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# COMPARATIVE ANALYSIS OF RESIDENTIAL FORMING CELLS

(A Comparative Studyon6Example Cities withSimilarClimates:Virginia Beach, Richmond, Anzali, Noor, Iwaki, Niigata).

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**Abstract-** ***The purpose ofthis paper isto determine thearrangement of forming cells inresidential areasof cities withtemperate and semi-warmclimateinorder toreach appropriate patterns and optimized strategies fordesign ofvilla residentialareas through comparative analysisofthestrengths and weaknesses ofeachidentified type.***
***Sixsamplesofvillaresidential areasin6cities withtemperate and semi-warm climateslocated near thelatitude 37degreesincluding "Virginia Beach" and"Richmond" inAmerica, "Anzali" and"Noor" inIranand"Iwaki" and"Niigata" inJapan were chosen for this study.***
***Typology was carried outintwoblockingscales in residential areasandresidentialcellsin small-scale dimensions for every house and its relation tothe street. In blocking scale two types were identifiedthat inonethere isamain axisas street and houses are charged by roadway on both sidesand through it and another type provides access of roadwaytohomes of a block through aby-way and on therear. Also in residential cells scale, 6different typesin6samples weredetectedthat offerdifferent combinationsofthe main street, roadwayaccess, publicgreen landscaping, private yardsandhouses.Theseforms dividedinto three categoriesbased onthe density oflowdensity, mediumdensityand highdensity. In general,withincreasing population density,length ofstreets decreases, publicgreenspacesdecreasetobeeliminatedeventually, privateyards become smaller in dimensionsandscattering ofbuildings anddistances betweenthemalso decreases.Also, fortheclimate,housingconditions becomesunsuitable***

***Keywords -*** Forming Cells - ResidentialCells–Temperate Climate – Arrangement of Forming Cells.

## I. INTRODUCTION

Achievingrepeatedmodulesin architecturaldesign and urban developmenthas a great importance. Itreducestime and energywasted on in large-scale urban designs.It alsomakes iteasier tocontrolthedesign of large series. Thisisparticularly importantinurban residential areasdesign, since the most usage ineverycity belongs toresidential spaceandproperdesigninthis areamayreduce the futureproblems.To achieve comparative analysis of residentialformsin urbanblocksscaleandalso residential cellarrangement, 6citiessimilar in climate in temperate and semi-warm climatein theareanearlatitude37degreesare chosen including: “Virginia Beach" and"Richmond" inAmerica, "Anzali" and"Noor" inIranand"Iwaki" and"Niigata" inJapan. Then, in these samples,villas residential areasare selected whichwerefound publicly indifferent spots of the cityorinlarge scale.Bydetermination ofproceduresas well ascriteriaspecific tothisstudy, repeated modules in residential areas are analyzed in a comparative method and features for different types are recognized for better solutions in large scales residential urban designs.

## II. THE RESEARCH QUESTION

The purpose of this paper is to determine the arrangement of forming cells repeated in residential areas of cities with temperate and semi-warm climate in order to reach appropriate patterns and optimized strategies for design of villa residential areas through comparative analysis.Types and arrangement of these forming cells, with their specific features and negative or positive points in different situations, makes this paper’s main question.

## III. THE RESEARCH HYPOTHESIS

Forming cells in different population densities have different types and arrangements which their modular repeated distributing patterns would have a great influence on the residential regions. Types and arrangements of these cells differ based on density of population and also cultural, economical and topological factors of the zone. Comparative analysis of these cells leads to have a better understanding of each types and recognizing strength or weakness of each type in urban design decisions.

## IV. METHODS, TOOLS AND STANDARDS

**Method**: This study discusses typology of residential blocks and forming cells combining some quantitative and qualitative criteria, by comparative analysis. Advantages and disadvantages of types are discussed and compared with each other to gain the hypothesis.

**Tools:** In the present study to obtain the required data, the images from maps.google.com website and Google Earth Software have been used.

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**Standards**: Considering instrumental facilities, special measures have been considered for this study. The main criterion in typology is the type of access to roadway and communication hierarchy from home to the main street. In this hierarchy, public green spaces and private yards are also important in arrangement of cells. Also, in quantitative dimension of the study, considering the internet tools used, determination of density of people per hectare, or other conventional compression is not possible and a new criterion depending on the instrumental conditions of this study has been noticed. In this study, density is the number of homes per hectare. This criterion is in line with the objective of the research which is comparative study of residential cells. It is considered a useful criterion, because in the types of cells, homes are examined individually. However, due to lack possibility for determination of the surface area occupied by houses, understanding the space occupied by each House may not be possible. Although, from the amount of spaces allocated to public and private in each region, it may be somehow guessed largeness or smallness of homes. However, doing so has no scientific value and for further more detailed studies, it is necessary to determine the occupancy level, surface area and also number of people residing in the house.

Also, two criteria were defined for path length of access to roadway, including direct access way to each home (which is obtained from length of a street divided by the number of houses fed) and the entire way of access to any home (which is resulted from length of direct access path and communication path to other blocks divided by number of houses fed in the block).

## V. Land Subdivision,ResidentialRegion Design

Land subdivisionis one of thefirstprinciples inshapingthe form andstructure ofurbanenvironments.Land subdivision is the process ofdivisionandsegmentationof urban landsforresidentialuses, public spacesand the networkof streets,roads andaccessibility methods.Main considerationsin this process is on thesizes andshapes oftheland plots, accesses, association of residential unitswith the main and subordinate streets, andobservingthe hierarchy in sorting ofthese elements.[1] [2] [3]

In this study the relationship between accessibilities (including distributor streets and local roadway passages), public and private green spaces and residential units are considered.

### i. Accesses

Accesses and pathways are the most important characteristics of the cities and improving their qualities is one of the main objectives of Urban Development. Duration of traveling, type of the network, distribution of spaces and population density are the factors affecting the access network [4]. In this study, the accesses are studied in two domains of “local distributors” (including traffic connections) and “direct access routes to buildings”[5].

### ii. Public Green Spaces

Urban landscaping is a part of morphological structure in cities and increases the biological quality of cities. They generally reduce dusts, air damping, increase relative humidity and elegance of air [6]. Citizens, especially children generally are interested in natural and green spaces in cities and prefer them to the artificial spaces. Trees and lawn increase the sense of safety and security in inner-city neighborhoods and creativity of children is doubled in green and full of trees spaces [7]. Hence, public green space has been considered as one of the key elements in arrangement of residential environment cells.

Public green spaces in this study are particularly the green pivots of margins along the streets that cover the spaces between residential units and streets. These pivots have generally social and ecological performances and cause secure movement of traffic, favorable sidewalks, reduce in listening and air pollutions as well as beautifying urban spaces [6]. Trees are used as one of the easiest and cheapest way to improve the quality of urban spaces [4]. There will be some compatibility between the plant and the architecture forms through coordination between the shapes of the buildings with shapes of trees and shrubs [8].

### iii. Private Green Spaces

Private green spaces include gardens and yards of residential units.Despite the lack of social function, they are important due to ecological efficiency [6]. In arrangement of residential environment forming cells, dimensions and also direction and position of the private yard’s placement towards the house, street and sunlight are considered. The best gardens depend on the height, direction and status of neighboring units. Gardens are generally considered longer on the north side of the houses so they would have the highest rate of skylight and sunlight [5].

### iv. Villa Residential Unit

Villa houses are independent houses that have private outdoor and yard spaces and are place of residence of one or two family. Density in these areas is very low and due to having garden and private yards, they are considered as green and pleasant spaces [9].

### v. Arrangements of Cells

In composition and shaping residential environments, observing the following points can improve the quality of the residential environment:

- Making residential retreat to provide semi-public open space
- Consideration of the relationship between components size, density and open space
- Variation in size and shape of residential components
- Solution’s to makecar’s speed slow like “woonerf”
- Avoiding the regular raster access networks
- Creating semi-public spaces between units to strengthen neighborhood units[10]

## VI. TYPOLOGY

### i. Introduction of Cities and Residential Villa Forms

Selected examples of residential cells are from 6 cities near latitude 37 with semi- warm and temperate climates. These cities include "Richmond" and "Virginia" from United States of America, "Anzali" and "Noor" from Iran and "Iwaki" and "Niigata" from Japan.

Table 1 illustrates climatic data of selected cities in comparison with each other. In each city villa residential areas are selected and common type of design and spatial hierarchy from the main street to the home are comparatively studied.

**Table 1: Climatic Data Comparison of the Selected Cities in Temperate Climate**

| Cities with Temperate Climate / Climate Statistical Data | Niigata (Japan) | Iwaki (Japan) | Anzali (Iran) | Noor (Iran) | Virginia (USA) | Richmond (USA) |
|---|---|---|---|---|---|---|
| Latitude | 37° 55' | 37°2' | 37°28' | 36°34' | 36°49' | 37°30' |
| Amount of Rainfall per Year (mm) | 1790 | 1450 | 1853 | 830 | 1110 | 1080 |
| Average Maximum of Daily Temperature per Year (C) | 16 | 16 | 19 | 20 | 20 | 20 |
| Average Minimum of Daily Temperature per Year (C) | 10 | 10 | 13 | 12 | 10 | 8 |
| Relative Humidity of Air in the Morning (percent) | 79 | 80 | 84 | 82 | 79 | 83 |
| Relative Humidity of Air in the Evening (percent) | 65 | 65 | 76 | 75 | 60 | 52 |
| Elevation from Sea Level (m) | 7 | 4 | -23 | -21 | 6 | 45 |

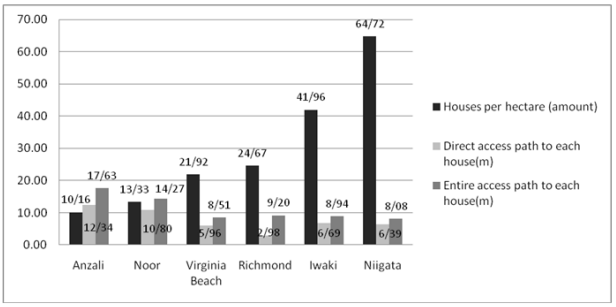
Reference: Authors (data gathered from windfinder.com, weatherbase.com and en.wikipedia.org)

It should be noted that in terms of climate, in urban areas with temperate and semi-warm climates, buildings are constructed separately, with yards and wide open spaces, the fence around these spaces is often shorter than the height of a human [11]. In order to optimize use of air flow and making draught between the blocks, buildings should be organized in the form of decentralized, fragmented and open plan [12].

### ii. Residential Region Typology based on Roadway Access (blocking type)

In this section the smallest cell that its repeated pattern forms the street and block networks is identified. In this study only two different types are identified. The first type is seen in all of the samples except Richmond City. In this type, roadway and pedestrian access to homes will be through the main street and buildings are located on both sides of that. In this system which is a common type in most raster blockings, the street is used efficiently so that for a certain amount of street length, more number of houses would be accessed. Traffic load including passing cars and cars belonging to the neighborhood both go down onto the same street. Subsequently, in terms of traffic load in high population density and populated regions, this method increases the risk of problems. The second type is only available in Richmond City sample. In this system there is two way of access to every house. The main street which is the way of passing cars, only provides access of the pedestrian to the inside of the buildings.Roadway accessis from rear yardin these blocks with a subordinate street. This method reduces traffic load but doubles length of streets. However, since there is two entrances in two side of a house, Security measures should be adopted for both entrances. In chart No.1direct access path to every house which is marked in light grey, indicates length of the street opposite to every house and the entire access path to every house which is in dark grey indicates division of length of the whole path existing in a block by number of houses.The difference between these amounts represents the optimal length of the street for the house. It is observed that the entire length of path in Richmond City sample is almost three times the direct length of path specific to each house. Also, another obvious point in chart 1 is the inverse relationship between density of houses per hectarein black color and the length of access paths, in such a way thatas the density increases length of the way falls consequently. Table 2 shows the positive and negative points of these two types of forming cells of residential regions.

**Chart 1: Comparing three factors of forming cells achieved from cases**




Reference: Authors

### iii. Typology of Residential Cells\

This section, in a smaller scale than previous one, discusses arrangement of spaces in residential cells from the viewpoint of hierarchy of access from the street to each home. 6 studied samples each have a particular cell arrangement. Considering density of regions, each sample has a different type in using public and private green spaces, observing climate points in context scale and method of access.

In typology cognition of samples based on density of homes per hectare, tree types of "low density" (10 and 13 homes per hectare), "medium density" (21 and 24 homes per hectare) and high density (41 and 64 homes per hectare) are obtained which belong to Iran, USA and Japan, respectively. It is necessary to explain that such an arrangement does not mean these patterns develop to the entire city or country. It should be noted that in the cities of Iran, villa residential regionhas very low density and are usually affluent or organizational and often are constructed in suburbs.Villa houses are rarely found in urban centers in a wide range environment. In the cities of Richmond and Virginia Beach common types of housing in urban areas is often villa not apartment, therefore, it has been preferred to select high density samples in these cities which are seen in urban spaces. Either in Japan, urban areas often have single-unit residential environments or villas in high density and compacted forms.Table 3 indicates the identified types and specifications of sample studies. It can be seen, the higher density of houses per hectare, brings less public green space as well as climatic scattering. Also, the yard will have smaller dimensions in comparison with the house.Only in the high density sample of Niigata there is no private yard.

**Table 2: Comparative Analysis of two blocking types**
Reference: Authors (pictures from google earth and maps.google.com)

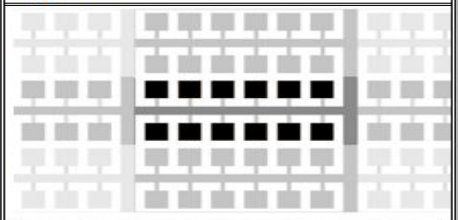
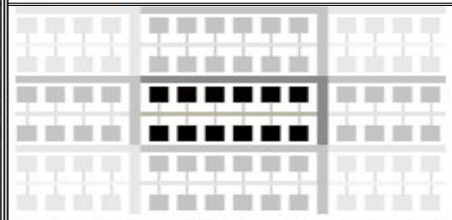
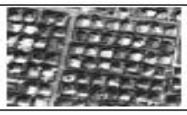
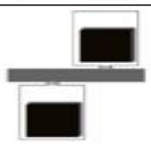
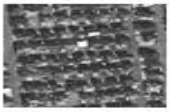
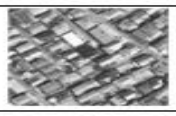
| | Type One | Type Two |
|---|---|---|
| Residential Buildings<br>Main Street<br>Roadway Access to Houses |  |  |
| Cities |  <br>Anzali – Noor – Virginia Beach – Iwaki – Niigata (Image of Noor) |  <br>Richmond |
| Positive Points | Decrease the Length of the Street to the Optimum | Separation of the Main Street and Subordinate Street for Passing Cars and the Resident's Access<br>Creating a Semi-Public Space for Neighbors |
| Negative Points | Increase the Traffic Load in High-Density Regions<br>No Semi-Public Zones for Neighbors | Increase The Entire Length of The Roadway<br>Possibility of Low Security for Houses |

**Table 3: A comparative study of residential cells in house scale**

| Cities | Residential Unit<br>Private Yard<br>Main Street<br>Subordinate Street<br>Roadway Access<br>Public Green Space | A typical Selected Region | • Density of "Number of Houses Per Hectare"<br>• Direct Access Path to each House (m)<br>• The Entire Access Path to Each House (m) | The Main Features of Cell Arrangement |
|---|---|---|---|---|
| Anzali (Iran) |  |  | • 10.16<br>• 12.34<br>• 17.63 | Decrease of Public Green Space and Allocation of its Space to the Private Lands and Villa Units. |
| Noor (Iran) |  |  | • 13.33<br>• 10.80<br>• 14.27 | Elimination of Public Green Space and Allocation of its Space to the Private Area of Homes.<br>Yards in the Northern Side and thus Weakening of Sunlight in Private Gardens |
| Virginia Beach (USA) |  |  | • 21.92<br>• 5.96<br>• 8.51 | Narrowing of Homes to Preserve Public and Private Green Space, as well as Efficient Use of Path Length Considering High Density.<br>Location of Private Yards in the Back Side. |
| Richmond (USA) |  |  | • 24.67<br>• 2.98<br>• 9.20 | Roadway Access through Subordinate street in Back of House, Decrease of Public Green Space in the Margin of Street. Creating Semi-Private Space Between Each Block. |
| Iwaki (Japan) |  |  | • 41.96<br>• 6.69<br>• 8.94 | Small Backyard Due to the High Density, Distinction Between Northern and Southern Buildings for Sunlight and Efficient Use of Southern Sunlight for Gardens |
| Niigata (Japan) |  |  | • 64.72<br>• 6/39<br>• 8/08 | Elimination of Public and Private Green Spaces Due to High Density and Compression of Buildings and Irregularities in the Plots |

**Low-density:** Low-densitycategorywhich includesNoor andAnzaliarevery similarto each other. They bothhaveeliminated the public green space toincrease privatespace and have formed large villa houses.
In the sample of Noor, yards are located in northern side of the houses which is likely to be affected by the position of the sea and its view, but doing so causes less advantage of sunlight for yards. In these samples there is no variation in the size and shape of components and this, alongside the raster design of blocks, would reduce visual qualities of residential environment.Woonerf or methods like that have not been used and there is no space dedicated to the neighborhood. In general, the main trend in these samples is allocation of more space to private properties which might be due to high price of land or other factors.

**Medium-density:** Two cities of Virginia Beach and Richmond (in USA) are placed in this category. In Virginia Beach by reducing the width of homes and making them longitudinal, possibility to locate more houses in each block has been provided. Also, retreating of houses has caused more spacefor public green space in the margin of streets. Private yards are located in back sides of the houses and this has led to decrease in dominance to the private environment. In Richmond, the main point is the path of roadway access from back side of the house and creation of semi-private environment for the residents of each block. On one hand, it would reduce traffic congestion and improve the neighborhood units, but, on the other side, it causes increase in length of streets in each block (almost doubled length of path) and decrease in homes security. In this sample, private yards were located on the backside of houses.

**High-density**: The cities of Iwaki and Niigata in Japan are among the high-density category. In Iwaki the public green space has been eliminated and retreat of houses toward the street is not seen. But, the positive point of this sample compared to all other samples of this study is considering of positions of private yards which are placed in southern side, so that the gardens would take the highest advantage from sunlight. Niigata as the highest density residential sample has a high compactionin morphology and public green space and private yard are almost eliminated. Hence,high density has caused some problems in terms of function, green space and climate due to compactness of buildings.

## VII. CONCLUSION:

In this paper, typology of blocking and arrangement of residential forming cells in villa residential regions in 6 cities with the same climate of Anzali, Noor, Virginia Beach, Richmond, Iwaki and Niigata was carried out. These cities with the same climate have been located near latitude 37 ° and have similarities in climate criteria. Therefore, comparative study of arrangement of housing forming cell becomes more accurate. By comparative analysis of samples and their residential forming cells, used patterns with their weakness or strength are studied and appropriate strategies for choosing types, repeating modules and cells for residential urban designs are recognized.

Cell typology of these samples due to differences in sort of arrangement of residential blocking in large scale which was including differences in street classification and type of access has led to introduction of two different types. The first type includes a main street and homes in two sides of it providing access of roadway to the homes through itself. This model which is considered a common type makes the length of roadway optimized but it might cause increased traffic load in high-density regions. The second type includes the main street and homes in both sides of it, but access of roadway to these buildings is occurred through the subordinate street in the back. This model makes forming of semi-public neighborhood unit possible for homes in a block and decreases traffic load in the main street. But, it doubles the length of street in a block compared to the first model and also it might decrease security of homes for two entrances in both sides of the homes.

In small scale which includes arrangement of spaces from street to each home including the street, public green space, private yard and the buildings, 6 samples have 6 different types.Points obtained from Comparative study of these types are as follows:

- By increase in density of houses per hectare, length of the roadway for each home is reduced and optimized.
- By increase of density, public green space is decreased and eliminated.
- With the increasing density of buildings, affordable distribution of temperateclimates is disappeared and buildings become more compact.
- By increase of density, to keep the public green space, it is possible to decrease width of houses (towards the street) and increase their length.
- In types, being northern or southern of yards of the homes (except Iwaki City) was less considered. Design of cells should be in such a way that advantages of southern sunlight for northern and southern yardsbecome maximized.
- In Richmond sample which has two roadways, one in passing and main form and other special for roadway to homes from back side; there is possibility for formation of semi-private neighborhood unit in back side of homes which has not been noticed practically.
- High-density eliminates public and private green spaces as well as forcing compactness to buildings (Niigata sample).
- Raster arrangement of cells and blockings for distribution in large-scale along the city is considered as a simple solution in design, but it will lead to uniformity of visual quality of the environment.

The typology of residential cell offers several models with distinct positive and negative points that eachofthese modelscan beused considering the situations in every subject of design and importance of priorities.

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