

Housing visual quality in urban pattern; Application of isovist method in old fabric of Bushehr city

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Abstract

Visibility is an important factor of environmental quality that has various influences on the quality of neighborhood. This paper aimed to find the relationship between urban form and visual quality. A public space with a spatial configuration in one of Bushehr city's neighborhoods was selected as the case study. Bushehr city is surrounded by urban development and the sea. Compact urban space, squares, long and narrow streets shape this fabric. Correlational research method was used with Isovist tool to evaluate visibility. A grid analysis and two paths inside the fabric with different urban forms were analyzed using Syntax2D software. The results show that the paths with different urban forms have various visual qualities.

Keywords: Urban form, Residential space, Bushehr city, Visual quality, Isovist

1. Introduction

A lot of factors influence neighborhood quality, visual aspect being one of them. Isovist, the visible points from a vantage point, is used to analyze visual quality in the environment. Isovist indexes studied in this paper are area, perimeter, drift, occlusivity, compactness and circularity. The neighborhood in Bushehr city's old fabric was studied and its visual quality was analyzed. The aim of this paper was to find out whether the visual quality of housing and urban open space in the neighborhoods is influenced by urban form or not. It, also, aimed to find the relationship between open space form of the neighborhood's unique fabric, its organic pathways, the linear main access which divides this fabric into two parts and the visibility.

2. Literature Review

Researchers have worked on developing different tools which could help to quantify the visual quality of the environment. Thiel was one of them, who suggested a sequence notation of the built environment in which the details of the

perception, which he thought of it as a biological function, would be recorded in a path [1]. This is a time scale linear record which its visible values were drawn from Lynch's "image-able elements" [2]. Another technique developed for visibility analysis was introduced by Benedikt. He figured that the analysis made by Thiel lacked the tool for working on both architectural space and form as they are visually being presented. Benedikt introduced isovist to those needing architectural analysis who were looking for a more accurate way of thinking of the space. He described 'isovist' as "the set of all points visible from a given vantage point in space"[3].

Benedikt's measures of the properties of isovists are area, perimeter, and occlusivity. He calculated the properties of point isovists at a grid of locations in the open space of a configuration to create isovist fields"Fig.1". Considering archetypes, he suggested that common elements of the isovist fields can be presented in a way to define spaces like 'corridor'

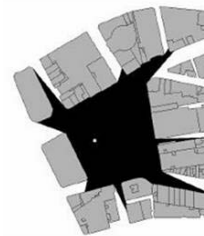


Fig. 1. Defining isovists through visibility graphs: (a) the isovist polygon generated from viewpoint defined by the open circle at 'O'[4].

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or ‘colonnade’. Tandy introduced the concept of isovists into spatial analysis[5], but it was Benedikt who worked on isovists as a way to analyze architectural spaces. Gibson was the creator of the idea of perceptual quality of isovist fields. He introduced the concept of ‘optic flow’ in landscape. To measure the visibility according to urban form attributes, Gibson suggested the ‘ambient optic array’ of urban visibility based on the direct perception of the viewers. The ambient optic array is measured spatially based on the collective amount of geometric Cartesian space occupied by the ambient optic array, which is reflected from physical surfaces that are visually perceivable from a particular vantage point [6]. Benedikt and Burnham showed the effect of isovist attributes on perception of space. They, also, proved that perception of ‘spaciousness’ is related to the complexity of the isovist[7]. Braaksma and Cook worked on Visibility graph based on isovists in space[8]. Hillier and Hanson studied graph analysis of built environment and visibility relationship of space [9]. They used isovist and space syntax techniques to deconstruct some architects’ houses and how they have created space. Turner and Doxa used isovist to study way finding [10] and[11]; while Batty et al. and Turner et al. worked on the relationship of visibility graph analysis and people movement [12] and [13].

3. Research method

In this paper, open space visibility of neighborhoods in Bushehr city’s old fabric and their isovist properties was analyzed in a correlational research to find out whether there is a relationship between urban open space form and visibility. Geometric measures of Benedikt: area, perimeter, occlusivity, circularity and compactness are the indices of analysis. Drift index was also analyzed. Drift index studies isovists longest possible line of sight. Occlusivity is the proportion of the perimeter on the solid boundary of the environment, while Compactness shows how close the isovists are to a convex space. Circularity, as Davis showed, is the spikiness of the isovists and the ratio of the square of the perimeter to area [14]. Different computer programs like Depthmap, Spatialist and Syntax2D can be used to analyze isovist. Syntax2d that ” is an open source spatial analysis program by the Taubman College of Architecture and Urban Planning at the University of Michigan” has been used in this paper [15]. Isovists were drawn on a plan representing major boundaries. In order to find this, a grid analysis and two paths in the neighborhood fabric was studied. The paths chosen on the study are different in form. One organically shaped and circulates the neighborhood while the other is linear in form and separates the neighborhood in two parts. The neighborhood fabric comprises a mixture of incremental and planned development “ Fig. 2”. One of the characteristics of this morphology is its composition. It is a set of rather long and narrow streets with number of squares which are different in shape.

Case study: old fabric of Bushehr city

Bushehr is a southwestern coastal city in Iran, located on the Persian Gulf [16]. The traditional fabric of Bushehr is compact which leads to the formation of an attractive cityscape and

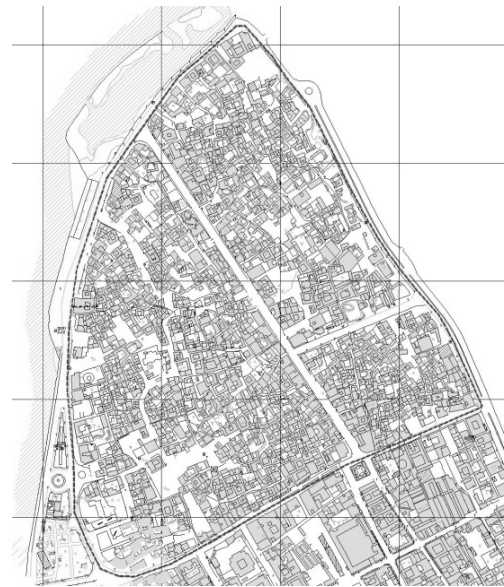


Fig. 2. Map of the area of the study- Old Fabric neighborhood of Bushehr City

makes Bushehr one of the most specified cities in Iran [17]. As Sabatsani noted, despite its warm and humid climate that causes the need for an open space in buildings for ventilation “Fig. 3”, the city seems compact [18].

In the old neighborhoods of this city, urban fabric is very compact and streets are narrow. Proportion of the walls’ height to street width is approximately ten to one. This is due to its commercial role and land worth. High buildings of approximately fifteen meters along these narrow streets create permanent shadow and play a great role in decreasing the environment’s temperature [19].

To use the cool breeze of the sea inside the urban fabric, open spaces are designed around the houses that are very effective elements in dividing the fabric into smaller blocks. Buildings look outwards to have the least number of shared walls in the neighborhoods, and by using maximum air draught, isolated blocks composed of one to a few dwelling units are formed. Access networks are shaped in a hierarchy influenced by environmental temperature, humidity, wind direction, land’s natural condition and social-economical character. Mass and space of this fabric leads to different air pressure inside the spaces and facilitates air draught. The neighborhood in this study is located in the northern part of the city on a 40 acre piece of land surrounded by the Persian Gulf, Lian Avenue and



Fig. 3. Compact and dense urban fabric of Bushehr with isolated urban blocks[20]

Taleghani Boulevard. The old fabric of the site consists of dwelling blocks, local squares and narrow streets.

Visibility Analysis of Case study

According to the literature review, isovist is a way of analyzing visual quality. Isovist indices of the neighborhood's open spaces of the study area are analyzed, using syntax2D software. The geometry graphs of the isovist indices and two paths in the neighborhood are shown in figures 4-9. Correlations between these indices are shown in table 1. The isovist is shaped for the all nodes specified on an evenly spaced grid of 0.2m, including publicly visible and accessible areas.

The spaces in the constellation of the streets and the squares in the neighborhood chosen in Bushehr city is represented by 3692 grid cells. The isovist fields and their frequency distribution are mapped in figure 4 from which it is clear that

streets dominate the space.

The plans show the grid isovist index of the neighborhood spaces. The coloring shows the most integrated (the shallowest of the nodes on average) in red and the least integrated (the deepest on average) in blue. The analysis shows that the area index is highly correlated with the perimeter, at 0.92. Furthermore, the area and the compactness maps are correlated with each other in the same manner as the drift and the area.

An interesting path through the neighborhood is shown in figure 6. Starting on the western part of the neighborhood, it travels along the fabric through streets and squares and reaches its eastern end. The profiles of six isovist indexes of the path circulating the neighborhood in the old fabric of Bushehr city based on 502 nodes are shown in this figure. Figure 7 shows the six line graphs of frequency distribution of the isovists comprising each isovist fields. In terms of the area index, the graph is downwards.

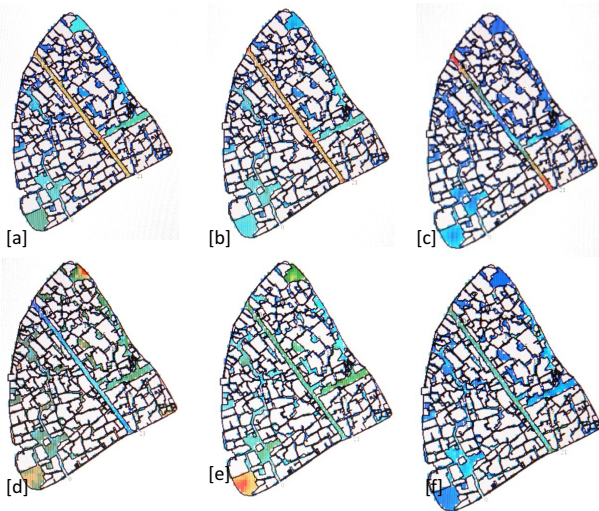


Fig. 4. Isovist graph analysis of housing in old fabric of Bushehr city based on a grid of 3692 cells; [a] area, [b] perimeter, [c] drift, [d] oculivity, [e] compactness and [f] circularity.

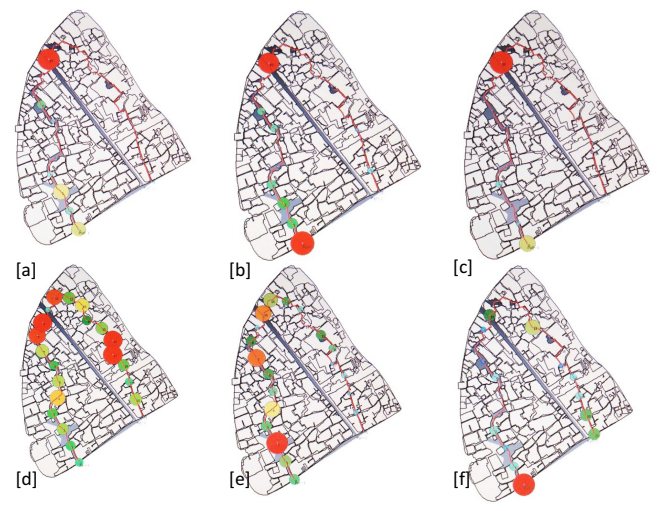


Fig. 6. Isovist analysis of path 1 based on 502 nodes; [a] area, [b] perimeter, [c] drift, [d] oculivity, [e] compactness and [f] circularity.

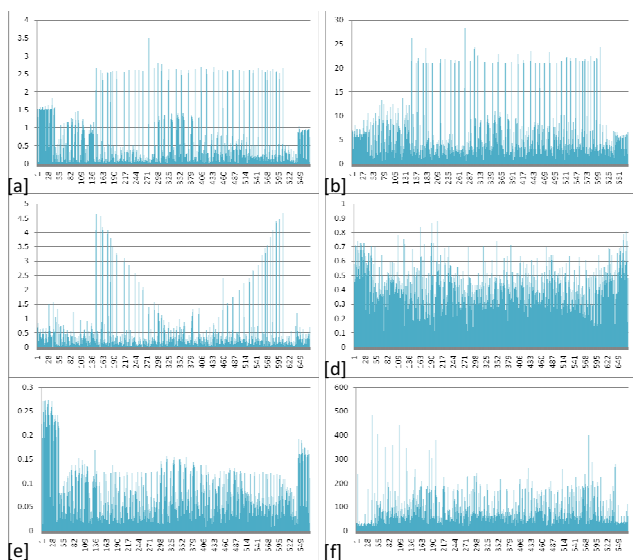


Fig. 5. Frequency distribution of isovists comprising each isovist field based on a grid of 3692 cells; [a] area, [b] perimeter, [c] drift, [d] oculivity, [e] compactness and [f] circularity.

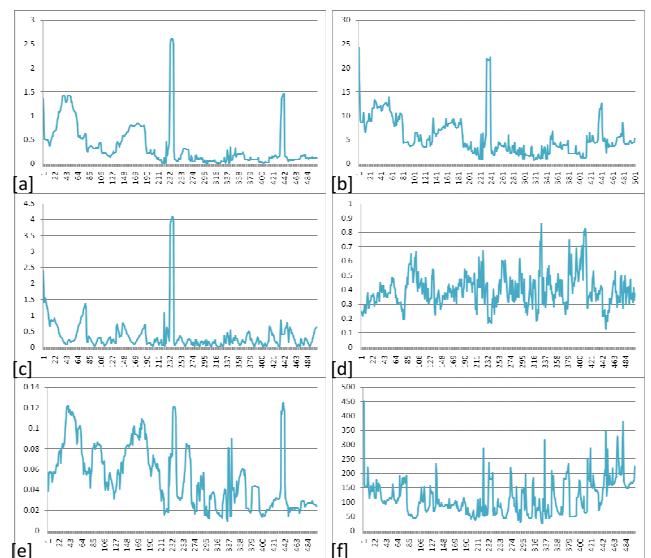


Fig. 7. Frequency distribution of isovists comprising each isovist field of path 1 based on 502 nodes; [a] area, [b] perimeter, [c] drift, [d] oculivity, [e] compactness and [f] circularity.

Enghelab avenue has the highest frequency of this index. On the other hand, the squares of the neighborhood's open spaces have the highest distribution of this index. Turning to perimeter index, the graph shows the same pattern. While the path reaches the main access street, dramatic increase in perimeter index is revealed. Area index of the path is correlated very strongly with the drift and the perimeter. Moreover, the profiles in figures 6(a) and 6(c) show, clearly, the changes in space encountered. As the path node changes from streets to squares, it shows domination of narrow streets in which long way could be seen, except when entering the main access road where the long linear vision increases the actual visible distance. In fact there are some positions where the viewer can see large areas, thus providing a feeling of spaciousness. This is also shown from the perimeter index which increases at major junctions.

Compactness index, which shows how enclosed the viewer feels in the environment is affected by the area seen, shows variation. Whereas, the occlusivity or circularity of spaces, which defines the path, fluctuates much in that these indices are influenced by the details in the space. A comparison of the path with the six isovist fields indicates that a variety of spatial experiences in the urban base are captured, ranging from long views in the narrow streets to complex views in the squares. Path 2, drawn along the Enghelab Avenue, divides the fabric into two parts. Figure 8 shows the six isovist indexes of the path. Their frequency distributions are drawn in figure 9. The study shows that area, perimeter, occlusivity and circularity indexes have the highest correlations, while compactness and circularity are the least correlated indices. Area, perimeter, compactness and circularity indices lack variety throughout the path. On the other hand, drift index gets lesser at the center of the path and higher, in value, at the ends, which indication of an environmentally tedious space.

The analysis of the isovist fields in these two paths shows interesting results. The compactness index dominates when it

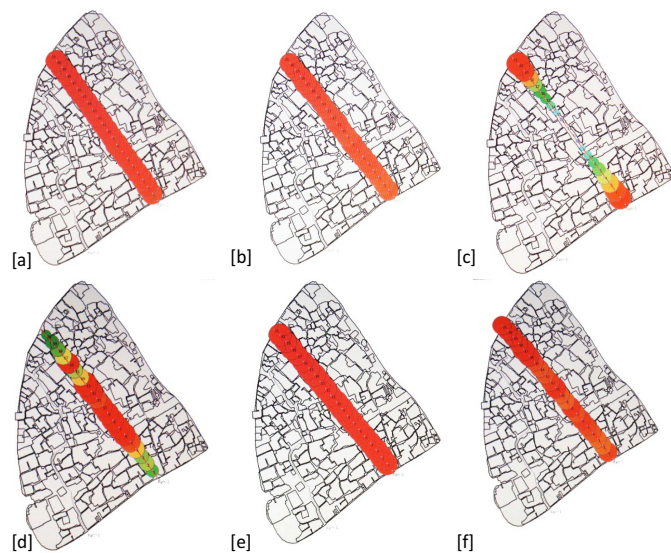


Fig. 8. Isovist analysis of path 2 based on 502 nodes; [a] area, [b] perimeter, [c] drift, [d] occlusivity, [e] compactness and [f] circularity.

reaches the Enghelab Avenue. Its central vantage point is the most compact of anywhere in the area. The squares which are indentations in the neighborhood's open spaces are more compact than the narrow streets which dominate the entire morphology.

The area index shows these patterns quite clearly. As shown in table 1, correlation between isovist indices reveals that the correlation between area, perimeter, drift and compactness are the highest. When the paths are examined, the compactness index of path 1, being higher in squares, shows a variety of values. While, in path 2 it reflects a few compact objects being present in the scene.

Showing the domination of long streets, the compactness index is the lowest index of all the others isovist fields in the study. The squares and some junctions have the highest compactness, while the main parts of the long streets have the least. The circularity field shows that areas on the edges of the streets have higher circularity than the center lines. this is the result of the organic form of the neighborhood plan.

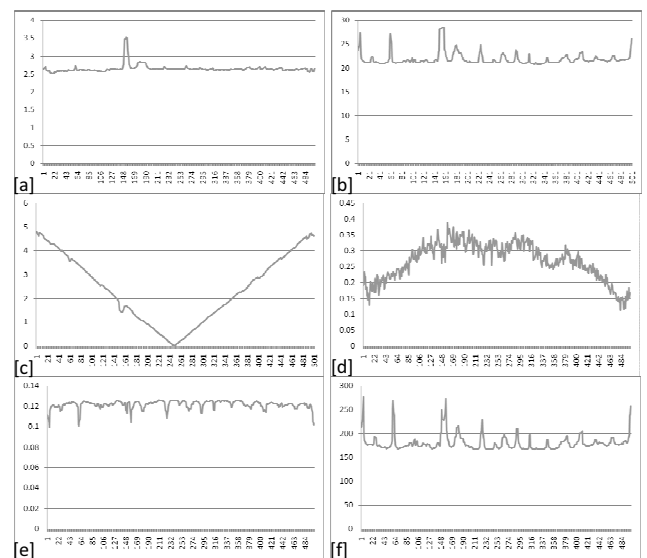


Fig. 9. Frequency distribution of isovists comprising each isovist field of path 2 based on 502 nodes; [a] area, [b] perimeter, [c] drift, [d] occlusivity, [e] compactness and [f] circularity.

Table 1. Correlations among the paths isovist measures

		Path 1 inside old urban fabric which is organically shaped					
"Path" isovist 502 Nodes		area	perimeter	drift	occlusivity	compactness	circularity
Path 2 along the main vehicular access dividing the fabric in two parts	area		0.93	0.8	-0.55	0.7	0.45
	perimeter	0.58		0.87	-0.63	0.49	0.69
	drift	-0.48	-0.08		-0.6	0.27	0.62
	occlusivity	0.44	0.13	-0.83		-0.15	-0.62
	compactness	-0.11	-0.87	-0.2	0.09		-0.18
	circularity	0.38	0.97	0.04	0.03	-0.96	

4. Conclusion

This study shows that isovist tool is applicable in analyzing visual quality in urban fabric. Two forms of urban open space were analyzed to evaluate visibility using Syntax2D. Six isovist measures in the grid and two paths, one with organic and another with linear form, were studied. Also, correlations between these measures in two paths were compared with one another. Studies and analysis show that area and perimeter indices have the highest correlation. In the organic path, these two indices have the highest value reaching the Enghelab Avenue. It divides this fabric into two parts. Moreover, these measures are higher in local squares than in long and narrow streets. On the other hand, these indices remain unchanged in linear paths. Drift index, which studies the longest possible line of sight, rises dramatically when it reaches the Enghelab Avenue; while, it almost stabilizes inside the organic paths. Turning to linear path, this index is the highest at the ends and the lowest in the middle of the path. Occlusivity index that is the proportion of the perimeter on solid boundary of the environment Shows fluctuation in organic path unlike the linear path. While Compactness index that is the indication of how close the observer feels to the environment shows notable variations in organic path, having a steady graph in linear path. Circularity index that is the square of the perimeter to area as it is influenced by details in space shows significant changes in organic path; while, it nearly stabilizes in linear path. To sum it up, it can be said that urban form has a direct relationship with its visibility. In other words, the organic path creates a variety of isovist indexes unlike the linear path that divides the neighborhood fabric into two parts. Furthermore, the analysis shows that the squares, which are the place of social interactions, are more compact than the streets of the neighborhood as they define the nonphysical geometries and variety in the spatial experiences achieved within them. Finally, the study shows that the form of the neighborhood's open space plays an important role in its visual quality and the quality of housing.

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