

A comparative study of the morphological characteristics of residential areas in San Francisco

Mehmet TOPCU*, Michael SOUTHWORTH**

* Selcuk University, Konya, TURKEY

** University of California, Berkeley, USA

Received: December 2013 Final Acceptance: April 2014

Abstract:

This study compares residential neighborhoods with different gridiron patterns in terms of some morphological properties. Nine different gridiron street patterns of San Francisco neighborhoods were chosen to assess the livability of residential areas in terms of several morphological evaluation criteria including accessibility (local and global spatial integration), intelligibility, density, livability index and time period. When measuring these criteria, the focus was on the street-block and building-lot relationships using several different methods. Accessibility and intelligibility values were measured by the 'space syntax' method which evaluates the street system of urban form. Density measures were calculated by the ratio of total built area within sample areas to the total sample area and by the ratio of private open spaces of sample areas to the total built area. In addition, a livability index was calculated by the ratio of pedestrian area to total built area. The contribution of time in the process of city building is also an important part of the morphology of cities. Therefore, in this study time period was used to analyze the historical background of the city. All the findings were evaluated according to these criteria by using GIS. In conclusion, based on the findings, this study stresses that the criteria of accessibility, intelligibility levels and density are inversely proportional with the degree of livability in the study areas. Therefore, we hypothesize that accessibility, density and livability index are the important inputs for making better designs for urban residential space and city design as a whole.

Keywords: *Urban morphology, residential areas, space syntax, density, livability, San Francisco.*

1. Introduction

Urban morphology analysis deals with the structure and/or pattern of a city. A well-established discipline dating back to the first half of the twentieth century, it provides an understanding of the form, processes of creation and transformation, spatial structure and character of human settlements through an analysis of historical development and the constituent parts that form the settlement (Conzen 1960; Whitehand 1986). Urban morphology is an important assessment method in determining the transformation

processes of urban fabrics, making sense of the historical roots of spatial and functional structures and bringing them to the present day (Larkham 2002). Morphological analysis involves examining the relationships between the different elements of the urban fabric one by one. Different researchers emphasize different relationships in their analysis according to their interests (Moudon 1992). For Conzen, a crucial part of the urban fabric is the town plan, which comprises three distinct complexes of 'plan elements': streets and their arrangement in a street system, plots and their aggregation in street blocks, and buildings or, more precisely, their block-plans. Within an urban area, distinct combinations of these plan elements form unitary areas termed 'plan-units' (Conzen 1960; Levy 1999). In addition, Moudon (1997) classifies the main elements of morphological analysis as *buildings, gardens, streets, parks and monuments*. For her, these elements are constantly used and therefore transformed through time. In her study Moudon (1997) mentions that morphological analysis is based on three principles which come from the acknowledgement of different researchers from "ISUF (*International Seminar of Urban Form*): (1) buildings and their related open spaces, plots or lots, and streets are three fundamental physical elements that define urban form, (2) building/lot, the street/block, the city and the region are the different levels of resolution of urban form, and (3) urban form can only be understood historically because the elements are under continuous transformation and replacement" (Moudon 1997).

According to Carmona (2001), buildings, particularly the land uses they accommodate, are usually the least resilient elements of urban settlement. Although more enduring, the plot pattern changes over time as individual plots are subdivided or amalgamated. Therefore, the most enduring and the least changing element tends to be the street plan (Carmona 2001). The importance of the street grid has long been argued by many authors. Because of being used simultaneously for vehicular movement, social contacts and civic activities, Southworth (1993) defines the street as a physical and social structure of the living environment (Southworth and Owens 1993). In this framework, he classifies the various typical street patterns of suburban residential neighborhoods of the United States which affect significantly the quality and character of the community environment into five distinct types; 1. gridiron, 2. fragmented parallel, 3. warped parallel, 4. loops and lollipops, and 5. Lollipops-on-a stick. This typological analysis at a street scale provides substantive information about the sense of neighborhood and street identity (Southworth and Ben-Joseph 2003).

Urban morphology has become a common and important research method for the analysis of the physical structures of cities through quantitative analysis. In this context, Hillier and Hanson, (1984) with the support of technological developments, combined this morphological concept with quantitative analysis of city patterns and called it 'space syntax'. According to Hillier space syntax is a method that can be used for morphological analyses of buildings, architectural plans, urban areas, and urban plans. It is possible to give quantitative descriptions of built spaces by using this method (Hillier and Hanson 1984).

In this context, nine different gridiron street patterns of San Francisco neighborhoods were chosen to assess the residential areas in terms of some morphological characteristics which comprise the measurements of accessibility (local and global spatial integration), intelligibility, density, livability

index and time sense. While measuring these values, the study focused on the street-block, building-lot relationships.

Accessibility and intelligibility values were measured by the space syntax method, which evaluates the urban street system by using accessibility measures (Hillier and Hanson 1984; Hiller 1996). Density measures were calculated by the ratio of total built area of sample areas to the total sample area and by the ratio of private open spaces of sample areas to the total built area. The livability index is used to identify the relationship between streets and their densities and gives a correlation between the total area of built environment and the total area of open spaces in a street zone. This index takes into consideration not only the open space around the buildings but also considers the open space that is free from cars, for pedestrian use only. The ratio of this livable land area to total construction is referred to as the 'livability index' (De Chiara, Panero et al. 1995). According to this definition, the livability index can be calculated by the ratio of pedestrian area to total built area.

The different periods of building construction and the contribution of time sense in the process of city building are also important within urban morphology studies. In this sense, the Muratorian School and the Conzenian School developed some approaches regarding time sense in urban morphology studies (Muratori 1960; Conzen 1981). For them, morphological studies should be evaluated within the historico-geographical (Conzen 1981) and typological (Muratori 1960) approaches. In this framework, the age of buildings are important and generally exhibit the typology of their own periods. Therefore, one of the criteria of this study is the time sense which includes the ages of buildings of the sample areas. They were classified into four periods and analyzed according to their construction dates. The boundaries of these periods were determined by major historical periods of the city of San Francisco.

Table 1. Evaluation criteria and methods used in the study.

Evaluation Criteria	Main elements of the morphological characteristics			Methods used in the study
		Street	Blocks	
	Accessibility of streets ((Global Integration	✓		
	Accessibility of streets ((Local Integration	✓		
	Intelligibility values	✓		
	Ratio of pedestrian area to total built area	✓	✓	
	Ratio of private open spaces of sample areas to the total built area		✓	
	Density of Buildings		✓	
	Age of buildings			

2. Evaluation criteria and method

With the aim of assessing the residential areas in terms of some morphological characteristics, residential sample areas with different grid patterns were evaluated according to seven criteria (Table 1). These evaluations can provide some clues for understanding the appropriate form for residential areas.

After determining the evaluation criteria and methods, sample areas within the city of San Francisco were chosen. Then, data were gathered from sample areas according to these criteria and transferred to the GIS database. Evaluation criteria calculations are described below in detail.

2.1 Accessibility (spatial integration) and intelligibility

"Streets have always been a key element for urban morphology studies and the space syntax method has often been used to understand and evaluate the physical form, street system and structure of cities by using the street configurations and accessibility" (Oliveira 2013). This method is generally accompanied by accessibility criteria which are understood in topological and geometrical terms (Hillier and Hanson 1984; Hiller 1996; Oliveira 2013). For assessing the topological accessibility of streets, first of all, an axial map is prepared. This method provides the integration of space, which is a function of the mean number of street lines and changes of direction that need to be taken to go from that space to all other spaces in the settlement system. This is the central concept of space syntax. The method allows expression of integration in numerical values which contribute to the intelligible structure of the city (Hillier, Hanson et al. 1983; Hillier, Hanson et al. 1987; Kubat 1997; Peponis, Ross et al. 1997; Hillier 1999).

Axial-mapping techniques, introduced by Hillier and Hanson (1984) and Hillier (1996), were used to analyze the spatial structure of the city and to highlight its features. The axial map is often constituted by the least set of axial lines cutting across the free space of an urban environment. Axial lines refer to the longest visibility lines for representing individual linear spaces in urban environments (Hillier and Hanson 1984; Hiller 1996) (Figure 1).



Figure 1. An illustration of axial mapping (left) and integration mapping (right) (Mehmet Topcu).

In addition, it is necessary to compare the integration values of different spaces in order to show the characteristics of the spatial organization. These integration values at the same time make it possible to evaluate accessibility (Hillier, Hanson et al. 1983). After preparing axial maps, global and local integration values are calculated, and the analysis of axial maps is made using these syntactical values. Global integration (or integration of radius n) is a measure of the depth (or number of syntactic steps in a graph) of each axial line in the map, relative to all other lines of the system. Local integration (radius 3) is a measure of the accessibility of each axial line to other lines up to three topological steps away (Oliveira 2013).

The intelligibility of a space or environment refers to the space that allows the observer to understand it and find his or her way around in it. Using

the space syntax approach, the global structure of an environment can be predicted from reading the local properties of an environment (Bafna, 2003). The syntactic intelligibility of an urban system is defined as the degree of correlation between the connectivity and integration values in the system. Connectivity is the number of spatial units which are directly connected to the number of axial lines intersecting an axial line, and it is also defined for each spatial unit (Hillier, Penn et al. 1993; Penn, Hillier et al. 1998; Bafna 2003). The term intelligibility is used because the stronger the correlation, the easier it is to infer the global position of a space from its directly observable local connections (Hillier, Hanson et al. 1983).

In this study, global and local accessibility of streets, in other words, global and local integration values of the streets and intelligibility values of the sample areas, were calculated. These were calculated on the generated axial map of San Francisco by using UCL Depthmap software (Turner 2004; Varoudis 2012). Integration and intelligibility values can also be evaluated with angular segment analysis by using street center lines, but, in this study, axial analysis technique was used.

2.2 Density

The second evaluation criterion in this study is density. "Density is the most important variable for building communities and for determining the condition of 'urbanity', which is a necessary requirement to ensure urban vitality and livability at the district level" (Vicuna 2012). Understanding the effects of density and its relationship with urban morphology are essential for 'urbanity' (Lozano 1990). Density contains valuable information about urban form and the performance of the built environment. An overview of the literature on residential density shows us that the impact of density on the quality or the livability of the built environment is a critical and complex issue (Breheny 2001; Lozano 2007; Berghauser Pont and Haupt 2010).

Density can be calculated using several physical indicators related to the amount of built area on a lot. Lot sizes, building foot prints and number of stories are related to density measures. One can see from the figure below that the same density values can be designed in different ways and they also reveal the perceived characteristics of the residential environment in different ways (Figure 2).

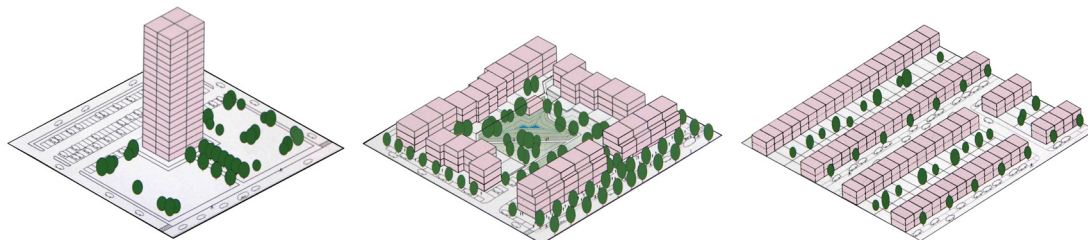


Figure 2. Three different types of urban areas with 75 dwellings per hectare. (Andrew Wright Associates, Final Report of the Urban Task Force, 1999).

In this study, density measurements were made by the ratio of total built area of sample areas to the total sample area and by the ratio of private open

spaces of sample areas to the total built area. These calculations were made for each sample area.

2.3. Livability index

The third evaluation criterion is the level of livability. The livability concept is complex and encompasses many aspects of urban life such as social, cultural, physical, functional, visual and economic characteristics. Livability includes such diverse qualities as the healthfulness of the environment, protection from natural disasters, and absence of crime, as well as opportunities for employment, affordability of housing, and the quality of schools and public services. (Southworth 2003). It is related to how well the city works for us as well as how comfortable and enjoyable our neighborhood and city are. Urban form can be critical to livability, and pedestrian and bicycle access is a key dimension. This study focuses on one physical aspect of livability and was measured by the ratio of pedestrian area to total built area (Figure 3). This ratio is named in the literature as 'livability index' (De Chiara, Panero et al. 1995). The index is used to identify the relationship between streets and their densities and gives a correlation between the total area of built environment and the total pedestrian area in a street zone (De Chiara, Panero et al. 1995; Bolen, Türkoğlu et al. 2007).



Figure 3. *The relationship between pedestrian area and building density (Mehmet Topcu).*

2.4 Time sense

The last evaluation criterion in this study is the sense of time in the built environment. The contribution of time in the process of city building is also an important part of the morphological analysis of cities. Therefore, to evaluate the morphological structure of the sample areas, the ages of the buildings were analyzed. Within this study, all buildings in the residential sample areas were classified into four periods (before 1906, 1906-1930, 1931-1970, after 1970) according to their construction dates. The boundaries of these periods were determined by major historic periods of the city of San Francisco.

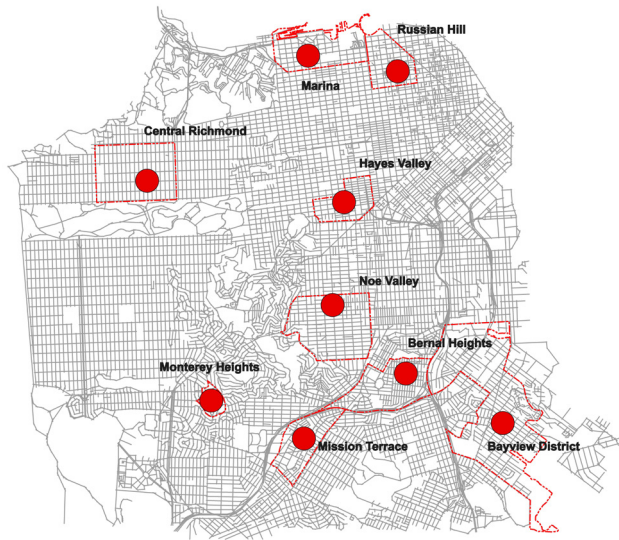


Figure 4. Location of sample areas in San Francisco axial map (Mehmet Topcu).

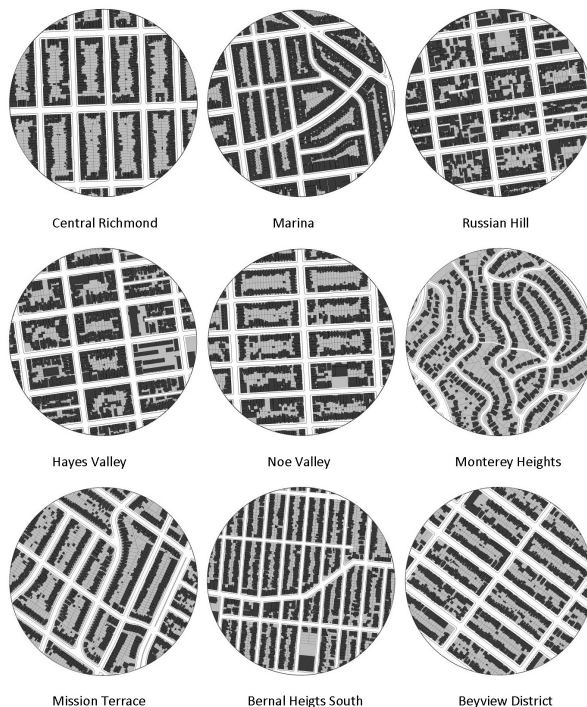


Figure 5. Physical patterns of sample areas (Data Source URL ; schematized by Mehmet Topcu).

3. Study areas

San Francisco was selected as a case because it offers a composite picture comparable to some other American cities and neighborhoods. Moudon (1986), in her valuable study, illustrates the genesis and evolution of neighborhood space through morphological analysis of individual architectural spaces and their transformations over time. As Moudon (1986) mentioned in her study of San Francisco's traditional urban neighborhoods, much of the development of the city not only paralleled what happened elsewhere in the country, but also exhibited a special mixture of nineteenth-century building practices: the traditional urban row house and suburban detached and semi-detached house. For her, San Francisco proved a valuable hybrid, a good model bridging both old and new forms in America, and exhibits a mixed, varied architecture and natural setting (Moudon 1986). According to Bosselmann (2008), the regular grids of blocks and streets were stretched over hills and valleys in San Francisco that seem to defy the natural topography. He counted twenty-seven different grids in his study and commented that San Francisco's street system has a rather complex geometry that evolved from 1849 to recent periods, changed here and there by human intervention, but in the last decade it has gained a relatively stable state (Bosselmann 2008).

In this study, 9 sample areas were chosen from the different residential grid patterns of San Francisco. Each selected grid pattern reflects its characteristic neighborhood pattern. The selected neighborhoods from San Francisco city are: Hayes Valley and Noe Valley neighborhoods from the central part of the city, Marina and Russian Hill neighborhoods from the north side of the city, Central Richmond from the west side and Monterey Heights, Mission Terrace, Bernal Heights South and Bayview neighborhoods from the south side of the city. Subsequently, a 500m diameter circle was overlayed on each of the 9 neighborhoods. These circles express a walking distance of approximately 10 minutes and cover 20 hectares (Figure 4-5).

4. Findings

Findings were classified into four groups according to the evaluation criteria, and the results are given based on these criteria.

4.1 Accessibility (spatial integration) and intelligibility

As mentioned in the evaluation criteria and method section, firstly, an axial map of San Francisco was generated. Secondly, local and global integration and intelligibility values were calculated on the generated axial map by using UCL DepthmapX 0.27b software (Figure 6, Figure 7, Table 2).

Examining the integration values of sample areas, we can infer from the table that *the global integration value* of the city of San Francisco ranges between the values of min.0.3279 and max.1.5714. Furthermore, the mean global integration value of the city is 0.8777. In this analysis, Central Richmond (1.1419), Russian Hill (1.1907), Noe Valley (1.1905), and Hayes Valley (1.2875) neighborhoods are the most integrated sample areas. The Marina neighborhood, which has a value over the mean value, is also integrated but not as much as the previous ones. Mission Terrace, Bernal Heights South, and Bayview District neighborhoods have average integration values and Monterey heights neighborhood is the least integrated one among these neighborhoods (Table 2, Figure 6).

When we evaluate the level of accessibility at the local scale, the integration value of the city of San Francisco changes between the values of 0.3333 and 5.360. The average local integration value of the city is 1.9316. In this analysis, Central Richmond, Russian Hill, Noe Valley, and Hayes Valley neighborhoods are the most integrated sample areas. Marina, Mission Terrace, Bernal Heights South and Bayview District neighborhoods are

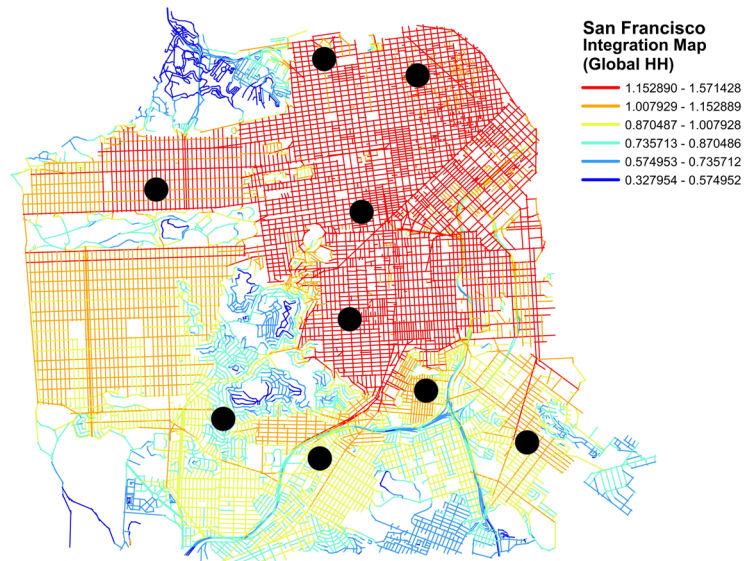


Figure 6. Integration map of San Francisco (global-Rn) (Mehmet Topcu).

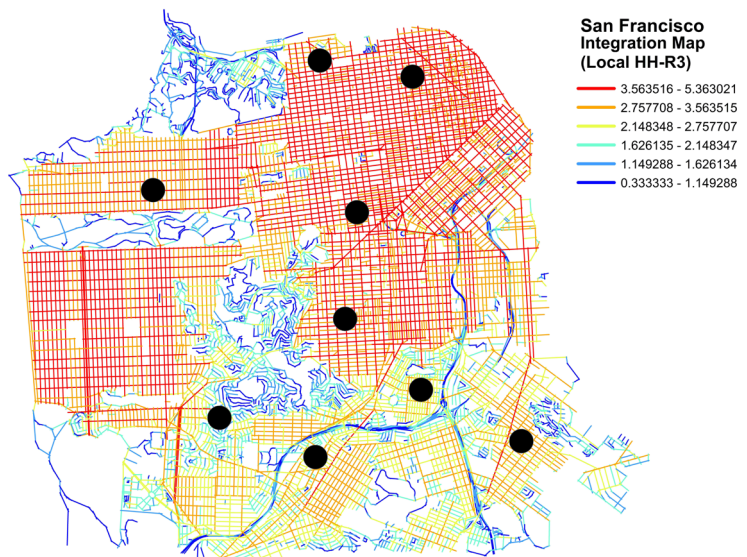



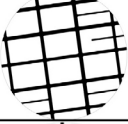
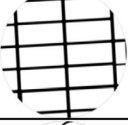
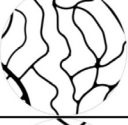

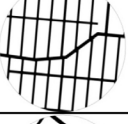
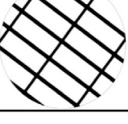



Figure 7. Integration map of San Francisco (local-R3) (Mehmet Topcu).

Table 2. Integration and intelligibility values (Highest values are indicated in boldface type).

Samples	Neighborhoods	Accessibility of Streets		Intelligibility
		Integration Values (Global HH) (Mean)	Integration Values (Local HH R3) (Mean)	Intelligibility Values
	Central Richmond	1.1419	3.5452	0.3879
	Marina	1.0847	3.1101	0.6844
	Russian hill	1.1907	3.5711	0.7937
	Hayes Valley	1.2875	3.8105	0.7515
	Noe Valley	1.1905	3.8358	0.6334
	Monterey Heights	0.7621	1.5069	0.5888
	Mission Terrace	0.9158	2.4090	0.3869
	Bernal Heights South	0.9237	2.6084	0.5422
	Bayview District	0.8922	3.0779	0.5387
	San Francisco	(0.3279-1.5714) Mean:0.8777	(0.3333-5.3630) Mean:1.9316	0.3634

integrated areas with values over the mean value. And, the Monterey Heights neighborhood is the least integrated sample when compared with the other sample neighborhoods (Table 2, Figure 7).

The syntactic intelligibility of an urban system is defined as the degree of correlation between the connectivity and integration values in the system as mentioned above. According to the results of syntactic analyses, the










intelligibility value of San Francisco is 0.3634 (Table 2). This means that the syntactic intelligibility ratio of San Francisco is relatively low since this ratio ranges between 0 and 1. When we analyze intelligibility values within the sample areas, it can be seen from the table that Marina, Russian Hill and Hayes Valley neighborhoods have highest intelligibility values. In addition, Monterey Heights, Bayview District, Bernal Heights South and Noe Valley neighborhoods have high intelligibility values while Central Richmond and Mission Terrace neighborhoods have lesser intelligibility values when compared with the other samples. However, these two neighborhoods' intelligibility values (Central Richmond and Mission Terrace) are closer to that of San Francisco.

4.2 Density

Density measures in this study were calculated by the ratio of total built area of sample areas to the total sample area and by the ratio of private open spaces of sample areas to the total built area (Table 3).

The Russian Hill neighborhood has the highest total built area (1.53) (Figure 8a) and the lowest private open space (0.15) according to the total built area ratio. The neighborhoods which have similar ratios to the Russian Hill sample are Hayes Valley (1.01 and 0.23) and Marina neighborhoods (0.94 and 0.21). In contrast, the Monterey Heights (Figure 8b), Bayview District and the Mission Terrace samples have lower total built area ratios and higher private open spaces in relation to total built area. Among these neighborhoods, Mission Terrace neighborhood has the least total built area (0.36). Bernal Heights South, Noe Valley and Central Richmond (Figure 8c) neighborhoods have average densities when compared with the other sample areas (Table 3).

Table 3. Density calculations of sample areas (Highest values are indicated in boldface type).

Samples	Neighborhoods	Space Usage			Ratio of Total Built Area to Sample Area	Ratio of Private Open Space to Total Built Area
		Total Built Area (m ²)	Private Open Spaces Area (m ²)	Total Sample Area (m ²)		
	Central Richmond	130,603.6	68,022.92	207,479	0.63	0.52
	Marina	195,704	41,883.79	207,479	0.94	0.21
	Russian Hill	318,149.6	46,806.34	207,479	1.53	0.15
	Hayes Valley	210,312.9	49,371.58	207,479	1.01	0.23
	Noe Valley	135,680.8	62,860.96	207,479	0.65	0.46
	Monterey Heights	93,493.78	104,563.5	207,479	0.45	1.12
	Mission Terrace	74,319.86	76,827.42	207,479	0.36	1.03
	Bernal Heights South	115,309.9	59,092.82	207,479	0.56	0.51
	Bayview District	82,603.6	66,275.01	207,479	0.40	0.80

4.3 Livability index

The livability index, as mentioned above, refers to the proportion of walkable open spaces free of vehicles (sidewalks, parks, squares, etc.) in the total

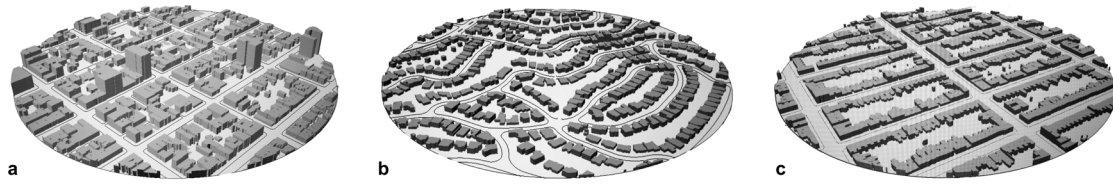


Figure 8. (a) Russian Hill, (b) Monterey Heights, (c) Central Richmond (Mehmet Topcu).

Table 4. Livability index measurements of sample areas (Highest values are indicated in boldface type).

Neighborhoods	Space Usage		Livable Area Index (Ratio of Public) Open Space to Total Built Area
	Public Open Spaces Area (m ²)	Total Built Area (m ²)	
Central Richmond	25,835.13	130,603.6	0.71864
Marina	22,692.99	195,704	0.32997
Russian Hill	29,070.06	318,149.6	0.23849
Hayes Valley	23,978.38	210,312.9	0.34876
Noe Valley	29,406.32	135,680.8	0.68003
Monterey Heights	18,278.62	93,493.78	1.31390
Mission Terrace	22,718.43	74,319.86	1.33942
Bernal Heights South	20,350.77	115,309.9	0.68895
Bayview District	27,831.01	82,603.6	1.13924
<i>Mean</i>			0.7552

built area and is used to identify the relationship between streets and their densities. This index gives a correlation between the total area of built environment and the total area of open spaces in a street zone. When the built environment has a higher livability index value, people have a sense of lower density. From the table, we can see that the average livability index value of the nine neighborhoods is 0.7552. In detail, Monterey Heights (1.3139) (Figure 9a), Bayview District

(1.1392) and Mission Terrace (1.3394) neighborhoods have high livability index values, whereas the Russian Hill (0.2384) (Figure 9c), Hayes Valley (0.3487), and Marina neighborhoods (0.3299) have low values. Bernal Heights South, Noe Valley and Central Richmond (Figure 9b) neighborhoods have average values (Table 4).



Figure 9. (a) Monterey Heights, (b) Central Richmond, (c) Russian Hill (Mehmet Topcu).

4.4 Time sense

In this study, all buildings in the sample residential areas were classified into four periods (before 1906, 1906-1930, 1930-1970, after 1970) according to their construction dates (Table 5). These periods were determined by major periods in the history of San Francisco: 1906 was the biggest earthquake in San Francisco history, and 1929 was the beginning of the economic depression.

According to Table 5, more than a half of the buildings in Hayes Valley and Noe Valley neighborhoods were constructed mostly in the first period (1850-1906). Most of buildings in the sample areas such as Central Richmond, Marina, Russian Hill and Mission Terrace neighborhoods were constructed in the second period (1906-1930). Construction processes of Bernal Heights South and Bayview District neighborhoods continued in the third period, and after 1970, the construction in the sample areas was much less (Table 5).

Table 5. Age of buildings according to the time periods (highest values are indicated in boldface type) (Data Source URL ; schematize, Mehmet Topcu).

Neighborhoods	Number of Buildings (In the Sample Area)	Age of Buildings (In the Sample Area)			
		1850-1906	1906-1930	1930-1970	1970-.....
Central Richmond	589	4 (%0.68)	528 (%89.64)	18 (%3.06)	39 (%6.62)
Marina	536	0 (%0)	456 (%85.1)	71 (%13.3)	9 (%1.6)
Russian hill	469	42 (%8.95)	352 (%75.06)	54 (%11.51)	21 (%4.48)
Hayes Valley	458	318 (%69.43)	91 (%19.87)	17 (%3.71)	32 (%6.99)
Noe Valley	569	323 (%56.76)	190 (%33.39)	48 (%8.43)	8 (%1.4)
Monterey Heights	336	4 (%1.19)	133 (%39.58)	190 (%56.54)	9 (%2.68)
Mission Terrace	548	15 (%2.73)	422 (%77)	107 (%19.52)	4 (%0.72)
Bernal Heights South	844	191 (%22.63)	436 (%51.66)	200 (%23.69)	17 (%2.01)
Bayview District	558	60 (%10.75)	280 (%50.17)	197 (%35.3)	20 (%3.58)

5. General evaluation and conclusion

To evaluate the morphological properties of selected neighborhoods in San Francisco, this study compared different gridiron residential patterns according to several criteria: accessibility, intelligibility, density, livability index and time sense. To sum up the findings the following can be said (Table 6):

- The Central Richmond neighborhood was predominantly developed within the 1906-1930 period. This neighborhood has higher accessibility at the local and global levels. Findings related to this neighborhood revealed that this area has average values in terms of the other evaluation criteria.
- The Marina neighborhood was predominantly developed within the 1906-1930 period. This neighborhood appears to have high accessibility at the local and global levels. Although this neighborhood has a high intelligibility value and high density of built area, it has a lower value in terms of private open spaces and a low livability index value.
- The Russian Hill neighborhood was predominantly structured within the 1906-1930 period. This neighborhood has a higher degree of local and global accessibility, density of structuring and intelligibility value. However, it has a lower ratio of private open space and livability index value.
- The Hayes Valley neighborhood was predominantly structured within the 1850-1906 period. This neighborhood has higher local and global accessibility values, density of structuring and intelligibility values. In contrast, it has lower

private open space ratio and low livability index value.

- The Noe Valley neighborhood was predominantly built within the 1850-1906 period. This neighborhood has higher local and global accessibility values and a high intelligibility value. It has average levels in terms of the other criteria.
- The Monterey Heights neighborhood was predominantly developed within the 1906-1970 period. In this sample, we can observe that local and global accessibility values are low and the density is lower. In contrast, the livability index value and private open space ratio are higher.
- The Mission Terrace neighborhood was built predominantly within the 1906-1930 period. It has high local accessibility and average global accessibility values. Although it has a lower ratio in terms of the density of structuring, it has higher private open space and livability index values.
- The Bernal Heights neighborhood was developed continually from 1850 to 1970. Although it has high local accessibility and intelligibility values, it has average values in terms of global accessibility, density of structuring, ratio of private open space and livability index.

And the last sample area, the Bayview District neighborhood was built predominantly within the 1906-1930 period. While this neighborhood has an average global accessibility value, it has high local accessibility, intelligibility, livability index and the ratio of private open space values. However, we can see from the analysis that the density in this neighborhood is lower (Table 6).

Table 6. General comparison of sample areas according to the evaluation criteria.

Sample Neighborhoods		Central Richmond	Marina	Russian Hill	Hayes Valley	Noe Valley	Monterey Heights	Mission Terrace	Bernal Heights South	Bayview District
Accessibility	Global integration	2	1	2	2	2	-1	0	0	0
	Local integration	2	1	2	2	2	-1	1	1	1
Intelligibility		0	2	2	2	1	1	0	1	1
Density	Ratio of total built area to sample area	0	2	2	2	0	-2	-2	0	-2
	Ratio of private open spaces to total built area	0	-2	-2	-2	0	2	2	0	1
Livability Index		0	-1	-2	-1	0	2	2	0	1
2: Higher degree		1: High degree		0: Medium degree		-1: Low degree		-2: Lower degree		

From the above findings, we can say that the elements that shape the morphological characteristics of urban patterns, especially accessibility and density, are important factors for the integration and livability of residential areas. In the San Francisco case, residential gridiron patterns have distinct characteristics in terms of their accessibility, intelligibility and density properties. However, it is possible to say briefly from the results that the higher density in a residential area relates to how accessible and intelligible that residential area is when compared with the other areas. But, in these areas, the livability index and private open space values are generally lower. Therefore, this finding suggests that accessibility, intelligibility levels and density are inversely proportional with the livability values of the settlement. In conclusion, this study suggests that accessibility, density and livability index are the important inputs for making better designs for urban residential spaces and for the city as a whole.

Future research should explore other dimensions of livability, as well. Case studies of global cities using similar methods will enhance our understanding

of the important relations between urban morphology and quality of life. All scales of urban form affect livability, from the design of individual residential sites, to neighborhood streets and parks, to citywide systems of arterial streets and open space. A highly livable city works at each scale. In order to have a real impact on the quality of the built environment, policies and improvements ideally would be distributed over the entire city to improve the everyday environment for all residents. Fortunately, a significant number of elements that impact the quality of the urban environment are part of citywide systems: streets, parks, public buildings, cultural institutions, schools, systems of lighting and signing, and utilities. These amount to a large portion of the urban fabric that is in public ownership or control, providing a city with significant leverage for improving the quality of the entire built city.

Acknowledgments

The corresponding author is grateful for the support of the 2219 Fellowship Program of the Scientific and Technological Research Council of Turkey and the Institute of Urban and Regional Development (IURD) at the University of California, Berkeley.

References

- Bafna, S. (2003) Space Syntax A Brief Introduction to its Logic and Analytical Techniques, *Environment and Behavior*, Vol.35, No.1: 17-29.
- Berghauer Pont, M., and P. Haupt (2010) *Spacematrix: Space, Density and Urban Form*, NAI Publishers, Rotterdam.
- Bolen, F., H. Turkoglu, et al. (2007) *Quality of Residential Environment in a City Facing Unsustainable Growth Problems: Istanbul*, Joint Congress of the European Regional Science Association and the Association de Science Régionale de Langue Française, Paris, August/September.
- Bosselmann, P. (2008) *Urban Transformation: Understanding City Form and Design*, Island Press.
- Breheny, M. (2001) Densities and Sustainable Cities: The UK Experience, in *Cities for the New Millennium*. Spon, London, pp.39-51.
- Carmona, M. (2001) Sustainable Urban Design-A Possible Agenda, *Planning for a Sustainable Future*: 165.
- Conzen, M. (1981) The Morphology of Towns in Britain During the Industrial Era, *The Urban Landscape: Historical Development and Management*, pp.87-126.
- Conzen, M.R.G. (1960) Alnwick, Northumberland: A Study in Town-plan Analysis, *Transactions and Papers (Institute of British Geographers)*, No.27: iii-122.
- De Chiara, J., J. Panero, et al. (1995) *Time-saver Standards for Housing and Residential Development*, McGraw-Hill Companies, New York.
- Hillier, B. (1996) *Space is the Machine: A Configurational Theory of Architecture*, Cambridge University Press, Cambridge, UK.
- Hillier, B. (1999) The Common Language of Space: A Way of Looking at the Social, Economic and Environmental Functioning of Cities on a Common Basis, *Journal of Environmental Science*, Vol.11: 344-349.
- Hillier, B., and J. Hanson (1984) *The Social Logic of Space*, Cambridge University Press Cambridge.
- Hillier, B., J. Hanson, et al. (1983) Space Syntax, A Different Urban Perspective, *Architects Journal*, Vol.178: 47-63.
- Hillier, B., A. Penn, et al. (1993) Natural Movement-or, Configuration and

- Attraction in Urban Pedestrian Movement, *Environment and Planning B: Planning and Design*, Vol.20, No. 1: 29-66.
- Hillier, W., J. Hanson, et al. (1987) Syntactic Analysis of Settlements, *Architecture et Comportement / Architecture and Behaviour*, Vol.3, No.3: 217-231.
- Kubat, A.S. (1997) The Morphological Characteristics of Anatolian Fortified Towns, *Environment and Planning B: Planning and Design*, Vol.24, No.1 : 95-123.
- Larkham, P.J. (2002) Misusing 'Morphology', *Urban Morphology*, Vol.6, No.2: 95-96.
- Levy, A. (1999) Urban Morphology and the Problem of the Modern Urban Fabric: Some Questions for Research, *Urban Morphology*, Vol.3: 79-85.
- Lozano, E. (2007) Density in Communities, or the Most Important Factor in Building Urbanity, in *The Urban Design Reader*, pp.312-327.
- Lozano, E.E. (1990) *Community Design and the Culture of Cities: The Crossroad and the Wall*, Cambridge University Press, Cambridge and New York.
- Moudon, A.V. (1986) *Built for Change: Neighborhood Architecture in San Francisco*, MIT Press, Cambridge, MA.
- Moudon, A.V. (1992) A Catholic Approach to Organizing What Urban Designers Should Know, *Journal of Planning Literature*, Vol.6, No.4: 331-349.
- Moudon, A.V. (1997) Urban Morphology as an Emerging Interdisciplinary Field, *Urban Morphology*, Vol.1, No.1: 3-10.
- Muratori, S. (1960) Studi per una Operante Storia Urbana di Venezia, Palladio 1959: 1-113. 122.
- Oliveira, V. (2013) Morpho: A Methodology for Assessing Urban Form, *Urban Morphology*, Vol.17, No.1: 21-33.
- Penn, A., B. Hillier, et al. (1998) Configurational Modelling of Urban Movement Networks, *Environment and Planning B: Planning and Design*, Vol.25, No.1: 59-84.
- Peponis, J., C. Ross, et al. (1997) The Structure of Urban Space, Movement and Co-presence: The Case of Atlanta, *Geoforum*, Vol.28, No.3: 341-358.
- Southworth, M. (2003) Measuring the Liveable City, *Built Environment (1978-)*: 343-354.
- Southworth, M., and E. Ben-Joseph (2003) *Streets and the Shaping of Towns and Cities*, Island Press, Washington D.C.
- Southworth, M., and P.M. Owens (1993) The Evolving Metropolis: Studies of Community, Neighborhood, and Street Form at the Urban Edge, *Journal of the American Planning Association*, Vol.59, No3: 271-287.
- Turner, A. (2004) Depthmap 4: A Researcher's Handbook. Available online, accessed October 2013: <https://data.sfgov.org/>
- Varoudis, T. (2012) depthmapX—Multi-platform Spatial Network Analyses Software.
- Vicuna, M. (2012) The Forms of Residential Density in The Contemporary City: The Case of Santiago, Chile, in M. Greene, J. Reyes and A. Castro (eds.), *Proceedings of the 8th International Space Syntax Symposium*, Pontificia Universidad Católica de Chile, Santiago, Chile.
- Whitehand, J. (1986) Taking Stock of Urban Geography, *Area*, Vol.18, No.2: 147-151.

San Francisco’da konut alanlarının morfolojik karakteristikleri üzerine karşılaştırılmalı bir çalışma

Bu çalışma, San Francisco kentinde farklı grid dokuya sahip konut bölgelerinin morfolojik özelliklerini ve yaşanabilirliğini, erişilebilirlik (yerel ve global mekansal bütünleşme), anlaşılabilirlik, yoğunluk, yaşanabilirlik indeksi ve zaman periyodunu içeren birtakım morfolojik değerlendirme parametreleri üzerinden tartışmaktadır. Buna yönelik olarak, San Francisco kenti genelinden her biri içinde bulunduğu konut bölgesinin karakteristik kimliğini yansıtan dokuz farklı örneklem alanı seçilmiştir. Bunlar; kent merkezi içerisinde yer alan Hayes Valley ve Noe Valley mahalleleri, kentin kuzeyinde bulunan Marina ve Russian Hill mahalleleri, batısında Central Richmond ve güneyindeki Monterey Heights, Mission Terrace, Bernal Heights South ve Bayview konut bölgeleridir. Seçilen her bir örnek konut bölgesinin büyüklüğü 500 metre çapında olup, yaklaşık 10 dakikalık yürüme mesafesine denk gelmektedir.

Çalışmanın odak noktası seçilen örnek konut bölgelerindeki sokak-yapı adası ve bina-parcel ilişkisidir. Bu ilişki belirlenen parametreler çerçevesinde farklı yöntemler kullanılarak değerlendirilmiştir; erişilebilirlik ve anlaşılabilirlik parametreleri, kent formu ve sokak sistemi arasındaki ilişkileri sayısal olarak anlamamızı sağlayan ‘mekan sentaksı’ yöntemi kullanılarak ölçülmüştür. Bu ölçümde, öncelikle San Francisco kentinin aks haritası oluşturulmuş, daha sonra Deptmap bilgisayar yazılım programı kullanılarak global ve yerel ölçekteki bütünleşme değerleri hesaplanmıştır. Anlaşılabilirlik parametresi için Deptmap programından elde edilen bütünleşme ve bağlılık değerleri arasındaki korelasyon hesaplanarak bulunmuştur. Bir diğer değerlendirme parametresi olan yoğunluk ile ilgili ölçümler ise iki şekilde yapılmıştır; birinci ölçüm seçilen örneklem alanı içerisindeki toplam yapılaşmış alanın örneklem alanına oranı, ikinci ölçüm ise özel mülkiyet olarak kullanılan açık alanların (bina arka bahçeleri) toplam yapılaşmış alana olan oranıdır. Yaşanabilirlik indeksi parametresi, örneklem alanların içerisinde yer alan ve yaya olarak kullanılabilen açık alanlarının (kamusal alanlar), toplam yapılaşmış alanına olan oranından hesaplanmıştır. Kent morfolojisi araştırmalarının önemli bir parçası olan zaman kavramının kent planlama sürecindeki önemi yadsınamayacağından, çalışma kapsamında kentin tarihsel geçmişini anlamak amacıyla zaman kavramı da değerlendirme parametreleri arasında yer almaktadır. Zaman içerisindeki değişimlerin morfolojik farklılıklar üzerindeki etkilerini anlamak için kullanılan bu parametrede ise seçilen örneklem alanları içerisindeki yapıların yapılış tarihleri (bina yaşları) önemli girdiler olmuştur. Bu çerçevede, seçilen örnek alanlar içerisinde yer alan tüm binaların yapılış tarihleri, San Francisco kentinin tarihindeki temel dönemleri oluşturan dört tarih aralığına göre (1906 öncesi, 1906-1930, 1930-1970, 1970 sonrası) sınıflandırılmıştır.

Çalışmanın bir sonraki aşamasında, elde edilen tüm veriler Coğrafi Bilgi Sistemi (CBS) kullanılarak ortak bir veri tabanında toplanmış ve belirlenen parametreler aracılığı ile morfolojik açıdan değerlendirilmiştir. Değerlendirmeler yapılırken, seçilen her bir örneklem alanının her bir parametre özelinde beşli skalada (çok yüksek, yüksek, normal, düşük, çok düşük) kategorize edildiği bir matristen yararlanılmıştır.

Çalışma sonucunda, elde edilen bulgulardan yola çıkılarak, San Francisco kentindeki farklı grid dokuya sahip konut bölgelerinin, erişilebilirlikleri, anlaşılabilirlikleri ve yoğunluk özellikleri açısından değişik karakteristiklere sahip olduğu ve bu konut bölgelerinin, bir başka deyişle, kent dokularının morfolojik karakterini şekillendiren parametrelerden özellikle erişilebilirlik ve yoğunluk parametrelerinin konut bölgelerinin yaşanabilirliği ve entegrasyonunda önemli faktörler olduğu söylenebilir. Bunun yanı sıra, konut bölgelerindeki yüksek yoğunluk, konut bölgesinin diğer alanlarla kıyaslandığında ne derecede erişilebilir ve anlaşılabilir olduğu ile ilintilidir. Fakat, bu alanlarda yaşanabilirlik indeksi ve özel açık mekan/yapılaşmış alan oranı değerleri daha düşüktür. Bu nedenle, bu bulgu erişilebilirlik, anlaşılabilirlik düzeylerinin ve yoğunluğun yerleşmenin yaşanabilirlik değerleri ile ters orantılı olduğunu göstermektedir. Dolayısıyla, erişilebilirlik, yoğunluk ve yaşanabilirlik indeksi parametrelerinin bütüncül kent tasarımı ve kentsel konut alanlarında üretilecek tasarımlar için önemli girdiler olduğu varsayılabilir.

Bu çalışma, konut alanlarındaki yaşanabilirlik konusunun morfolojik boyutunu fiziksel açıdan inceleyen bir çalışma olup, diğer boyutları göz ardı etmiştir. Dolayısıyla, gelecekte konut alanlarında yaşanabilirlik üzerine yapılacak çalışmalarda bu konunun diğer boyutlarının da incelenmesi gerektiği düşünülmektedir. Global kentlerde benzer örnek alan ve yöntemler kullanılarak yürütülecek çalışmalar, kent morfolojisi ve yaşam

kalitesi arasındaki varolan önemli ilişkileri anlayışımızı da geliştireceğinden oldukça önemlidir. Konut alanları tasarımından, sokak ve park tasarımlarına, kent genelindeki açık alan ve sokak tasarımlarına kadar her ölçekteki kent formu yaşanabilirliği etkilemektedir. Yaşanabilirliği yüksek olan kentler her ölçekte başarılıdırlar. Yapılı çevre kalitesinin yükseltilmesinde gerçek bir etki oluşturmak ve tüm kullanıcıların günlük yaşamını iyileştirmek için gerekli politika ve düzenlemelerin ideal bir şekilde tüm kente dağıtılması esastır. Kentsel çevre kalitesini etkileyen elemanların çoğu (sokaklar, parklar, kamusal yapılar, kültürel kurumlar, okullar, aydınlatma ve yönlendirme elemanları ve kamu hizmetleri gibi) aynı zamanda tüm kent sisteminin de parçasıdırlar. Bu durum bize aynı zamanda kent dokusunun büyük bir bölümünün kamu sahipliği ve kontrolünde olduğunu ve bunun da tüm kentin yapılı çevre kalitesini geliştirmek için önemli bir baskı sağladığını göstermektedir.