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The Optimization of Open- Space Based on Social Theory in Iran

[1]Mehran Faramarzi, [2]Nasser Barati, [3]Iraj Etesam*

[1]Ph.D., Department of Urban Planning, Faculty of Civil, Art and Architecture, Science and Research Branch, Islamic Azad University, Tehran, Iran.
[2]Associate Professor in Urban design, International University of Imam Khomeini, Qazvin, Iran.
[3]Professor in Architecture, Faculty of Art and Architecture, Science and Research branch, Islamic Azad University, Tehran, Iran.

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ABSTRACT: The usage of social theories in human built environment caused to enhance life quality. It may consist of human needs in residential areas. Sometimes, building codes can help to exist accepted life space, but the building codes do not have basic theory such as actual open space in residential plots. The study was an attempt to represent a new approach in urban land subdivision and the relationship between social theories and built up area. The research question was how to determine the open- space ratio. Main indicators were related to residential areas in urban areas in Iran which the lot size and urban density appear. The study tried to represent optimum open- space ratio based on Edward Hall's theory. The method was based on mathematical model and social theory. Finally, it resulted in optimum OSR in lot and it was not enough open- space ratios in existing situation. This study came to this conclusion that existing open- space measure was not enough for any Lot in new residential areas based on mentioned theory. In addition, investigation showed that the human distances effected on open and built up space ratio in a new residential layout. It was concluded that every residential area can have an optimum open- space ratio based on its situation. The results can use new residential layouts for enhancing human built environments, but it noticed that there are not certain tools for making high quality environments based on social theories.

Keywords: *Iran, Land subdivision, Lot, Optimization, Open- space.*

INTRODUCTION

The 'open' space was intended as a means of 'opening the dwelling to nature, to light and to fresh air' and, as such, was considered a hygienic environment (Moor & Rowland, 2006, 107). Always, there is a challenge in determining measure of open- space in human built-up such as residential areas, especially, new residential layouts. There appeared ration of 60 to 40 percentages built-up to open- space, in action plan. But, how has this ration been determined? Basic theories do not pose, about measure of open- space ratio in new residential layouts. In development plans of Iran, practically given OSR is used. OSR was used as an instrument to stipulate that a development must provide a certain amount of open- space on a zoning lot in specified districts. It can be viewed as an expression of the trade-offs between the desire to maximize the building bulk (program or FSI) and the public and private demand for adequate open- space. In land subdivision, it is same the ratio bulk and open- space in all residential layouts have the same ratio. The optimum open- space ratio is never considered in new residential development. The most consideration of open-space and bulk ratio is related to energy consumption, but human and social needs, such as social distances are ignored. Zoning ordinance defined a series of development standards, commonly expressed as minimum requirements focusing on such elements as lot size, building height, yard requirements, open space, and impervious cover, but they do not describe how it is determined.

Literature Review

Berghauser Pont & Haupt (2009) offered quantities and analytic model for open- space in residential lots, but it was not posed as an optimum open- space. In this research, relationship between building density and open- space ratio was dealt with, but it did not describe how it determined the size of open- space and build up. At the level of a lot (or building block), Hoeing (1928) proposed a minimum of one square meter of open-

*Corresponding Author Email: *Naser.Barati2012@yahoo.com*

space for every square meter of built floor area. According to Hoeing (1928), when this standard was met, the area could be described as spacious (Berghauser Pont& Haupt, 2009, 84). The open- space ratio was formulated by Pont and Haupt that was 1-GSI/FSI.

In Berlin building ordinance, building categories for open-space were described, as density increases, , open- space decreases (Table 1).

The land to building ratio (LBR) indicates the share of the area covered with structural facilities, compared to the size of the lot. The land to building ratio (LBR) states the built-up proportion of a lot. The LBR is a decimal number with one or two fractional digits. Thus, the formula for the calculation of the LBR for the preparation of the present map is derived as follows: The sum of all built-up areas on a lot - here, the block area - is divided by the total area. Today's inner-city area within the urban railway (S-Bahn) Circle Line, built as the "imperial-era tenement belt" around the old centre of Berlin, even today has the highest structural density, with FSIs of between 2 and 4. On the perifery of the inner city, much of it containing many residential areas of the Weimar period, most areas have an FSI of 1.0 to 1.2 (Senate Department for Urban Development and the Environment of Berlin, 2012, 1-4). (Fig.1)

In Germany, the coverage measure was applied to limit the negative effects of solid urban patterns. Baumeister, Stübben, Hoepfner and Hoenig all worked with the concept of coverage and in 1925 it became part of the official planning policy in the Building Ordinance of Berlin (Berghauser Pont& Haupt, 2009, 79). In the Netherlands, coverage is used in zoning plans (bestemmingsplannen) to regulate maximum utilization of an area.

Boob& Rao (2014) represented suitable model of urban land subdivision, and described measure of built up and open- space in lots, but it did not state how it selected (Table 2).

Table1: Building categories within the construction ordinance of Berlin in 1925-(Source: Berghauser Pont & Haupt, 2009, 84)

	Number of stories	Open- space ratio	Number of housing
1	2	9/10	2
2	2	8/10	4
3	2	7/10	6
4	3	7/10	9
5	3	6/10	12
6	4	6/10	16
7	4	5/10	20
8	5	5/10	25
9	5	4/10	30

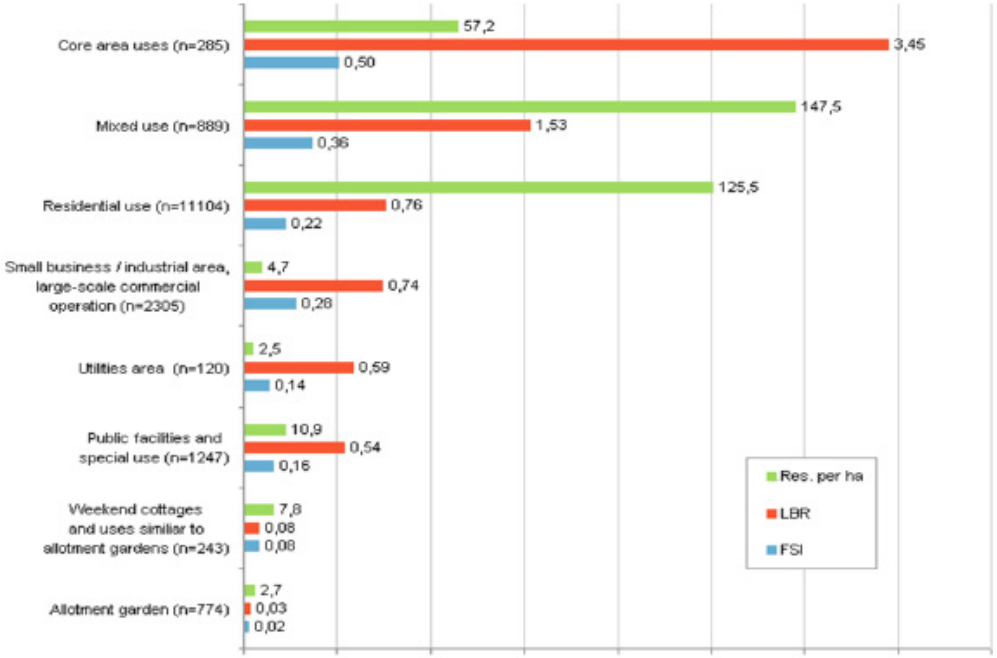

Fig. 1: Residential density, FSI, LBR of select uses in comparison(Berlin) (Source: Senate Department for Urban Development and the Environment of Berlin, 2012, 5).

Table 2: Open- space and built up ratio in urban India regulation

	Size of plot	Number of stories	Open- space ratio	Size of built up area
1	450	3	2/3	1/3
2	Above 300	3	2/3	1/3
3	Above 150	2	1/2	1/2
4	Above 100	2	1/2	1/2
5	Above 50	2	1/2	1/2
6	30	2	1/4	3/4

United Neighborhood Houses (2015) considering the percentage of open public space, but it ignored open- space in lots. For example In Europe and North America the cores of cities have 25% of land allocated to streets, whilst suburban areas have less than 15%. In most city cores of the developing world, less than 15% of land is allocated to streets and the situation is even worse in the suburbs and informal settlements here less than 10% of land is allocated to street. This is a reflection of the huge inequalities in many cities of the developing world (United Neighborhood Houses, 2015, 2). So this paper could not analyze the solution of measure of open-space in lots (United Neighborhood Houses, 2015, 2).Colin Rowe used the figure-ground analysis to visually represent coverage as the distribution of (built) mass and open- space (Rowe & koetter,1978). The 1916 New York City's Zoning Resolution restricted the amount of ground that could be covered by buildings (New York Department of City Planning, 1990). The studies show there is not an organized method to determine optimum or minimum of OSR in residential layouts, especially in low and medium densities. The open- space ratio is the amount of open- space required on a residential zoning lot in non-contextual districts, expressed as a percentage of the total floor area on the zoning lot. For example, if a building with 20,000 square feet of floor area has an OSR of 20, 4,000 square feet of open- space would be required on the zoning lot (0.20 × 20,000 sq ft) (Zoning Resolution of the City of New York, Section 12-10. It seems there is not the certain methods for calculating open space ratio in Land Development Regulations and what is basic theoretical reasons. Spaciousness, defined as the relationship between open- space and total floor area, as a measurement of the quality of an urban plan. Spaciousness is equivalent to the Open- space Ratio mentioned in the New York City's Zoning Resolution (New York Department of City Planning, 1990). The relationship between OSR, FAR and height is calculated as equation 1. (Fig. 2) (Table 3)

Dublin, urban development standards defined plot and

$$\frac{1}{F.A.R} = \frac{O.S.R.}{100} + \frac{1}{H.F.}$$

Equation 1: (Source: New York Department of City Planning, 1990, 210)

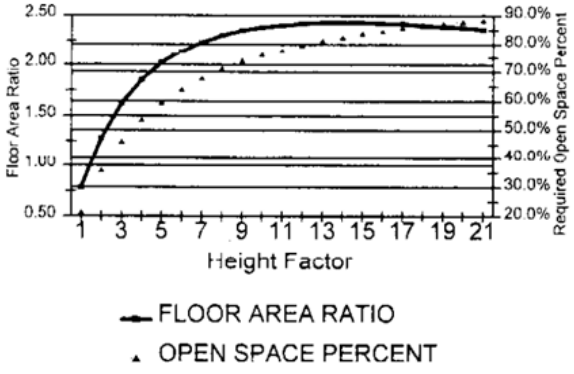

Fig. 2: Relationship between OSR, FAR and Height (Source: New York Department of City Planning, 1990, 210)

Table 3: OSR for non-profit residences for the elderly (Source: New York Department of City Planning, 1990, 214)

Minimum of OSR	Districts
66.5	R3
39.4	R4
23.1	R5
17.7	R6
12.8	R7

coverage ratio without any reasonable factors. Plot ratio is a tool to help control the bulk and mass of buildings. It expresses the amount of floor space in relation (proportionally) to the site area, and is determined as follows: plot ratio=gross floor area of the building/site area

Plot ratio will apply to both new buildings and extensions to existing buildings. Site coverage is a tool particularly relevant in urban locations where open- space and car parking standards may be relaxed. The plan sets out recommended standards for the city Centre, district centers and the Georgian core. These standards are intended to be indicative only. The special Considerations, which apply to plot ratio, will also apply to site coverage (Council Dublin City, 2005, 123).

Plot ratios can determine the maximum building floor space area or volume on a given site, but on their own cannot determine built form. The same area or volume can be distributed on a site in different ways to generate very different environments (Council Dublin City, 2005, 123). In new residential developments 10% of the site area shall be reserved as public open- space (Council Dublin City, 2005, 129).

In Australian residential codes open- space is defined in two types, first private open- space and second, communal open- space. Private open- space is developed to suit the requirements of occupants and is likely to be modified over time as occupiers' requirements and landscaping trends change. Although grouped and multiple dwellings are not required to provide communal open- space, it should not be discouraged if considered appropriate within a development (Western Australian Planning Commission, 2015, 46). In this development codes are explained in necessary open- space, but it did not present any methods how to calculate it.

A dwelling should have private open- space of an area and dimensions in the schedule of the zone should be specified. If no area or dimensions are specified in the schedule of the zone, a dwelling should have private open- space consisting of an area of 80 square meters or 20 per cent of the area of the lot, whichever is the lesser, but not less than 40 square meters. At least one part of the private open- space should consist of secluded private open- space with a minimum area of 25 square meters and a minimum dimension of 3 meters at the side or rear of the dwelling with convenient access from a living room (Victoria State Goverment, 2015, 24). In urban development regulation of Park Ridge City, it was decided to separate single and two and more families for calculating open- space based on Table 5.

Open space (bulk regulation) of Land within a zoning lot is

Table 4: Plot and coverage ratio in Dublin (Source: Council Dublin City, 2005, 123)

Zoning objective	Plot ratio	Coverage
Zone 4	2	0.8
Zone 5	2.5-3	0.8-1
Zone 8	1.5	0.5
Zone 10	2-2.5	-

Table 5: OSR in urban development regulations, Victoria, Australia (Source: Community Preservation & Development, 2007, 3)

Zone	Type of family	OSR
R1	Single family	0.45
R2	Single family	0.40
R3	Two family	0.30
R4	More family	0.30

devoted to landscaping, lawns and other similar uses. Open-space shall not include driveways, streets, parking lots or spaces, sidewalks, plazas, terraces, patios, swimming pools, decks or other similar impervious or semi-impervious surfaces (Community Preservation & Development, 2007, 3). Multiple dwellings yield more lots than single or grouped dwellings on land coded R30 and above, as multiple dwellings are controlled via plot ratio, maximum building height and minimum open-space rather than minimum and average site area (Cockburn.wa.gov.au, 2014, 3). (Table 6)

Quantitative data have been calculated for all 30 schemes, to facilitate the comparison of average data for the whole sample for each construction phase. The account that follows will begin from a figure/ground analysis of the buildings and open spaces, and will move on to consider the character of the open spaces, the proportions of primary(building) and secondary (open space) boundaries, and how these relate to the axial organization(Cooper, Evans& Boyko, 2009, 119). (Fig. 3)

The foundation representation in space syntax, 3 on which all other representations and measures are based, depicts the figure/ground map for each housing scheme in the form of a plan or Nolli map4 that contrasts the buildings, shown in solid black, with the open spaces, shown in white. This way of representing urban space has been popularised by Rowe & Koetter (1978) in their book Collage City, as well as by Hillier & Hanson (1984). From the figure/ground map it is possible to measure the total area of the building footprint for each urban block, and compare it with the amount of unbuilt space that is left over. The lower this ratio, the more built-up the block; the higher the ratio, the more open space there is left around the buildings. Given what has been said already about the transformations that have occurred in the urban tissue over the last 100 years, it is to be expected that housing from different historical periods will have different figure/ground ratios that reflect the prevailing architectural philosophies of the day (Cooper, Evan s& Boyko, 2009, 120). A residence or any building for a public function may occupy one or more lots. But the area of lot coverage for construction must always be less than half the entire site (Watson, Plattus & Shibley, 2003, 81). In Haynie-Sirrine Neighborhood Zoning Overlay Code was assigned to maximum 50 percent for lot coverage in 3 stories buildings, so minimum of open space was 50 percent (Walters & Brown, 2004, 240).

Human distances for residential areas

Like diversity, social distance is a key characteristic of urban

Table 6: OSR in urban development regulations Hamilton Hill, Cockburn, UK

R-code	Maximum plot ratio	Minimum open- space
R30	0.5	0.45
R40	0.6	0.45
R50	0.6	0.45
R60	0.7	0.45

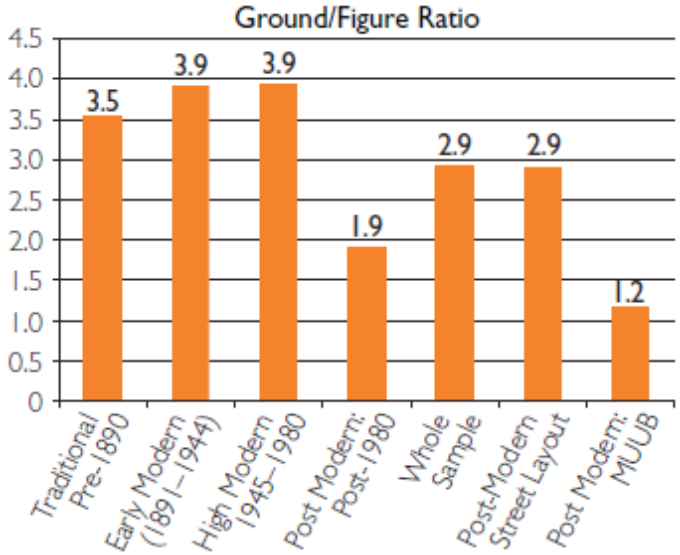

Fig. 3: Figure/ground ratios for the 30 residential developments, by time band (Cooper, Evans & Boyko, 2009, 120)

spaces and a successful concept in international sociology (Ethington, 1997). Al-Homoud (2003) studied the functional and physical distances and their effects on social interactions. Functional distance depends on the position of functional activities and opportunities for additional activities as determined by the setting design, while physical distance refers to the actual measurement between dwelling unites. Potentially, varying functional distances can be present while physical distance remain constant. Functional distance refers to the degree of perceived distance encountered in moving from one point to another (Al-Homoud, 2003, 168). Al-Homoud related human distances for representing social interactions, but in his research, he did not investigate physical model for open and built up space in residential areas.

Anne Clementsen (2015) represent social distance related to the impact of other people's presence on the individual's experience. Social distance entails the relation between the individual and other people. The term social distance used in the present study implies the experience of distance on the basis of differences between individuals in the same culture, which is available to the individual visually when navigating in urban spaces (Clementsen, 2015, 4). She explained four social distances based on diverse types of impact on the individual's behavior in an urban space. In this classification of social distance, four types are introduced: 1- stranger: The most general type of social distance that was underlined in this study was that other people are Strangers. Social distance between strangers has a spatial and behavioral impact on the individual's use of an urban space. The feeling of social distance to strangers in urban spaces can result in people's choice not to simply use urban squares at given times, if it is not possible to position yourself in a certain physical distance to strangers. 2- Multiculturality: multiculturality is characterized as a motivating social distance, which has an emotional impact, since it makes people feel comfortable and at ease. 3-social status: At a larger physical distance people only react upon the specific characteristics of other people, when they experience extremes 4-Deviant behavior: It is the type of social distance with the most apparent influence on the individual's experience and use of urban spaces is deviant behavior (Clementsen, 2015, 13-15).

The methodological research on social distance (SD) draws its roots from a project of collaboration between various Italian universities that worked for the study of this phenomenon in seven large urban areas. It started from a common theoretical basis and it was developed into a program, aimed at building instruments that could measure the concepts proposed in the initial conceptual scheme. This research – that resulted in the publication of six volumes where its achievements and many dimensions are presented and analyzed – also inspired the present article, which synthesizes the reflections carried out for the empirical transformation of the concept of SD, using a mixed approach to social research (Bichi, 2008, 488). We can thus identify at least three modalities of the construction/ reproduction process of sSD: a perceived social distance (pSD), distinct, recognized as such by who experiences it; an expressed social distance(eSD), intentionally put in practice as an action of distancing oneself; an undergone social distance (uSD), the result of the distancing action (Bichi, 2008, 493). The concept of "distance" as applied to human, as distinguished from spatial relations, has come into use among sociologists, in an attempt to reduce to something like measurable terms the grades and degrees of understanding and intimacy which characterize personal and social relations generally (Kidwell & Booth, 2011, 412).

It seems the among social distance theories, Hall (1966) could state real survey because it is based on human needs and he analyzes every distance with behavioral needs. The other social theories cannot relate with physical aspects of human distances as Hall,s theory (1966).

Table 7: four different types of social distance and their respective type of impact on the individual's experience of and behavior in the urban spaces (Clementsen, 2015, 13)

Type of social distance	Motivating	Restricting	Emotional Impact	Behavioural Impact	Spatial Impact	Time Impact
Strangers	■			■	■	
Multiculturality	■		■			
Social status	■	■	■	■	■	
Deviant behavior		■	■	■	■	■

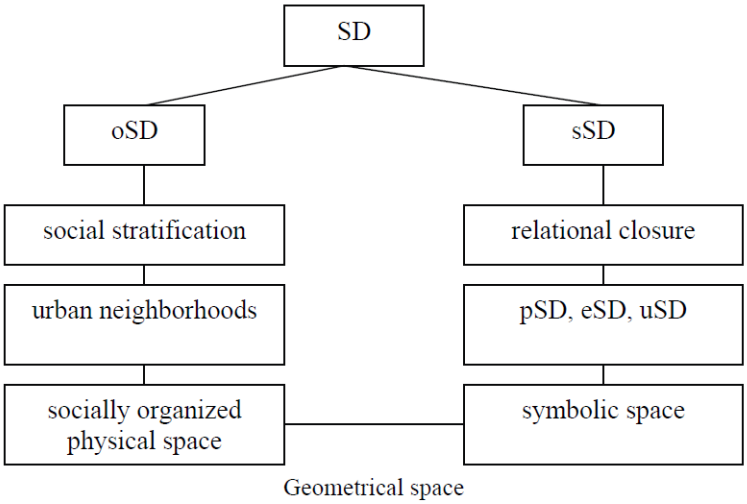

Fig. 4: The model of the social distance concept (Source: Bichi, 2008)

MATERIALLS AND METHOD

In the study, basic theory was Edward Twitchall Hall theory about human distances. He has divided human distances into four parts, that is, intimate, personal, social, public distances. This study used it as space cells for physical model for calculation of built up and open- space ratio

Fig. 4 shows intimate, personal, social and, public distances. It is an important theory about how space conforms in lots. These distances presented by E.T.Hall (1966) based on survey research for different cultures. So it is between top and low strands. This research converted them to certain areas for any person. These distances was transformed to square cells, these circles were surrounded with squares.

Cell area stated is based on Edward's theory, as Fig. 5 shows.

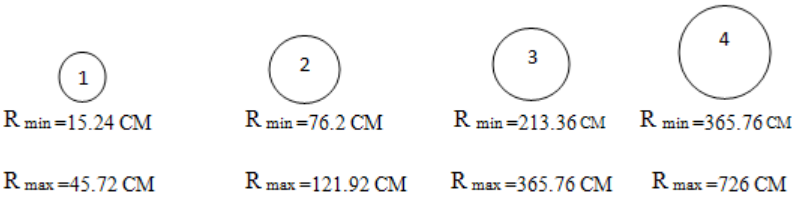

Fig. 5: The human distances based on Hall , s theory

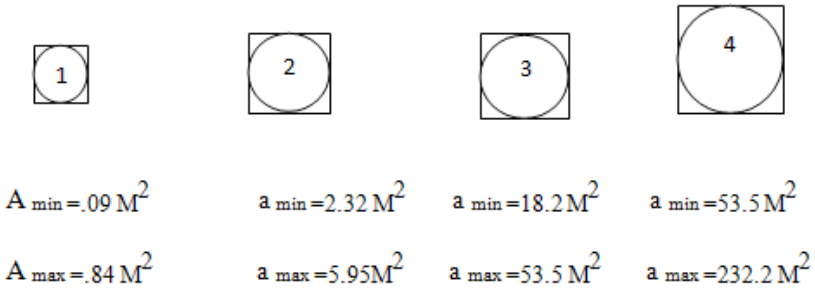

Fig. 6: square cells based on Hall , s theory

Fig.7: Open and built up space

These cells are basic theory for modeling coverage and built up area in housing lots. It seems intimate and personal space can form the inner space and built up areas, that is items 1 and 2. Intimate distance: This is the distance of love-making and wrestling, comforting and protecting. Physical contact or the high possibility of physical involvement is uppermost in the awareness of both persons. The use of their distance receptors is greatly reduced except for olfaction and sensation of radiant heat, both of which are stepped up. In the maximum contact phase, the muscles and skin communicate. Pelvis, thighs, and head can be brought into play; arms can encircle. Except at the outer limits, sharp vision is blurred (Hall, 1966, 117). 2: personal distance is the term originally used by Hedgier to designate the distance consistently separating the members of non-contact species. It might be thought of as a small protective sphere or bubble that an organism maintains between itself and others (Hall, 1966, 119). The kinesthetic sense of closeness derives in part from the possibilities present in regard to what each participant can do to the other with his extremities. At this distance, one can hold or grasp the other person. Visual distortion of the other's features is no longer apparent. However, there is noticeable feedback from the muscles that control eyes (Hall,1966, 119).

As it is shown in Fig. 6, open and built up space form a lot. It is important to distinguish ratio of them. There is not any research about ratio of open and built up in lot, this study aimed at gaining optimum open- space based on Hall' s theory. (Fig. 7)

RESULTS AND DISCUSSION

Case Study

In new urban extension of Iran, ratio of open- space of lot is 40 percent of all, and 60 percent of it is built up and coverage. This ratio is for 1 to 3 stories building in Detail plan, but it is never investigated why the ratio is 2 to 3 for this densities. For high densities, built up area decreases up 30 percent. This ratio is different in other countries, and there is no certain method for distinguishing them. In Iran, Area of Lots is between 150 to 400 m2 in new residential areas. On the other hand, based on this survey, numbers of persons on lots are between 4 to 12. Average of number of household members is 4, so the existing situation can be formulated.

Data Analysis

Ratio of top strand between intimate and personal space is 7, so that is P (personal) =7I (intimate). This ratio is economic rather than low strand, so this proportion between intimate and personal space is economic. The tool for analyzing data is MATLAB software. In the first step, we must formulate relationship between variables. Main purpose is the creation of logical proportion between variables based on existing situation in Iran. In formula (L) is area of lot, (a) is open- space for Lot and (b) is built up of lot and (n) is the number of person on lot. (Fig. 8 and Fig. 9)

Equation 2: $L= a+b$

Fig. 8: The relationship between open and built up space

```
clc
clear all
format long g
i=1;
s=input('enter factor: ')
for n=4:12
    for I=.09:.03:.84
        for L=150:2:400
            a=1-s*I*n/L;
            e(i)=a;
            i=i+1;
        end
    end
end
fprintf('minimum is: ')
min(e)
```

```
minimum is:
ans =

    0.4624
```

Fig. 9: optimum open- space by Matlab software

Equation 3: a/L=1-(b/L)

Equation 4: b=P+I==>b=7I+I=8I

Equation 5: a=1-(8In/L) , 4<n<12

It seems, making logical formula between variables in Equation 1, 2, 3 and 4. Final Equation (5) shows the ratio between variables.

CONCLUSION

Main purpose of this study was to represent optimum OSR in lots in residential layouts. It seems there has not been any specific procedure for calculating measure of open- space ratio and built up area up to now. The consideration of urban development regulation showed that there are not any certain methods for determining measure of OSR in residential areas in land developments. The Open space ratio in urban development regulations of Iran has been determined as a stable phenomenon; however, there was not a logical reason for this ratio. The OSR absolutely depends on FAR and GSR, and it changes from district to district. All of open- space regulations ignore human and social needs and lack a basic theory for measuring of open- space ratio. The Matlab software was used for calculating minimum open- space ratio in lots. Thus, the calculation of this study was based on E.T.Hall's theory (1966). In this relation, the measure of intimate space was between 0.09 to 0.84 m2 for any person. Given data was based on existing situation of Iran, in new residential areas. Fundamental method for distinguishing measure of open- space for any Lot is necessary that do not have scientific ways. But we try to create preliminary movement based on social theory. The research can conform social theory to mathematical modeling and extract new method for making decision about open- space and built up ratio. Minimum OSR of Lot in residential areas, based on this research was 0.46, so in existing situation of residential layouts in low and medium densities, OSR was 0.4, and this size may decrease, but this minimum measure must be 0.46 according to this research and it conforms to the social theory.

The lot coverage and open-space ratios should vary according to local regulations and size and bulk requirements of principal user groups. The open- space and built up ratio always do not have basic reason in land subdivision and detail plan. This study tried to construct basic theory for this idea, but it is not stable and it may change. It seems that the implementation of social distances in new residential layouts cause other physical indicators.

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