed by means of quantitative techniques for the first time and based on factor of spatial differences in a theory posited by Bill Hillier (1986) and it was called Space Syntax. Until this time, spatial values were assessed only by qualitative techniques in different theories, but utilization from quantitative method along with qualitative technique in space syntax prepared he ground for analysis of relationship among culture of inhabitants and spatial values of their living context as a new outlook in this respect.

Accordingly, first of all it is discussed about way of spatial arrangement of houses in this region using architectural review and analysis on traditional houses and modern houses of Roodsar city in this paper. Afterwards, the created changes in spatial arrangement of houses are analyzed and the rate of compliance is analyzed among parameters of location-behavior and consequent behavioral system. In this respect, the concept of house and theoretical basis of space syntax method are presented according to theoretical studies at the first step and then some samples of traditional and modern houses in Roodsar city are selected using random sampling method and they are analyzed by means of quantitative and qualitative techniques. The qualitative analysis is implemented according to location-behavior parameters including space-function, space-behavior and space- form indices. Using UCL Depthmap software as well as three parameters of integration, connectivity and depth and two analytical graph-projection and convex techniques are utilized for quantitative analysis on samples. At the end, the given results from analyses are comparatively assessed and strategies are presented.

1-2- Research questions

- What transformations have been created in space syntax of Roodsar city houses over the time?
- How much such changes are consistent with parameters of inhabitants' location- behavior and sociocultural values of the people in space syntax of houses?
- How can we improve architecture and spatial organization of modern houses using space syntax method?

1-3- Research hypothesis

Compared to modern houses of this city, spatial organization of traditional houses in Roodsar city possess more compatible spatial arrangement with parameters of public location-behavior.

2. Methodology

Space syntax approach has been properly assumed as research type of logic reasoning. Wang denotes system foundation of grammar of form as follows: 'Architecture requires for division of various space parts. Such separation may result from illuminated lines. Architectural space is created by organizing a system of shapes. From the same token, architecture is related to natural and cultural phenomena resulted from nature- human practice.' This system has been founded by this notion that natural and manmade forms can be converted into accurate organizing rules for relations between lines and space. Sum of these rules makes up a grammar that can describe composition of the existing works at initial levels and may probably reveal unknown characteristics for the designer. Thus, secondary studies will be benefitted from its defined factors (Groat & Wang, 2016: 305).

This paper employs space syntax technique for some houses and therefore it operates with some variables which can be both measured and manipulated e.g., integration and or depth of space. Therefore, it is included in empirical test studies. In fact, this essay has utilized findings of a logical reasoning research to test them in a few houses. The methodology of current paper is also based on empirical test techniques ad according to book of Groat.

3. Research path

The path or steps taken based on this method are as follows:

I: Presentation of a history of space syntax technique using analytical method and by attribution to librarian studies;

II: Selection of 21 case-studies, 7 traditional houses, 7 modern villa houses, 7 modern flats (apartments), using random sampling method as well as observation and field study;

III: To identify variety of activities and behavioral system created in space types by means of observation and interview;

IV: Analysis and evaluation of specimens by the aid of space syntax expert software (UCL Depthmap);

V: Comparative analysis on the given results and final conclusion

4. Approaches toward house

4.1. Concepts of home and housing

Term 'home' (*Maskan*) is the place noun denotes resting location and settlement (*Sokoonat*) is derived from the root 'settle'. Lexically, housing is called to the place where human lives. Dehkhoda Persian Thesaurus, home (*Maskan*) pertains to the concept of location of inhabitance and house and place for settlement and position and calm place. (Dehkhoda Persian Thesaurus: Entry for term '*Maskan*') Also Iranian Statistical Center defines it in this way: 'Residential unit is a location, space and or site where some families live and it includes one or more entrances (Public Street or Private Street).' (Iranian Statistical Center: 1996) Term housing 'Maskan', as a shelter, may comprise of several economic, political, and sociocultural definitions in community's mind. (Davoudpour, 2019:18) After food and cloth, housing is assumed as the most basic biological needs for the human and very important for survival of individual and society. Each member of community from any class or group needs to shelter and suitable settlement specified to their own lifestyle (Zanjani, 2015: 156). The social parameters are assumed as one of devices and methods of recognition to housing features thereby one could identify effective factors on housing issue and provide for any type of proper planning and decision made for housing (Arjomandnia, 2015: 54).

The home has been expressed differently as symbol of housing and the most private architectural space during various periods. Various communities and cultures take different approaches toward housing; some these impressions about home and housing in Table 1.

Table 1: Concepts of home and housing from viewpoints of thinkers (Authors, 2020).

Concepts of home and housing	Researchers
House as self; there is a type of symbolic relation among self and house in human mind; therefore, home is something more than housing (Marcus, 2003: 87).	Clare Copper Marcus
The home is a sample of microcosm we also build us rather than building of it (Schulz, 1974: 50)	Christian Norberg Schulz
The material and spiritual life of human forms in the home. Settlement is clear and distinct sign of existence per se; the existence against which the human is mortal and thinking is a necessary factor in housing and settlement phenomenon. Settlement is the product of thinking and construction, but if these two are not put together, settlement is not realized (Marcus, 2003: 88).	Martin Heidegger
The home is not an object or machine in which we live, but is a world human creates it for oneself by imitation from genesis model of deities i.e., universe genesis (Eliade, 1964: 51).	Micea Eliade
The houses are designated for living not for looking. Thus, their use is deemed important than their appearance unless both points are gathered in a house.	Francis Bacon
Just as the house and otherwise are included in main division of geographical space, self and other are considered as division of soul's space. The house both encloses the space (interior) and repels it (what exists outside). Therefore, house possesses two very important and different parts: Interior and façade (Bachelard, 1964: 45).	Gaston Bachelard
House form is derived from shape of temple (house of deities). This shape is the symbol of initial beliefs of human about world tradition and form (Raglan, 1964: 111).	Lord Raglan
The house is assumed as an institution at first place not a structure and this institution has been made for very complex purposes. Whereas construction of a house is a cultural phenomenon, its spatial form and organization is strongly influenced by culture to which it belongs (Rapoport, 1969: 50).	Amos Rapoport
House is the center of the world for its inhabitants and serves as the most salient structure for the locality toward consolidation of location concept (Zarghami & Sadat, 2016: 62).	Charles Villard Moore
Alexander posits and describes anonymous quality within housing context; he presents a gem to them by forming of living environment based on human nature and experience of human being for thousands of years and to withdraw it similar to the past periods since they have forgotten it (Alexander, 2007: 92).	Christopher Alexander

This real nature is a settlement; that is a place for peace, a shelter not only against difficulties, but versus fear, doubt and detachment. It is not a flat if it is not so, but it is a part of outside world we have built a roof over its top.	John Ruskin
House is a machine for life (Gardner, 1996: 32).	Le Corbusier
Personal home may be assumed as a 3D space that includes a family composed of certain number of individuals. It is clear that there should be a direct relationship among human's internal and spatial life as the basis for objective actions of his/ her daily life (Judat & Miawaki, 2008: 31).	Tadao Ando
Architecture can be interpreted at three levels i.e., practical, semantic and hybrid. Based on practical utilization, the house is the space where one could do easily all of home activities. Under semantic mode, house provides the space thereby the people are enabled to get rid of greed, alienation and stresses of urban life and in hybrid condition, house is most primitive type of architecture in which the relations can be combined within architectural elements (Ibid: 32).	Toyo Ito
The home is the place the inhabitants do not feel uneasily. The house interior should be highly diversified so that not to get tired (Pirnia, quoted from Memarian, 1996: 33).	Mohammad Karim Pirnia
Among the surrounding spaces, house is the most immediate space relating to the human. Human is daily affect by it and influences in it. It is the first space where human feels spatial belonging sense. The group of five senses passes constantly through it and they are shortly accustomed to it. Home is the only location in which the first immediate experience of space takes place in isolation and within group. Privacy for oneself, spouse and children and others is totally possible without intrusion by other. (Haeri, 2009: 62)	Mohammad Reza Haeri
Housing serves as a shelter against coldness, heat, noise and others. Housing is similar to the fire i.e., family center for nutrition, protection, loneliness and relaxation etc. Housing acts as nature to provide sunlight, green space and peace (Judat and Miawaki, 2008: 25).	Mohammad Reza Judat

What is more clearly visible in most of these impressions is the attention paid by thinkers to relationship and interaction among human with his/her home and habitant within different fields and consequences of this bilateral tradeoff emerge. The theorists call the house as a dimension of human's self. They think there is a direct relationship among intellectual life and living space of human and that denotes concept of place and immediate spatial experiences. It can be implied according to this definition that many thinkers have persisted in this fact that the house may meet material, trans-material, mental and spiritual needs for human and except Le Corbusier who has highly and obviously reduced the position of house, other scholars have referred more or less to immaterial dimensions of the house.

Paying attention to various notions about house is deemed important in this paper because Assessment of the given houses will be finally done according to the same expectations from house architecture. In other words, type of attitude of this paper to the houses may clarify the criteria used in evaluation of them. The fact that why architecture has been noticed for traditional house in hypothesis of current paper is that Iranian traditional houses have always managed to have high utility by establishing duly relation with lifestyle and social conditions at their time. Traditional housing possesses an apparent vision and an intrinsic nature that is expressed by code and allegory. The appearance of traditional housing is summarized in functional spaces and clear geometry, but its intrinsic nature results from a higher fact existing in human nature (Masayeli, 2017:28-29).

4.2. Types of houses

4.2.1. Traditional house

It is a kind of house that has been built before the given changes by the effect of contemporary architecture based on principles of spatial organization and techniques of traditional architecture.

4.2.2. Detached villa house

It is variety of house with both closed space and open private space (yard); and place of living for one or two families. This type of house may often be found in old city texture and it includes a great number of rooms. The relatively large and independent houses are called and well-known as villa house in new urban texture. Those localities in which this type of houses are built, are considered as very low density zone.

4.2.3. Flat houses (apartment)

The further part of city houses are the same in metropolises and medium-side cities. Given the apartment houses are built in low-income and or high-income areas, they will be various in terms of size and type and amount of variation. The residential apartment texture is specific to high-density urban areas. These areas possess particular sociocultural features of which one can refer as urban lifestyle (Iranian Statistical Center, 1996: 97).

5. Space Syntax

Memarian has translated terms 'Space Syntax' and added this explanation: 'Term of syntax means order of words in the sentence in literature.' Ferdinand de Saussure divides relations between words into two categories:
Syntagmatic: It refers to various roles the words play in sentence structure. (Syntax)
Associative: It is role of word outside the sentence. (Morphology)
Therefore, one can select term syntagmatic for this word in Persian (Memarian, 2002: 75).

5.1. Background of space syntax technique

The necessity for a comprehensive method, which could specifically show a clear relation among formative texture of environment and public behavior, was led to emerging of space syntax technique. This method was introduced by Bill Hillier and Julian Hanson in Bartlett School at the end of 1970s and during four decades following to theoretical development; on the one hand, and expansion of space analytical techniques and solutions; on the other hand, it is converted into modern form. Software development, especially in 1980s, led space syntax to the current status and this was mainly due to achievement of extensive studies conducted in Bartlett School in London. During recent decades, Georgia Tech University in USA and some of universities in Netherland, Sweden and Brazil have done several activities in this regard. Table 2 shows the processes of development of space syntax theory. Memarian and Abbaszadegan (2002) were also among the first researchers, who have introduced space syntax approach in Iran. Later, several studies have been also conducted concerning urban textures by benefitting from this theory in Iran.
Space Syntax is a theory that addresses configurative aspect of space; the dimension that distinctively affects social life of citizens of a city or behavior of persons inside a building and it can be called as one of the foremost and contemporary methods of space morphology (Hillier & Hanson, 1985: 164). It can be mentioned by simplest explanation that space syntax is a technique which deals with study on space configuration at architectural and urban scale in order to describe quality of mutual effect of space configuration, social organization and behaviors. Theoretical foundation of this dimension is that space configuration is the foremost factor that affects practice and method of utilization and presence in the constructed space (Hillier, 2007: 62). Therefore, space syntax indicates that how status of space configuration expresses a social or cultural concept (Dursun, 2007: 51). Space syntax theory mainly aims to find way of social relations in space e.g., limits and degrees of privacy and public status of spaces. The configurative relation of all spaces is analyzed with each other in space syntax technique and space features are presented by mathematical and graphic factors (parameters). Mathematical parameters may be employed in in making a pattern about way of prediction of function and behavior in the space. In other words, the consequence of formative changes in space is recognized both in urban and architectural spaces in subjectivity and thus behavior of inhabitants by the aid of space syntax technique.

Table 2: The development process of space syntax theory (Authors, 2020)

First phase	1970s	-Morphological studies done by Steadman and development of graph theory in architecture - Working on real contexts, local and organic buildings - Finding of productive factors and hidden behavior patterns of species (genotypes[4])
Second step	1980s	-Presentation of drawing technique called justification diagram -Publication and presentation of theoretical bases in book of 'the social logic of space' by Hillier and Hanson
Third step	Since 1990s	-Development of analytical methods and publishing book of Space is the Machine by Hillier and Hanson -Globalization of space arrangement method and publication of several books and papers by them - Holding of Space Syntax Biannual Seminars

[4] - Genotype or hidden lifestyle is a group of information placed within a species. Genotype is defined in architecture as internal information hidden in architectural space.

5.2. Concept of space

Space is a word that is widely used in several fields and different areas including philosophy, sociology, architecture and urban design. However, the frequency of usage of term 'space' does not mean the same notion for those fields and definition of space can be explored from various viewpoints. Studies show that despite presence of common dimensions seems to be derived from this term, almost no census is visible unanimously about single definition of space in scientific fields and this term has relatively high frequency so there is no certain and comprehensive definition about this term that can cover all aspects of this concept.

What clear is that human life and any action s/he does has also a spatial aspect because it occurs within the same space. Human attachment to space is deep-rooted. This attachment originates from human need to have relationship with other humans it can be fulfilled by various languages. Similarly, human may adapt oneself to physical objects by physiology and technology and thereby a dynamic relationship and balance may be created among human and environment (objects) rather than relationship among humans. These objects may be classified according to one or more specific internal and external relations, far or close, single and united, continuous and discrete ones. In order to enable human to realize his/ her imaginations mentalities, s/he should perceive these relations and coordinate them within a single spatial concept. Thus, space does not represent a specific type of communication, but it is a comprehensive form that covers any type of relationship either between humans or among human and environment (Madanipour, 2018: 78).

Amos Rapoport is one of the most important space theorists. Rapoport assumes human actors as one of important space factors. Accordingly, he classified theories about space in three categories:

1- Theories in which space is assumed as determinant in human relations.
2- Theories in which human relations are considered as space formation factor.
3- Those theories where the space and human is assumed in mutual interaction (Rapoport, 2002: 86).

In this study, it is emphasized in interactive dimension of space and mutual relationship among human and environment.

According to opinion of Hillier, an independent definition should be proposed for the space; a definition that is not concerned with space usage or imagination and or it should not reduce space to abstract background of human and objects based on Cartesian attitude. It is the space which defines relations. This definition assumes space as equivalent to configuration or arrangement. Configuration refers to perception of totality of organization type. Two space types may be separated from each other in this regard: small space scale and large-scale space. Buildings organize the space and define the social relations and activities outside and inside their own. Therefore, buildings convey social notions and values.

5.3. Parameters in space syntax theory

Benefitting from five parameters in space syntax theory, space is explored and assessed as follows:

5.3.1. Connectivity

It is frequency of accesses to a specific space that is directly related to other spaces. For example, rate of connectivity of given space that possesses three entries to its adjacent spaces is three (Lima, 2001: 36).

5.3.2. Integration[5]

It represents rate of continuity or detachment of a space from general system or less second-order system. A space is more integrated if it is more consistent and united with other spaces. This parameter has linear relationship to parameter of connectivity so that the more integration is the same as more connectivity (Jiang, 2000: 42). The concept of integration can be defined as follows: The rate of integration of a space is the mean number of mediating spaces thereby one could have access to other spaces. Thus, integration has connective aspect in space syntax technique and nit interval and metric dimension (Noorani, 2017: 16).

5.3.3. Depth

It shows that it should pass from a few other space in order to reach a given space; in other words, depth denotes number of changes in

[5] - It denotes putting together, consolidation, completion, joining and unity (Airanpoor English Dictionary).

direction takes place to reach from a space to another.

5.3.4. Choice

It indicates the rate of access and path in the given space. The space has a lot of choices if further number of connective shortcuts is passed through the given space (Klarqvist, 1993: 41).

5.4. Analytical methods in space syntax

Four types of analytical methods for space syntax are as follows:

5.4.1. Axial technique

A link diagram is given in this method based on this fact that how any connectivity line interacts with its surrounding lines. This method is mainly used for representation of texture of city, village and or a residential unit and related neighborhoods (Montello, 2007: 63). This technique notices the longest line 'access and vision' in space. Therefore, axial technique possesses a structure composed of open spaces which are given according to the longest vision line and access. For example, a street with several breaks the straight vision is not placed along it so it will be subject to a few broken axial lines (Noorani, 2017: 20).

5.4.2. Convex technique

All space is covered in two sides in this method. No part of line, which links two points in the space, is placed outside the space in convex space (Hillier & Hanson, 1985: 24). This method is more utilized in those environments where there is nonlinear free space e.g., the interior space at buildings where most of rooms have been along with it at both ends (Klarqvist, 1993: 51).

5.4.3. Isovist technique

This technique indicates vision fields from which they are visible from specific point and they are given by way of light reflection and it represents kinetic behavior patterns of people (Montello, 2007:22).

5.4.4. Visibility Graph Analysis (VGA)

This technique analyzes basic parameters in space syntax method using visibility analysis. This analysis results in a map in which any parameter is shown blue within red color spectrum the maximum to minimum range of parameter is revealed.

Drawing convex space and linear maps are to strategies presented by space syntax theory to convert continuous space into discrete and separated parts. The equivalent to this impression in architecture context is the space that provides dominance and control over all surrounding points of that space by placement within the given space (Hillier, 1985: 90).

6. Analysis on Roodsar houses using space syntax technique

6.1. Brief introduction of Roodsar

Roodsar is one of cities in Gilan Province in Iran and Roodsar is the capital of this province. Based on first census 2011, population of Roodsar was counted 37'579 (Iranian Statistical Center, 2011). Roodsar is limited from the north to Caspian Sea, from the south to Alborz Range, of east to Mazandaran Province and from the west to Langerood. Roodsar people are Shia Muslims.

Name of this city was changed from '*Hosam'* to Roodsar by Seyed Razi Kia as descendent of Kiayee Sadat Dynasty and as ruler of eastern Gilan about 789-829h (1388-1428 AD) (Ruling period of Seyed Razi Kia) (Koochaki, 2017: 96). Persian term 'Roodsar' is composed of two parts: '*Rood'* (river) and '*Sar'*. Term '*Sar'* meant 'beside' in Daylami and Pahlavi language and accordingly name of this city means beside the river (Sotoudeh, 1987: 256). In book of the *Caspian provinces of Persia* (Mazandaran and Astarabad), Hyacinth Louis Rabino has mentioned name 'Hosam' as a seaport and harbor for the ships that carried provisions from *Gorgan* (Astarabad) and *Tabarestan* (Hyrcania) (Rabino, 1978: 233).

Roodsar unevenness includes two parts i.e., mountainous and plateau. The mountainous part covers more area of this city and it includes the southern region of this city and it is a part of western Alborz Mountains that are called Eshkevar. These mounts are the sources of all rivers which enter Caspian Sea water basin within limits of Roodsar city e.g., Polrood and Shalmanrood (Marashi, 2010: 241).

Roodsar was a city for merchants in the past and it had converted Gilan province into an important commercial center among Iran and Russia 150 years ago. As one of the classic architectural samples in Roodsar, Municipality Square is more noticeable than other related buildings. This square includes Municipality Building decorated with the well-known Gilan architecture design and the similar architectural building is visible in Rasht Municipality Square and near seven other historical monuments. Construction of this square started during period of Reza Shah Pahlavi and it also finished at the same era. Unfortunately, following to

extensive demolitions within two recent decades in texture of Roodsar city, sociocultural, formative and functional textures of constructed spaces were subject to destruction in this zone so that formative symbols of some concepts such as locality and neighborhood unit etc. were seriously played down and disrupted. Now, one no longer can easily find real examples of these concepts in traditional texture of Roodsar city. This issue clarifies further necessity for conducting study in this regard (Fig 1).

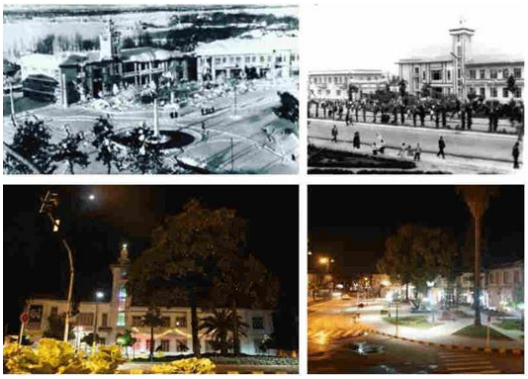


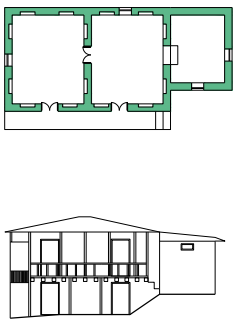
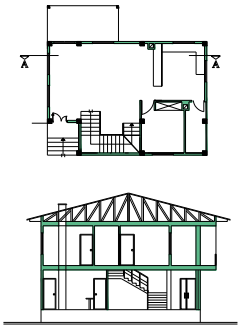
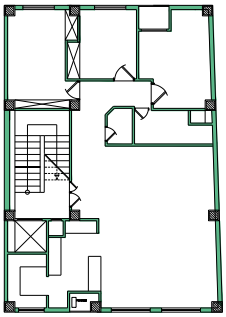
Fig 1: Roodsar Municipality Square from 1969 to 2020. *Source*: (Nasri Roodsari, 2016 & authors, 2020)

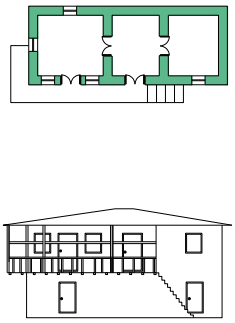
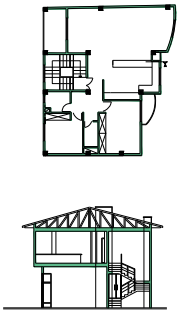
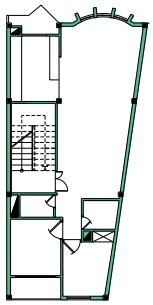
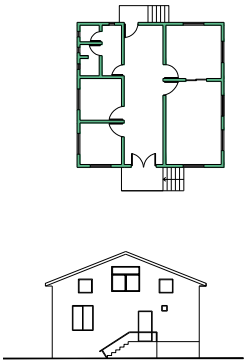
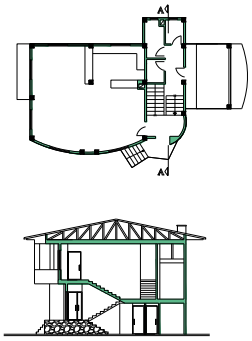
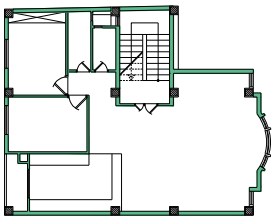
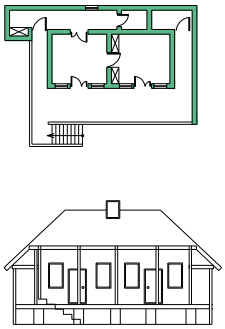
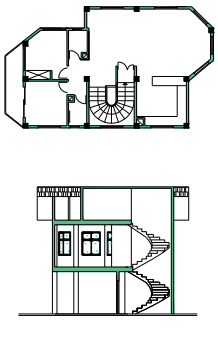
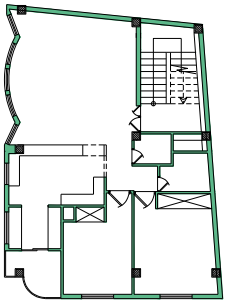
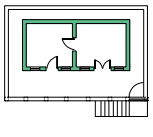
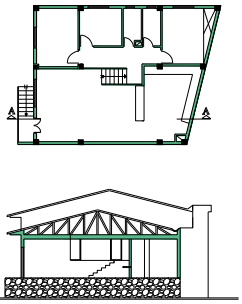
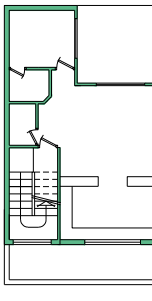
6.2. Examples of studied houses

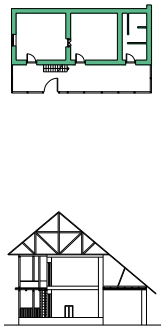
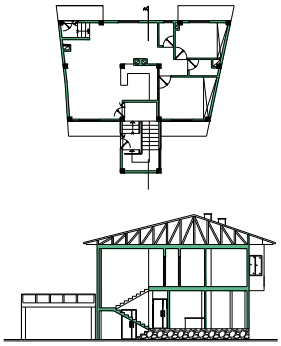
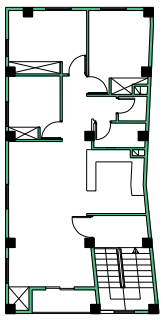
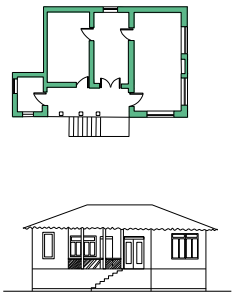
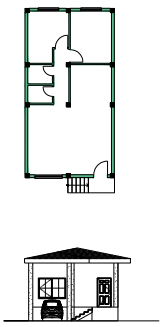
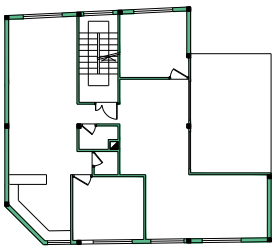
All rural houses in Roodsar city were traditional ones until recent century and most of these houses included two large rooms, a large southern balcony with a kitchen beside them. Application of local constructional materials of this region e.g., straw grout and wood and also using traditional building technique have turned these houses into a peaceful and adaptive environment to ambient conditions. Over the time, construction and maintenance of these houses became difficult and their maintenance cost was also increased more. However, following to abundant and low-cost supply of cement and iron in plateau zones of Roodsar during recent century, most of houses were destroyed and they were replaced with modern buildings. Despite all of these conditions, traditional houses, apartments and villas are still visible along with urban texture at this region so that no one could separate historical texture from modern city texture. For this reason, in order to select case study samples, it was tried to use all three types of traditional houses, apartments and villas and to examine way of spatial arrangement in them. Whereas no quantitative statistics were available about types of houses in Roodsar localities therefore it was tries to select samples by random sampling and considering identical numbers for all three types of houses. Likewise, the ground floor map of houses was assumed as criterion in quantitative analysis of samples by means of UCL Depthmap software.

In this section, 21 traditional contemporary houses are introduced in Roodsar city where they were selected according to random sampling (Table 3).

Table 3: The houses under analysis and assessment (Authors, 2020).

Traditional house	Villa house	Apartment
		
1- Ibrahimi house	2- Rahimi house	3- Pashapour house

		
2- Mohammadi house	9- Golmohammadi house	16- Ismailzadeh house
		
3- Amani house	10- Mobarhan house	17- Zabihi house
		
4- Rafiei house	11- Daneshvar house	18- Malekpour house
		
5- Alidoost house	12- Abutalebi house	19- Ahmadi house

		
6- Bakhshandeh house	13- Naeimi house	20- Parhizi house
		
7- Moradi house	14- Rahmati house	21- Alizadeh house

6.3. Analysis and assessment of houses

6.3.1. Parameters of evaluation of Roodsar houses

Home and housing are considered as the foremost subjects in living spaces and at the same time they are one of the most important forms of social organization of space that has dual nature similar to most of human-made systems: The first is that it is formed under influence of culture and the second is that in turn it may affect the culture as well (Ileca, 2015: 166). The housing use covers quantitatively maximum percent of urban buildings including Roodsar city texture, but type and method of architectural design of housing may have qualitatively fundamental and determinant impact on lifestyle of various social groups (Akrami & Zare, 2013: 56). The sociocultural analysis on architecture of house is important if it is known how the house interacts with it with respect to the culture governing over social and normal system of this region. On the other hand, social studies attach importance to way of interaction of individuals in the house. That fact that how they interact with each of different spaces in the house and some characteristics e.g., respect, normal and specific nature of them, may be interpreted and explained. Given the conducted studies, system of compatible functions and behavior may be introduced as one of the prominent symbols for housing culture and lifestyle. Thus, in order to achieve way of effectiveness of behavior on patterns of location and emerging of its form, the functional and behavioral models of house inhabitants should be separated into some elements and levels. Three parameters have been considered for determination of location-behavior patterns of houses in this study:

6.3.1.1. Space-function parameter

They show field and potential for doing work in human life in the space which can be identically done in different places and times e.g., eating, sleeping, working and praying etc.

6.3.1.2. Space-form parameter

It indicates space adaption to the needed form to do function. In fact, form is deemed as context for doing of function that may vary with respect to time and type of behavior.

6.3.1.3. Space-behavior parameter

It is called to a behavior is taken to do practice in space and it will vary with respect to type of function and the underlying behavior.

The important point is that as we proceed from functional aspect to the hidden dimensions of the related activity and behavior, rate of variation increases. Except space-function parameter that is generally fixed with respect to time, other parameters e.g., space-behavior and space-form will be exposed to a lot of variations

and changes when passing from traditional time
to the present.
Tables 4 and 5 may display qualitative analysis of traditional and contemporary houses from perspective of location- behavior patterns.

Table 4: Qualitative analysis on Roodsar traditional houses from perspective of location-behavior parameters (Authors, 2020).

Function-space parameter		Space-behavior model	Space- form parameter
1	Praying	-Perform ablution (access to water) -Prayer in privacy and toward Qibla -Recital of Quran and beading of God	-Presence of pool beside entrance step to use water and doing of activity -Building of niches to put prayer rug - Prayer was performed in lateral rooms which were generally used as sleeping location.
2	Working	- To bring farming crops in house and storing them -Preparation forage (straw) for livestock	-Building of stable in house to store forage -Utilization from roof space to store crops -Using from a part of covered veranda to store foods
3	Cooking	-Preparation of woods, foods and related materials -Cooking	-Kitchen is often located at northern front -Preparation of food store inside and behind kitchen
4	Eating	-Sitting on ground around tablecloth -Hospitality	-Eating food in large room (Dining room)
5	Washing of dishes and cloth	-Sitting beside pool and washing -Fastening of rope on veranda or yard to hang cloth	-Existing pool beside entrance step or in yard
6	Washing and cleaning	-Washing hands and face -Utilization from sanitary services and leg-washing	-Sanitary services locating outside rooms and living space - Locating general near the pool
7	Sleeping	- Replacement of cloth and easy dress - Sleeping on the ground - Using quilt, mattress and pillow	-Lateral rooms for sleep in winter season -To build a store for beds at the side of rooms - Corridor and veranda for sleeping in summer season - Guest room for sleeping of guests
8	Amusement and gathering of family members and neighbors	-Gathering of all family members for conversation -Evening party with neighbors	-The existing guest room generally at the house center - The existing veranda and corridor at southern front

Table 5: Qualitative analysis on Roodsar contemporary houses (villa & apartment) from perspective of location-behavior parameters (Authors, 2020).

Function-space parameter		Space-behavior model	Space- form parameter
1	Praying	-Perform ablution -Prayer in privacy and toward Qibla -Recital of Quran and beading of God	-Using sanitary services to perform ablution - It is done in one of the house spaces and generally in bedroom.
2	Working	- Doing of job-related activities	-The existing working room in some houses - Utilization from some part of bedroom as working space
3	Cooking	-Preparation of foods and related materials -Cooking	-Kitchen and cooking place

4	Eating	-Sitting around table	-A part of kitchen - The existing dining space
5	Washing and cleaning	-Washing hands and face -Utilization from sanitary services	-Sanitary services and bathroom
7	Sleeping	- Replacement of cloth and easy dress - Using bed	-Bedroom
8	Amusement and gathering of family members and neighbors	-Gathering of all family members for conversation -Hospitality	-The existing guest room and dining room

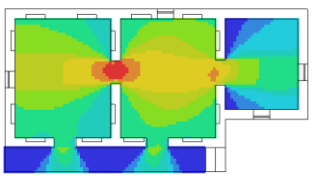
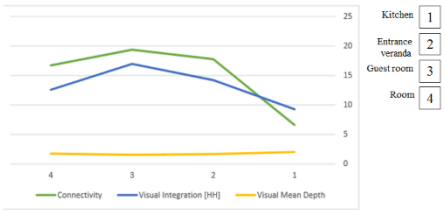
6.3.2. Quantitative analysis on traditional and contemporary houses using UCL Depthmap software

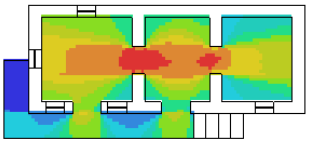
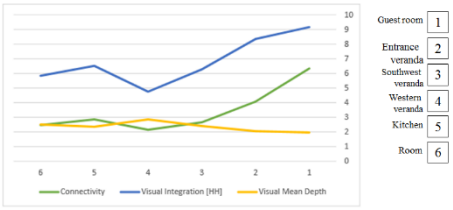
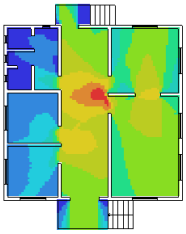
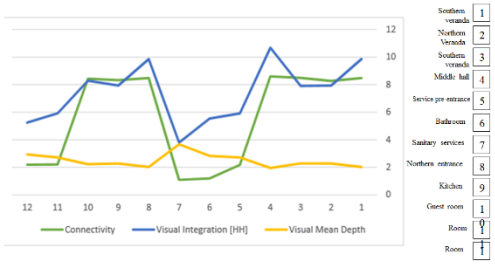
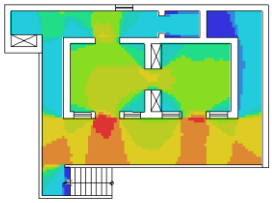
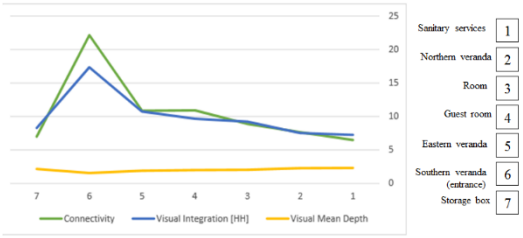
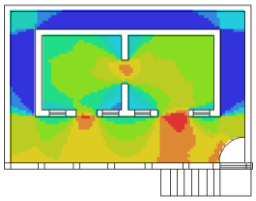
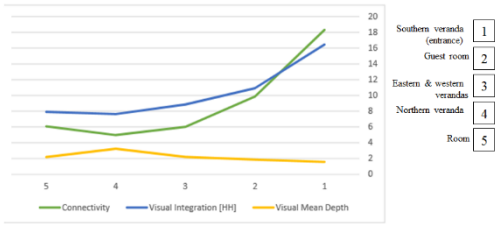
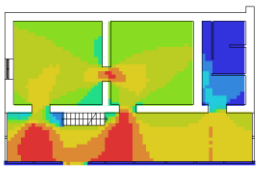
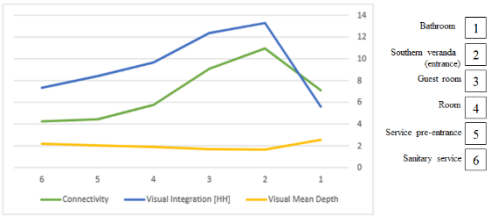
As it already mentioned, quantitative analysis of houses is done by means of space syntax technique. Today, this method is turned into an effective technique among used methods in architectural research since whereas space syntax assumes space as the basic architectural element thus it caused the related theory and achievements to be doubly important for architects; the importance is due to practicality of this technique through the daily experience of architects in formation of space. In better words, architects can directly utilize directly from results of studies in their experiences for architectural and urban design and employ it for their design. Space syntax theory fundamentally aims to look for approaches to describe configuration space, such a description may be capable to discover social logic hidden in its lower layers and serves as a basis for secondary theories that cover sociocultural events (Groat & Wang, 2016: 231).

Whereas this study is employed at the scale of single building and with respect to the given definitions in section of theoretical bases, the quantitative analysis has been conducted by space syntax expert software using both convex and Visibility Graph Analysis (VGA) techniques. Given the subject of site divisions has been examined in traditional and contemporary houses in this study, three parameters of integration, connectivity and depth have been selected and quantities derived from space syntax software have been converted into linear diagrams. As a result, three parameters have been analyzed for each of houses in a separate diagram thereby to perceive better the relationship between parameters.

With respect to conversion of plan of houses into graphic analyses about parameter based on Visibility Graph Analysis (VGA) and related diagrams for integration, connectivity and depth based on convex technique are given in Tables 6-8 with graphic diagrams and analyses for each house and data are assessed.

Table 6: Space syntax analysis in Roodsar traditional houses (Authors, 2020).

Title of house	Parameter of connectivity in VGA approach	Parameters of connectivity, depth and integration in convex approach
Ibrahimi house		

Mohammadi house		
Amani house		
Rafiei house		
Alidoost house		
Bakhshandeh house		

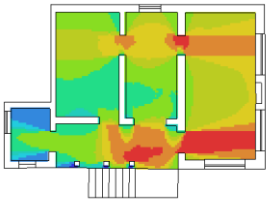
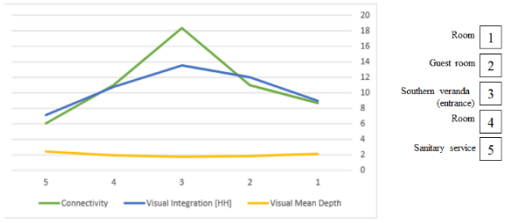
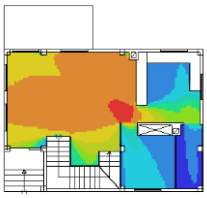
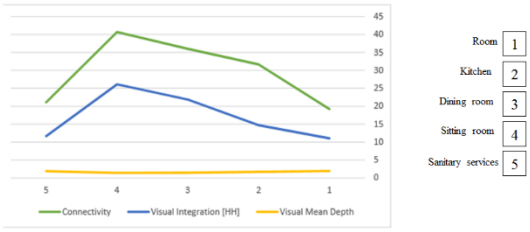
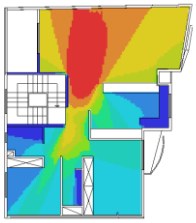
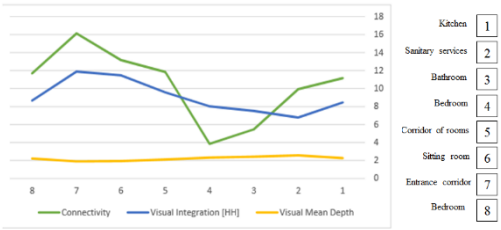
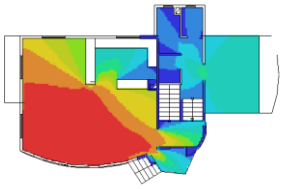
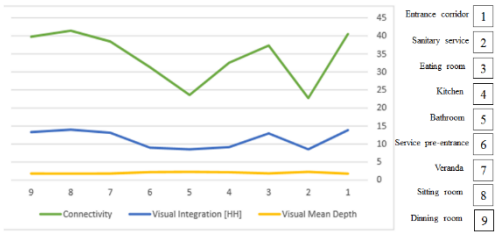
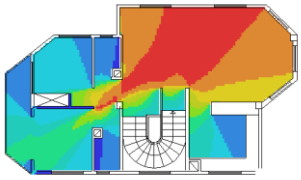
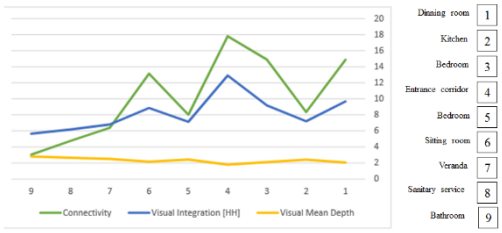
Moradi house		
Legend: Red color shows the maximum rate of connectivity, blue color indicates the minimum rate of it in plans. In these diagrams the colors show green= connectivity; blue= Integration, and yellow= depth.		

Table 7: Space syntax analysis in Roodsar villa houses (Authors, 2020).

Title of house	Parameter of connectivity in VGA approach	Parameters of connectivity, depth and integration in convex approach
Rahimi house		
Golmohammadi house		
Mobarhan house		
Daneshvar house		

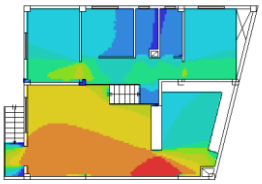
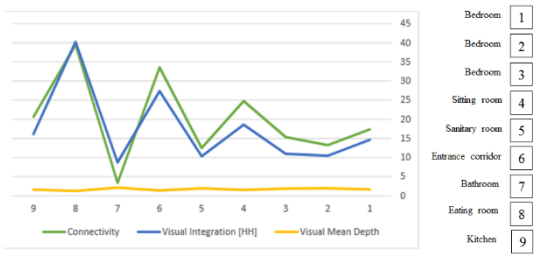
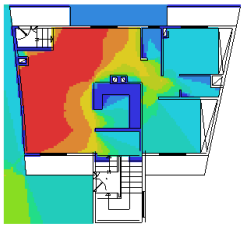
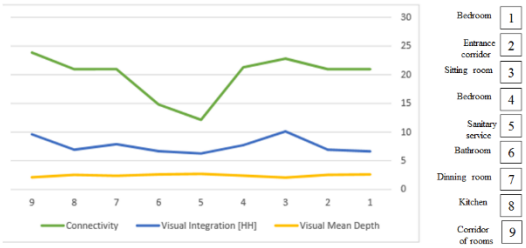
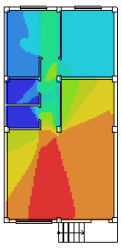
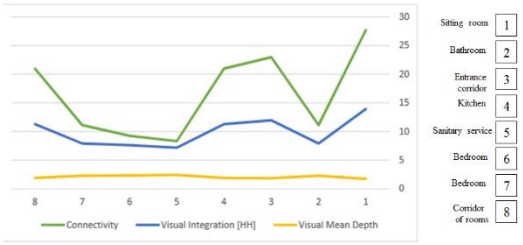
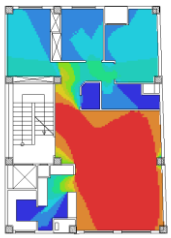
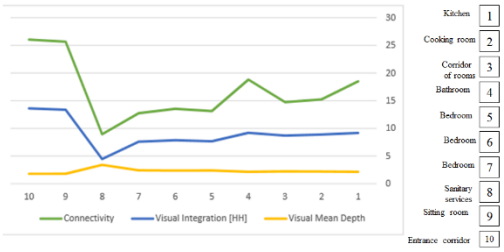
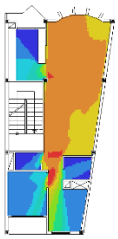
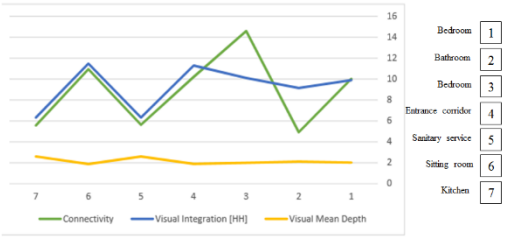
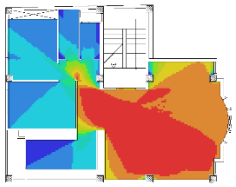
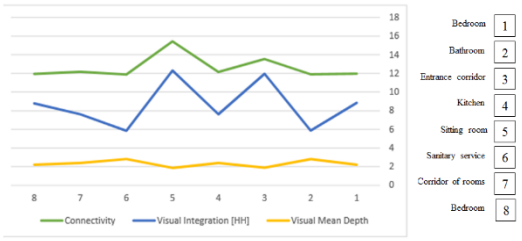
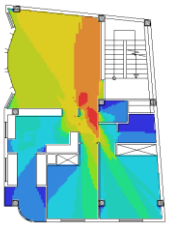
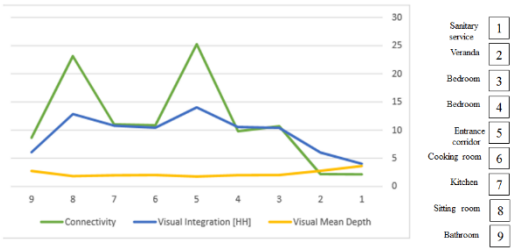
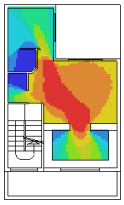
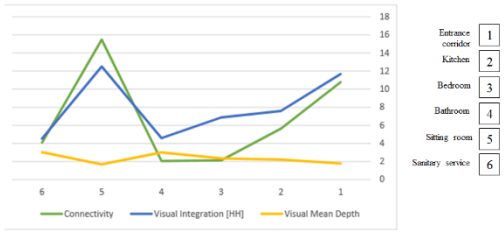
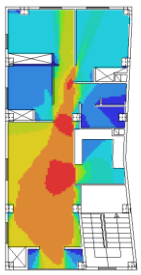
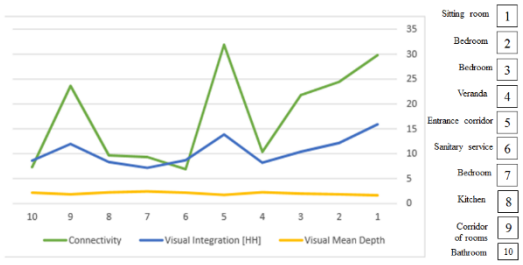
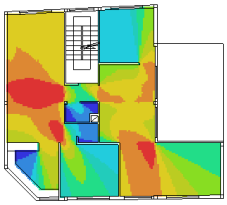
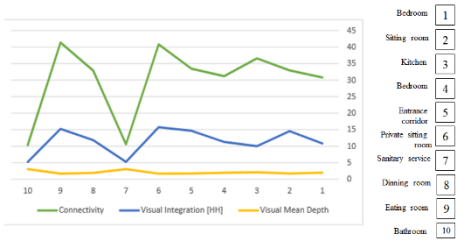
Abutalebi house		
Naeimi house		
Rahmati house		
Legend: Red color shows the maximum rate of connectivity, blue color indicates the minimum rate of it in plans. In these diagrams the colors show green= connectivity; blue= Integration, and yellow= depth.		

Table 8: Space syntax analysis in Roodsar apartment houses (Authors, 2020).

Title of house	Parameter of connectivity in VGA approach	Parameters of connectivity, depth and integration in convex approach
Pashapour house		
Ismailzadeh house		

Zabihi house		
Malekpour house		
Ahmadi house		
Parhizi house		
Alizadeh house		

Legend: Red color shows the maximum rate of connectivity, blue color indicates the minimum rate of it in plans. In these diagrams the colors show green= connectivity; blue= Integration, and yellow= depth.

6.3.3. Analysis and assessment of tables and data

6.3.3.1. Evaluation of traditional houses

It is inferred from analysis on Roodsar traditional houses that the maximum connectivity rate belongs to guest-house space and southern veranda; and lesser rate existing in western and eastern verandas and much lesser in northern veranda. In the same vein, the minimum depth rate often belongs to guest-house and southern veranda while the maximum depth rate is found in other verandas. Overall, southern veranda is employed in most of plans for traditional houses in these areas e.g., entrance and as a link between spaces as well and by possessing small depth they have the maximum connectivity and integration with spatial configuration in houses. With respect to VGA of Amani house, the middle hall of this house that acts as access route to house spaces as well, rooms have more depth than samples with veranda. Some houses which include both swage sink and bathroom in these spaces possess the maximum depth and minimum connectivity rate.

6.3.3.2. Evaluation of villa houses

It is inferred from VGA analysis on villa houses that the minimum depth rate belongs to sitting space and entrance corridor. The maximum rate of this parameter both belongs to swage sink, veranda and bedrooms. Parameters of integration and connectivity are at maximum rates in entrance corridor, sitting room and eating room based on analysis of diagrams. Similarly, Kitchen has higher depth than cooking room in traditional houses.

6.3.3.3. Evaluation of apartment houses

It is derived from analysis on diagram of apartment houses that the rates of integration and connectivity are at maximum level in entrance corridor, sitting room and corridor of rooms respectively. On the other hand, swage sink, bathroom, veranda and bedrooms have the minimum rates of connectivity and integration. One may refer to more depth in modern kitchens than in cooking place in traditional kitchens as the differences derived from quantitative analysis on the houses and with respect to open-counter space in the kitchen, one may attribute this fact to bilateral and sometimes trilateral relations among cooking room and the given surrounding spaces in traditional houses versus unilateral relation among kitchen and sitting space in modern houses.

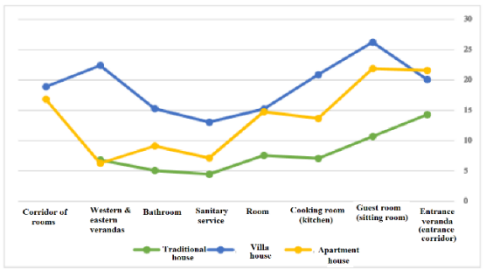
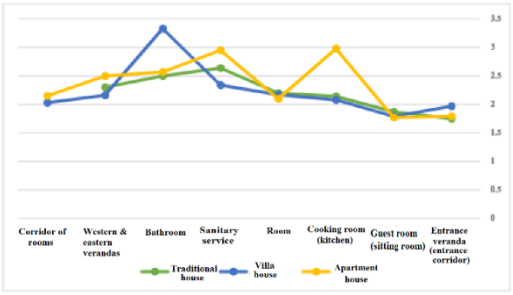
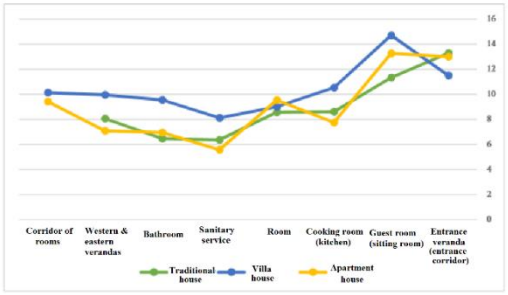
Likewise with respect to VGA analysis of plans, the minimum depth rate belongs to entrance corridor, sitting room while their maximum rates are related to swage sink, bathroom and veranda.

One can find differences and similarities in spatial configuration of these houses by comparative analysis and given quantitative analyses from traditional and modern houses. For example, sitting space in modern houses is aligned to guest-house in traditional houses. Although this space includes lesser depth than guest-house in traditional houses, it has also the least depth rate in modern houses. Similarly, entrance corridor in apartment houses and modern villas is equivalent to southern veranda in traditional houses and it is applied instead of entrance and connection among outside and inside spaces where after sitting space it still has small depth and more connectivity and integration rates than in other spaces. The other given similarity derived from analysis on samples denotes the high depth existing in swage sink space in both traditional and contemporary houses.

Despite all found similarities, several differences are also observed in function and configuration of space in veranda in contemporary period than in traditional era so that balcony and terrace in contemporary houses are equivalent to veranda in traditional houses and in many places, they are related to a space (i.e., housed private or semi-private space) and their integration has been reduced with entrance open space. For this reason, according to opinion of those who have experienced living in traditional houses, the vacant position of this space is critically felt in modern houses since some activities including social interactions, daily works, evening party, neighborhood relations and even eating lunch and dinner can be done better and vitally by using this space with this space in most times of the years.

Overall, compared to traditional houses, modern houses have less depth, integration and more connectivity. This in turn shows difference existing in definition of limit in recent time and also importance of semi-open space of veranda in traditional houses to reach to this important parameter (Table 9).

Table 9: Comparative diagram for syntagmatic parameters of connectivity, depth and integration in traditional and contemporary houses (Authors, 2020).

Connectivity parameter	
Depth parameter	
Integration parameter	

6.3.4. Interpretation of analyses and assessments for traditional and contemporary houses

It is inferred from comparison of qualitative and quantitative analyses on diagrams that:

■ The hierarchy of access to space is deeper in traditional houses and as a result these spaces were in contact with intermediate space. This factor is led to lesser integration and further privacy of course in spatial configuration of traditional houses.

■ Wet and dry spaces have been separated more in these houses than in modern houses.

■ In traditional houses, spaces are multipurpose and ranked (hierarchical) with access from open space to semi-open space and then to closed space, but spaces are generally single-purpose in contemporary houses and access hierarchy is placed from entrance to open space and then to closed and semi-open space.

■ The space of veranda, which is assumed as semi-open space in modern houses, has lost its former function and it has been only converted into the space with higher depth and less connectivity and integration; presence and absence of this space has also no high impact on spatial relations, while semi-open spaces have been one of the major and organizing elements in spatial configuration of traditional houses in these areas.

■ Topology of cooking room is visible at northern side in traditional houses in all plans. However, such spatial organization is not seen in modern villa and apartments. Likewise, depth of space in kitchen is found more in modern houses than in traditional houses.

Inter alia, what deemed as important is to paying attention to site division of private and

public spaces in modern houses and topology of bedrooms and sanitary spaces in high depth and lesser connectivity than other spaces of the house. These characteristics may be assumed as positive points in spatial configuration of modern houses.

It seems that compared to the past time, transformation of space-behavior parameter in contemporary period has been in turn as an important factor for changing spatial configuration of houses and creation of different space-form parameters. It can be probably concluded that change in sociocultural behavior and patterns of environment has caused transformations in formative model of house spaces. From another viewpoint, one could assume slow change in form of house spaces as the variation factor in behavioral patterns of the people. In other words, behavior and location affect each other and also influence in them.

7. Conclusions

The comparative analysis of 21 examples of traditional and contemporary houses in the area show that spatial configuration in traditional houses has been organized according to traditional concepts and models of location-behavior. According to the analysis by UCL Depthmap software, traditional space houses have been able to respond correctly to the indicators of Space-function parameter, Space-form parameter and Space-behavior parameter. The form of traditional house represents way of world view and approach toward life by its inhabitants. What deemed as important in traditional house is the proper answer given to human and his/her material and spiritual needs before anything else. However, from the analysis and evaluation of contemporary houses, common features and differences were found that indicates the change in functions and its followers, the spatial needs of today's life. Some key functions are still considered and some have been left out. For example, the living room in contemporary houses has found a function similar to the guest house in traditional houses. In new apartments and villas, the entrance can be considered equal to the south Veranda in traditional houses; because instead of input and connector, outdoor and indoor space is used.

The following preferences are inferred from analysis and comparison of space syntax among traditional houses with modern houses:

a- Traditional house are created in adaptation to environment and behavioral system of inhabitants while modern house possesses single-purpose spaces and it is not clear whether it could meet the different patterns of modern space-behavior parameter or not.

b- Although isolation of private and public spaces is properly seen in modern houses, it does not seem that any attention is paid to limits in ranking (hierarchy) for its entrance spaces.

c- It is ignored to utilize special lighting conditions in geographical directions in configuration of house spaces e.g., kitchen and sitting rooms etc. in modern houses.

d- It has been forgotten to employ semi-open space (Veranda) and this effective space in traditional houses and today it has lost the position. Today, they are replaced by balconies and terraces. These spaces are associated with only one of the private or semi-private spaces of the house.

e- Modern house versus traditional house has more connectivity in terms of space syntax, but at the same time it has not also proper configuration for semi-private and private space.

f- Separation of wet and dry space in these houses by the middle space is more than contemporary houses.

g- In traditional houses, the hierarchy of access to spaces has been deeper; As a result, the spaces are related to the middle space. This factor has led to less integration and, of course, more privacy in the spatial organization of traditional houses.

In response to the final question of the article, which deals with how to improve the structure of contemporary houses in accordance with the space-behavior patterns of the space syntax method, the following suggestions are offered for further adaptation of behavioral and formative patterns of contemporary houses:

1- Paying more attention to respect for limits and privacy in access to entrance space of building to closed space inside the house;

2- Suitable access from kitchen to building entrance;

3- Addressing proper topology for space in veranda as a semi-open space for some functions e.g., passing leisure times and as working space etc.;

4- Topology of adaptive house spaces with characteristics of light and radiation in four geographic directions from climatic viewpoint and function.
5- Paying attention to the depth and correct design of the middle mid-doors at the junction of private and public spaces.
6- Paying more attention to the spatial pattern of In-Between Spaces in responding to special functions in the house.
7- Paying attention to the pattern of special arrangement of houses in accordance with the specific behaviors of each space.

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