Extending the Scope of Morpho Analysis: an Iranian Exploration

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Abstract

The study of urban form in Iran has been mainly focused on historical urban landscapes. Furthermore, morphological studies have mostly adopted a descriptive qualitative emphasis, many times related to 'particular' aspects of the object under analysis and not to 'general' frameworks of explanation. While acknowledging the unique urban history of the country, this paper focus on contemporary urban forms, offering a balance between description and explanation, qualitative and quantitative analysis, and 'particular' and 'general' views. It proposes the Morpho methodology, focused on the town-plan elements – streets, street blocks, plots and buildings – for the analysis of contemporary urban landscapes. Morpho is applied into two districts in Tehran. The application makes evident how this morphological framework can be used in the description and explanation of contemporary urban landscapes, highlighting the main strengths (high density of street blocks and plots, high coincidence between building and plot frontages) and weaknesses (low to medium permeability of streets) of the two districts.

Keywords
Urban Morphology, Morpho Methodology, Town-Plan, Contemporary Urban Landscapes, Tehran

Introduction

Encompassing some of oldest cities of the world in its current borders, Iran has a rich repertoire of urban forms shaped by geographical diversity, different dynasties ruling the country over 2500 years of urban history, profound changes in religious beliefs from Zoroastrian to Islam, and the technological achievements of each period.

The study of urban form in Iran, mainly relies on archaeological excavations, descriptive narrations of single cities (Sami, 1951; Schmidt 1953; Morris, 1963), and typological analysis of specialized buildings, like exceptional houses, mosques, schools, baths, gardens, and their pavilions (Memarian, 2006a, 2006b; Shaterian, 2011). There are few studies on neighbourhoods, streets and squares, and available analytical works of urban forms mostly use interpretative methods to describe the morphological nature of Iranian cities (Ferdosian, 2002; Ahari, 2014). Although there are some works addressing the urban form of Iranian Cities in a morphological perspective, like general studies of main cities (Bonine, 1979; Habibi, 1999; Karimi, 1998), or investigating well-known cities (Bahrambeygui, 1972; Costello 1998), only some recent papers have relied on classical analytical methods of urban morphology to offer new perspectives on reading the physical form of cities (Esfanjary 2015, Lak and Hakimian 2018). Still, even these recent studies generally neglect contemporary cities (or contemporary parts of old cities), as well as their urban fabrics and buildings.

The history of contemporary Iran began when the Qajar dynasty took control of the country in 1786, moving the capital city from Shiraz to Tehran. After more than 100 years of war, following the Safavid dynasty, the Iranian government strengthened its relationships with different countries, mainly in

Europe. These relationships led Iranian kings to follow European processes of urban development as a sign of modernity. Naser-al-din Shah, the fourth king of Qajar, expanded the borders of the city and started to import the main forms and functions of European cities. The next and last Dynasty of Iran, Pahlavi, was contemporary of international modernism, and the first king of the dynasty, Reza Shah, started the modernization process of Iran, with extensive relationships, mainly with Europe. In this period, Tehran, the capital city, became the 'showroom' of modernistic buildings and urban forms in Iran.

This paper addresses a part of Tehran developed in the first and second Pahlavi periods, including some urban fabrics structured by new boulevards and streets, plot systems radically different from traditional ones, and many of the first modernistic towers of the country. A new planning and architectural paradigm are evident in the way these streets, street blocks, plots and buildings are organized. The study area of this paper addresses districts 6 and 7, including 14 residential and service areas: Tehran University, Fatemi, Amirabad, Valiasr, Iranshahr, Qaemmagham, Abbasabad, Arjantin, Bahar, Amjadieh, Niloufar, Sohrevardi, Yousef Abad, Gandhi, and Abbasabad city centre. The study area is separated from the historical part of the city by Enghelab street, starting from Enghelab sq. in the west to Imam Hossein sq. in the east. These areas have been developed after the Iranian Revolution of 1979, mainly as mixed zones, including residential, commercial, service, business, administrative and educational land uses. The area has been the first exploration of modernism in Iran. Many traditional cities after Tehran repeated this modern pattern of urban development. Yet, in recent years, this type of urban fabric has been facing increasing criticism (Madanipour, 2006). This is mainly based on comparison with traditional fabrics, and to the inefficiency of new fabrics in relation to current requirements of urban development.

The analytical approach proposed in this paper is supported by the Morpho methodology. Morpho has been originally proposed as a methodology to address the physical form of cities through a focus on the most permanent elements of urban form – the town-plan, or ground plan. The methodology was first applied at the street scale (Oliveira, 2013). It has been subsequently developed and applied at the city scale (Oliveira and Medeiros, 2016), and later in the comparison of a large number of cities (Oliveira *et al*., 2020). Morpho first analyses the density and spatial accessibility of the street system, moving then to the density of street blocks and plots, and finally to the coincidence between building and plot frontages. The application to Tehran highlights the main strengths (high density of street blocks and plots, high coincidence between building and plot frontages in two representative streets) and weaknesses (low to medium permeability of streets) of districts 6 and 7 of the Iranian capital.

Contemporary Tehran

About 240 years ago, Tehran, an 'organic' walled town structured by the traditional elements of Iranian cities – the castle (*arg*), neighbourhoods (*mahallahs*), square (*meidan*) and bazaar – and being the home of 15.000 people, became the capital of Iran, under the rule of the Qajar dynasty (Figure 1). After becoming the capital, the city grew, and in mid-nineteenth century the need for structural changes became obvious. The process of transformation was carried out by King Naser-al-din-shah. The city walls were demolished, the *mahallahs* have grown, a high number of straight streets have been built, and 'traditional buildings' have been replaced by 'eclectic buildings'. All these changes, taking place in the late nineteenth century, were simultaneous to major transformations in different cities around the world (Figure 2).

Figure 1. Brezin map of Tehran, 1827 (source: public domain).

Figure 2. dolqaffar map of Tehran, 1903 (source: public domain).

In 1920, the Ghajar kingdom was replaced by the Pahlavi kingdom. The aim of the first king, Reza Shah, was to start a new process of modernization of the country. Based on principles of effectiveness and efficiency of the modern city, Iranian old fabrics went through extensive 'surgery', including the construction of long straight streets into extant areas (Figure 3).

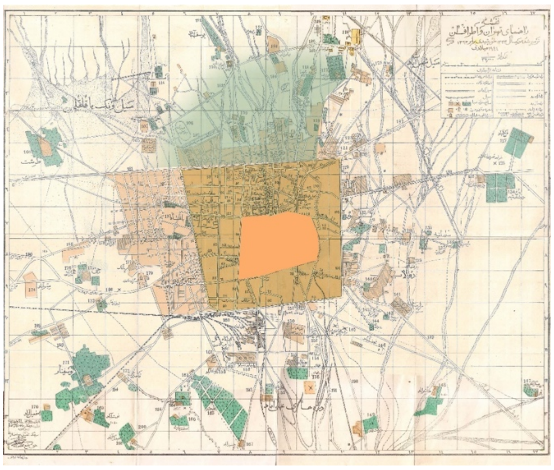

Figure 3. Qaffari map of Tehran, occupation of Allied troops, 1924 (source: public domain).

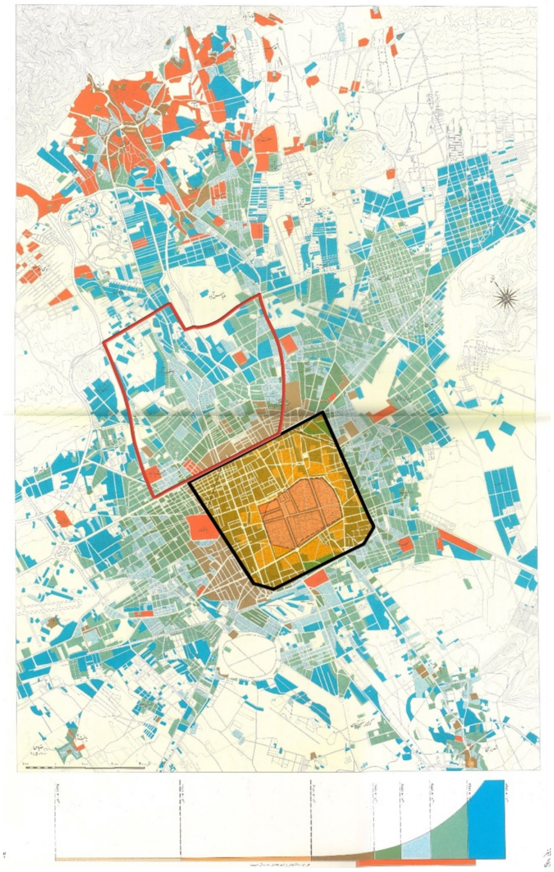

Figure 4. Tehran in second Pahlavi dynasty (source: Iranian Supreme Council of Culture and Art, 1977).

This process continued during the government of the next king, Mohammad Reza Pahlavi. As a first influence of modern planning in the country, many modern forms have been inserted into the urban fabric: highways, boulevards, public buildings, and towers, to name just a few (Figure 4). Tehran grew rapidly. This growth, developed under a new planning framework, needed a number of fast-spreading forms guided by new regulations. That is the case of a building coverage rule that had a strong impact in the Iranian capital, proposing 60% of building coverage, the building occupying the north part of the plot (Figure 5).

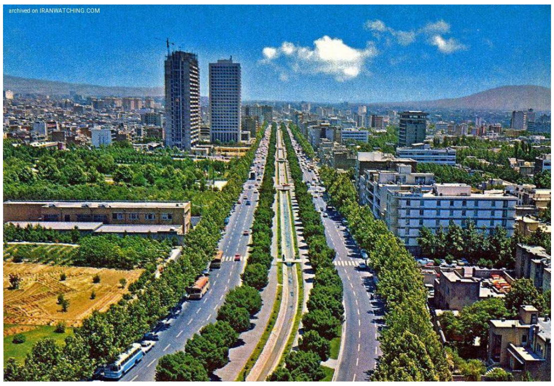

Figure 5. Keshavarz (Elizabeth) boulevard in the 1970s (source: Shafaonline press).

In 1979, the Islamic revolution introduced a dramatic change in the country, from a parliamentary kingdom to an elective, but value-oriented, system. During this period of four decades and after the war between Iran and Iraq, Tehran experienced intense growth, and currently it is a metropolitan area of 730 km², made of 22 districts and the 'night' home of 8.6 million inhabitants within the city boundary (Figure 6).

The study area of this paper includes district 6, and part of district 7, which started to be developed during the Reza Shah dynasty, being continuously developed in the Mohammad Reza Shah Dynasty, and completed in the Islamic Revolution period. This part of the city is the home of 400.000 inhabitants, mainly middle-class citizens (Figure 7). The study area includes different streets, street blocks, plots, buildings, and activities. Figure 8 and 9 portrait the different urban landscapes of the study area, highlighting the presence of the so-called 'international style' (8a and 8b, Keshavarz Boulevard), with its partial hill areas and complex combination of buildings (8c, Gandhi Street), and with its south to north slope, part of some of the main streets of the city (8d, Valiasr Street). This diverse area contains early modern buildings (9a), artistic manifestations of modernist architecture, in the forms in individual buildings (9c), in the incidence of the international style (9d), and the domestic representation of modern concepts in residential buildings (9e).

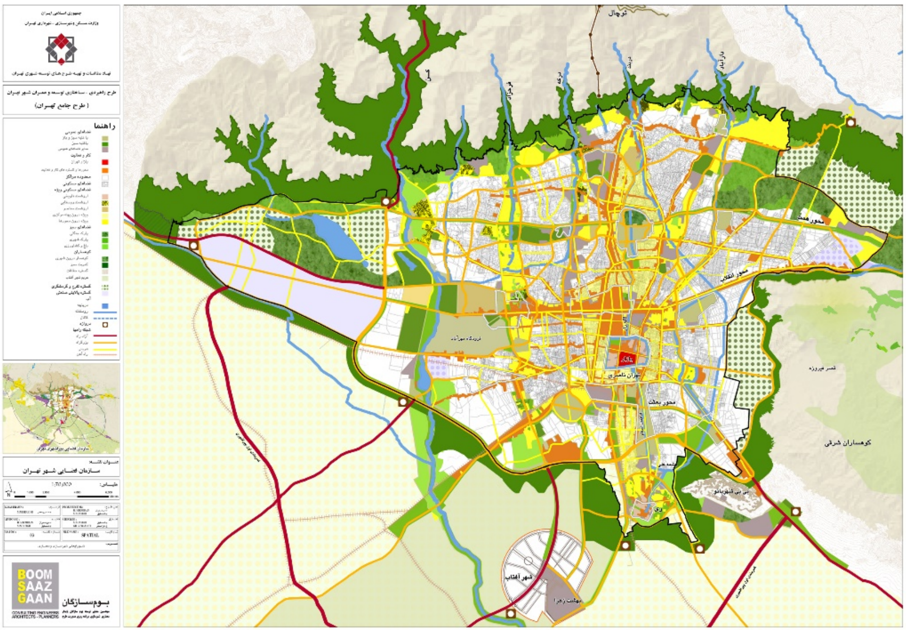

Figure 6. Plan for Tehran, 2012 – Boomsaazgaan Consulting.

Figure 7. Early modern developments in Tehran (case study area in white), north of the historical centre (in grey).

Figure 8. (a) (b) Keshavarz (Elizabeth) Boulevard; (c) Gandhi Street (north to south); and (d) Valiasr Street (south to north).

Figure 9. (a) Commercial-business building in Bozorgmehr Street; (b) Poursina Street, the backstreet of the University of Tehran; residential building in Tavanir neighbourhood; (d) Taleqani Street, gathering many business headquarters; and (e) 1940s residential building (change in utilization) (c) 1970s.

Morpho methodology

Morpho has been proposed in the debate as a methodology to address the physical form of cities, focusing on the most permanent elements of urban form. While addressing different elements and characteristics when studying different scales (from the plot to the neighbourhood, and from this to the city and the metropolitan area – Oliveira 2020), the core of analysis is made of streets, street blocks, plots, and the block-plans of buildings. The methodology was first applied at the street scale (Oliveira, 2013), then at the city scale (Oliveira and Medeiros, 2016), and finally in the comparison of a large number of cities (Oliveira *et al*., 2020).

The focus on the town-plan as the key element for the description and explanation of the historico-geographical structure of the urban landscape – being then complemented by the analysis of the building fabric, and the land and building utilization – is shared by the historico-geographical approach (see, for instance, Conzen M. R. G., 1960; Conzen M. P., 2018; Oliveira, 2019). While the historico-geographical approach addresses the processes of change through a number of concepts, from the fringe belt (Conzen M. R. G., 1960; Whitehand, 1972; Conzen, M. P., 2009) to the burgage cycle (Conzen M. R. G., 1960; Slater, 1990), Morpho explores the dynamics of urban transformation through the specific changes in the main characteristics of the fundamental elements of urban form (Oliveira *et al*., 2020).

What is specific to Morpho is the selection and quantitative measurement of a particular set of characteristics of streets, street blocks (contrarily to the historico-geographical approach where these are addressed indirectly, Morpho has a direct focus on street blocks due to their major importance in understanding urban form), plots, and the block-plans of buildings, and the innovative nature of one characteristic – the coincidence between building and plot frontages. It is argued that the reading of these elements offers a structural understanding of the urban landscape.

Being selective and proposing a structural understanding of urban form, Morpho does not aim to deal with all relevant aspects of that physical form. Accordingly, this analysis of the town-plan can be complemented by other three-dimensional elements of the building fabric, particularly in areas containing significant heritage structures, such as historical landscapes (Oliveira, 2020). Finally, it was argued that there is a correlation between the density and accessibility of streets, density of street blocks and plots, and frontage coincidence (the focus of Morpho), on the one hand, and the socioeconomic diversity and environmental sustainability, on the other hand (Oliveira, 2020).

Morpho first analyses the density and spatial accessibility of the street system, including not only streets, but also squares and gardens. It addresses the density of intersections, highlighting the presence of 4- (or more) ways nodes in relation to 3-ways nodes, as being more effective in promoting the diversification of urban flows. Morpho then moves to the density of street blocks and the density of plots. Finally, the coincidence between building and plot frontages (front wall of building on front of plot) is analysed. More particularly, in each street-block, the number of plots where building and plot frontage is coincident is measured and expressed as a percentage. In terms of measurement procedure, one building within one plot is considered aligned if more than 50% of the building frontage coincides with the plot frontage.

Adjustments in the methodology for application into Tehran

The application of Morpho to Tehran has three innovative features. Firstly, it is the first application of this methodology into an Iranian city. Secondly, the measurement of density of the street system is explored in greater detail being divided into five simple measures and one composite measure. Thirdly, the measurement of the street block is divided into two measures.

The first measure of the street system is intersection density (following closely Remali and Porta, 2017). The measure is the weighted number of intersections ($ID = 3N_4 + 2N_3 - 1N_1$), where: N_4 is the number of four (or more)-way nodes, N_3 is the number of three-way nodes and N_1 is the number of dead ends, in each cell. The second is street density, the total street length relative to each grid cell area (16ha). The third is the link-node ratio, meaning the number of links (streets) divided by the total number of nodes (including dead ends) within each cell. The fourth is internal connectivity, the ratio between the number of 'real' nodes (non-dead ends) and the number of all nodes (including dead ends) in each cell. The fifth is external connectivity, meaning the density of ingress/egress points at the boundary of each cell ($EC = IE / PL * 100$), where IE is the total number of ingress/egress points, and PL is the total perimeter length of each cell (here 1600 m). Ingress/egress points are the notional intersections created where the case study area boundary crosses a street. Finally, permeability is a combined measure resulting from these five measures. The measurement of the street system (Figure 10) considers a super grid, of 400*400m cell size. As the regular border of the super grid covers more area than the irregular boundary of the case study, some adjacent areas are considered in measurements to eliminate the bias of calculations. The calculation of these five measures, in ArcMap software, uses a number of intervals offered by the Natural Breaks (Jenks) method.

The analysis of street blocks is based on two measures. The first is the density of street-blocks, and it is expressed by the size of each street block. The second measure is the elongation of street blocks, which is the quotient of the perimeter by the area of the street block (in hectares). The analysis of plots is based on the density of this element of urban form, meaning the number of plots in each street-block (per hectare). The analysis of buildings is based on the coincidence of building and plot frontages, according to two categories: (i) coincidence or mostly coincidence (coincidence of building and plot frontages is present in more than 50 percent of the street-block); and (ii) non-coincidence or mostly non-coincidence (non-coincidence is present in more than 50 percent of the street-block). Two representative streets, west-east Keshavarz boulevard and north-south Gandhi street, are investigated for the detailed assessment of the last criterion.

Figure 10. The street system of the grid study area.

Morpho application into Tehran Streets

The analysis of streets is divided into five measures and a sixth composite measure. Table 1 gathers the results of each measurement. This paragraph, as well as Figure 11, offers more detail on the measurement of intersection density. The analysis of intersection density and the other four measures, draws on five different classes. The first class (low density, represented in Figure 11 by a bright colour) includes the street system of vacant lands and large areas, such as parks. The second class includes the streets serving administrative and official areas, mainly located near vacant lands. The third class covers most parts of the grid study area, representing the regular street system of commercial areas and well-defined intersections distanced from each other, as well as a number of squares. The fourth class includes streets serving areas with diverse types of street blocks, diverse types of intersections, sometimes with more than four streets, and short distances between intersections. The fifth class (high density, represented in Figure 11 by a dark colour) comprises the street system of areas with small street blocks with several dead ends, short distances between intersections, and fine-grained residential fabrics.

Permeability makes evident how different measures interact. It is calculated by multiplying all measures together. As such, a composite number is the complex result of interaction between different simple numbers. The values of permeability are interpreted qualitatively. Four classes are considered (Figure 12). Areas with immeasurable values (covering 25 cells of the grid, 11.1% of the study area) have been eliminated from classification. The first class, low permeability, includes areas where highways cut the extant urban fabric, boulevards, and wide streets (with large street blocks). The second class, medium permeability, comprises areas made of medium-size street blocks, generally with three-sides intersections. The third class, high permeability, includes areas in which small blocks and medium-size street blocks are combined. Finally, the fourth class, very high permeability, comprises small size street blocks, and a street pattern near to gridiron; it also includes street blocks with dead ends. Apparently, the small size of the street blocks and the grid pattern compensates the negative weight of dead ends.

Table 1 gathers the different measures for street network analysis, representing horizontal relations between the different measures. Firstly, different measurements have identified vacant lands with highway peripheries covered between 12.4 to 17.3 % of the study area. Secondly, there are class/classes in each measure that include/s areas with large plots. The area sum of the boundaries that cover vacant lands, administrative and official plots, and large plots is nearly 50 % of the total study area. Thirdly, in three measures, street density, link-node ratio, and internal connectivity, there are classes indicating gridiron patterns covering 22 to 35% of the study area. Finally, diverse classes dealing with dead ends show a clear interrelationship; the lowest and the highest values pointing to the presence of dead ends are near 21 %-33 %). The combined measure of permeability confirms the results founded in the different measures. In this measure, the first class, low permeability, covers near 55 % of the study area. Similarly, the sum value of high and very high permeability is near 20 %, close to the classes that indicate the gridiron system. It seems that areas included in other classes of measures are combined to configure the 'medium permeability' class, although they might be covered partially by boundaries of low, high, and very high permeability.

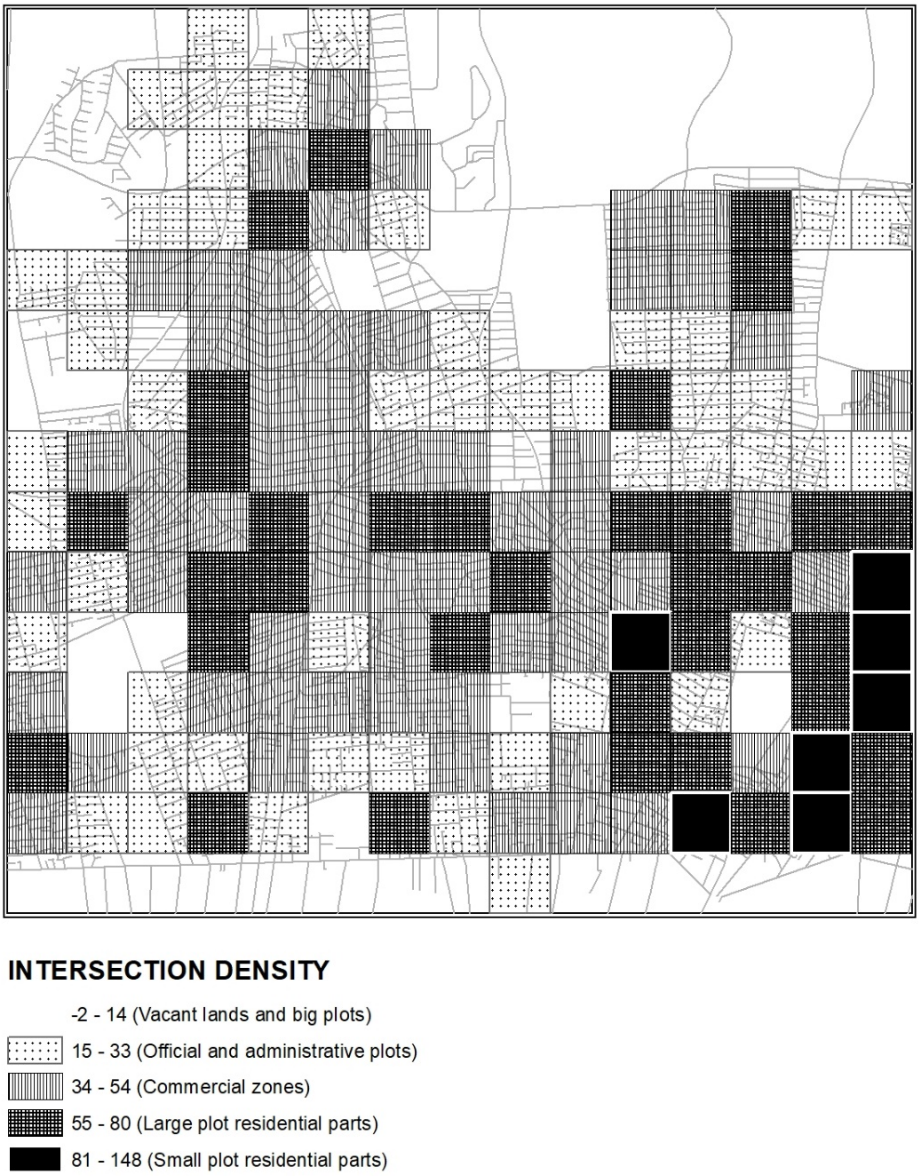

Figure 11. Intersection density.

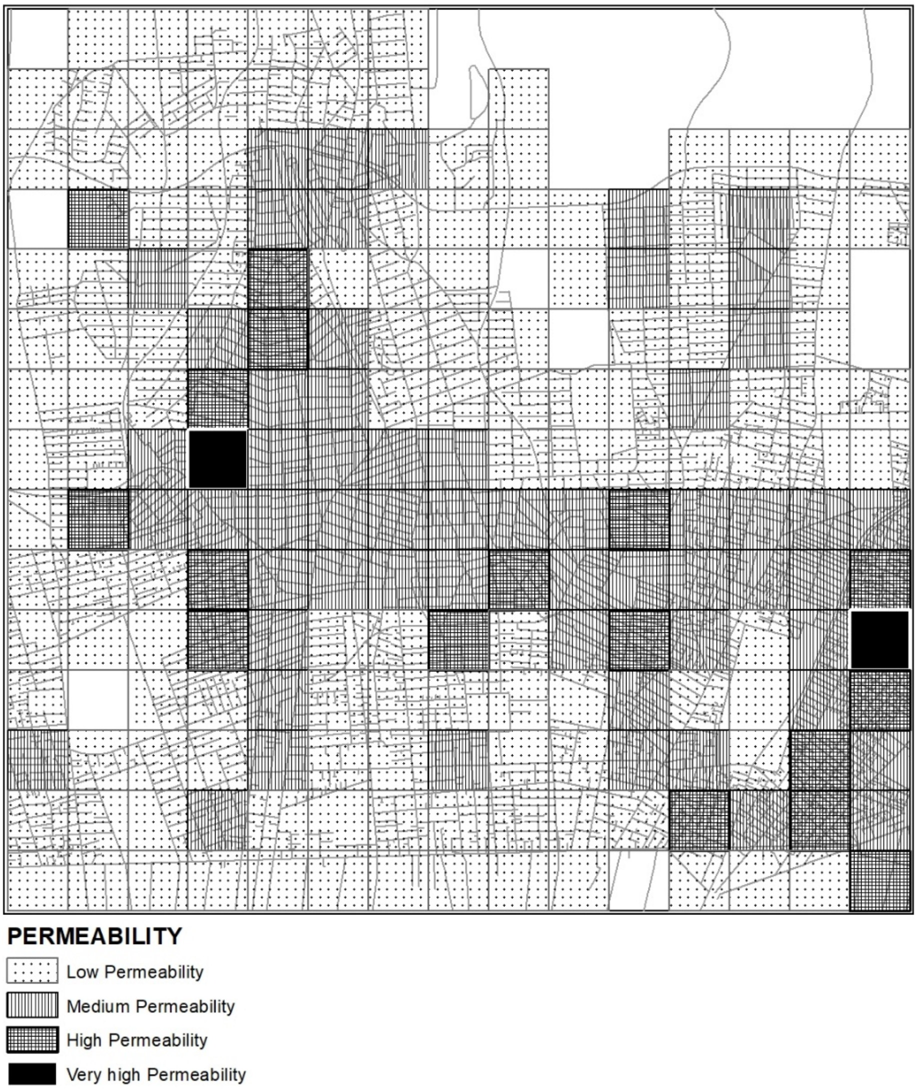

Figure 12. Permeability of streets.

Street blocks

Street blocks are first classified according to their size into three main groups: small (classes 1 and 2), medium (class 3), and large (classes 4 to 6) – Table 2. The highest frequency is small size street blocks (72,9 %), followed by medium (19,8 %), and large size (7,3%). Figure 13 shows the geographical distribution of street block size. Despite the very large street blocks (larger than 100.000 m^2) located north, north-west and in the southern strip of the study area, the frequency of small size street-blocks is higher, especially at north, north-west, south, and south-east of the study area.

Street blocks are then classified according to elongation (the relation between length and width)

Four classes are considered: no elongation, low elongation (rectangular shape, where length is usually two or three times higher than width), medium elongation (street blocks with several dead ends, where length is, in general, five times higher than width), and high elongation (narrow and non-rectangular shape, with several dead ends) – Table 3 and Figure 14. Only 2% of the street-blocks belongs to class 1, which generally include vacant lands, administrative areas, universities and city parks. One third of the study area is made of street blocks of reduced elongation, but the most frequent street block elongation is 'medium'. Nearly one out of four street-blocks has high elongation, which can be found in the north-east and south-east parts of the study area.

Table 1. Streets: synthesis of different measures

Measurement	Classes	Distribution (%)
Intersection density	Vacant lands; large plots	34,2
	Official and administrative areas	21,4
	Commercial areas	26,2
	Residential areas; large plots	15,1
	Residential areas, small plots	3,1
Street Density	Vacant lands and highway peripheries	12,4
	Tissues with low number of streets; large plots	21,3
	Tissues with long street-blocks and tissues with large plots	19,6
	Low number of dead ends; large plots	24,0
	Regular grid pattern; medium and small-size plots	22,7
Link-node ratio	Vacant lands and highway peripheries	14,2
	Street-blocks with dead ends	33,3
	Main streets with large plots	29,8
	Similar to complete grid	17,8
	Complete grid pattern	4,9
Internal Connectivity	Vacant lands	14,7
	Street-blocks with dead end alleys	28,5
	Street-blocks with few dead ends	21,3
	Complete grids, mixing large street-blocks with some dead ends	20,9
	Complete grids, with no dead ends	14,6
External Connectivity	Vacant lands and highway peripheries	17,3
	Street-blocks with large plots	26,2
	Large and long street-blocks; large street-blocks with few dead ends	28,0
	Medium-size street-blocks	21,8
	Small-size street-blocks	6,7
Permeability	Low permeability	54,7
	Medium permeability	25,8
	High permeability	7,5
	Very high permeability	12,0

Table 2. Dimension of street blocks

	Small		Medium	Large		
Type	0-5000 m^2	5000-10000 m^2	10000-20000 m^2	20000-50000 m^2	50000-100000 m^2	>100000 m^2
%	36,2	36,7	19,8	5,7	0,7	0,9

Table 3. Elongation of street-blocks

Type	No elongation (<=200)	Low elongation (201-500)	Medium elongation (501-800)	High elongation (801<)
%	2.1	33.7	40.2	24.0

Table 4. Density of plots in the street blocks (per hectare)

Type	High		Medium		Low	
	>51 plots/ha	50-21 plots/ha	11-20 plots/ha	6-10 plots/ha	2-5 plots/ha	1 plots/ha
%	19.6	62.0	11.6	2.0	2.5	2.3

Table 5. Coincidence of building and plot frontages

	Keshavarz Boulevard		Gandhi Street	
Type	MC (%)	MNC (%)	MC (%)	MNC (%)
%	68	32	84	16

Figure 13. Density of street-blocks.

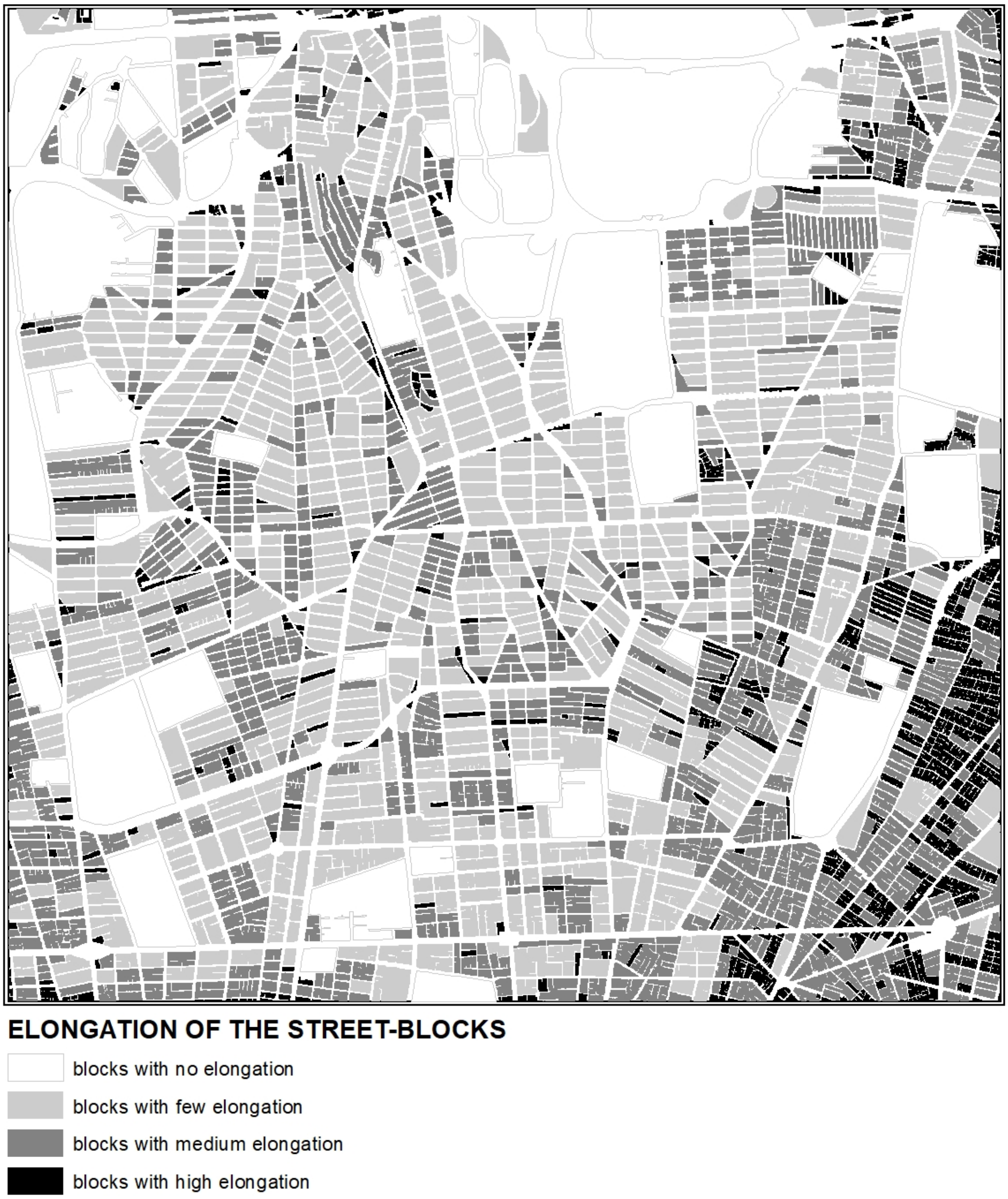

Figure 14. Elongation of street-blocks.

Plots

Plots are analysed according to their density in street blocks, considering the size of the latter. As in the former case, the analysis if based on six classes divided into three major groups – high, medium and low density (Table 4 and Figure 15). Most street blocks (about 80%) have high density of plots. The street blocks with the highest density of plots are concentrated in the south-west of the study area. This area has a compact urban fabric, made of narrow streets and the building stock is dominated by houses and apartments of lower price than other parts of the study area. The other street blocks with high density of plots are scattered through the case study areas as 'islands'. The second class of higher density can be seen in many parts of the study area, corresponding to residential areas. Nearly one in ten street blocks has medium density of plots. The street-blocks of this group are scattered through the study area. Only 6.8% of the street blocks have low density of plots. These are located near vacant lands, universities, business areas and, in some cases, correspond to low-density housing areas.

Figure 15. Density of plots.

Block-plans of buildings

The relation between building and plot frontages has dramatically changed in the process of modernization that took place in many Iranian cities. This change can be seen in parallel with the transformation of Tehran building types, driven by new regulations, including the mentioned building coverage rule (60%) and a new building position within the plot (north side), contained in the first comprehensive plan prepared for the Iranian capital. Accordingly, the new building would be positioned within a walled area. After some years, a variation of this type was designed, with the same building coverage, and a cubic form. Finally, in recent developments, an optional elimination of the wall has been proposed (Abaee, 2019) – Figure 16. The urban fabric in the study area is a combination of types, generated from the beginning of the Pahlavi era onwards. Due to the new regulations, the appearance of a south-north street can be very different from an east-west street.

The analysis of the fourth criterion focuses on two streets: the main arterial east-west boulevard, Keshavarz, with some administrative and public buildings (for instance, the Ministry of Agriculture, Laleh Park, and the Museum of Contemporary Art); and a north-south street, Gandhi, with business offices and jewelry shops. Both streets were built between 1950 and 1960.

The Keshavarz Boulevard starts in the west, in the entrance of the Faculty of Veterinary Medicine (University of Tehran) and is extended east (Valiasr Square, the boulevard extends in its main intersection, with Kargar Street, increasing the number of lanes, the width of the middle section, and the width of sidewalks). Gandhi Street starts in a 'cozy' three-way intersection in the north, passing the beginning of a highway, Jahan-e-Koudak, and continues to another highway, Hemmat, crossing it (bridge), and continuing south, changing its name to Vozara Street before arriving to Argentina Sq.

Figure 17 offers a general view of streets, plots and buildings in the Keshavarz Boulevard and Gandhi Street. Table 5 gathers the results of the analysis of building and plot frontages. The rate of mostly non-coincident frontages in Keshavarz Boulevard is two times higher the rate in Gandhi Street. This difference can be interpreted by the effect of the general planning code (locating the building in the north part of the plot, covering 60 % of its area). As such, the code is expressed in the frequency of non-coincident buildings in the north side of the east-west street.

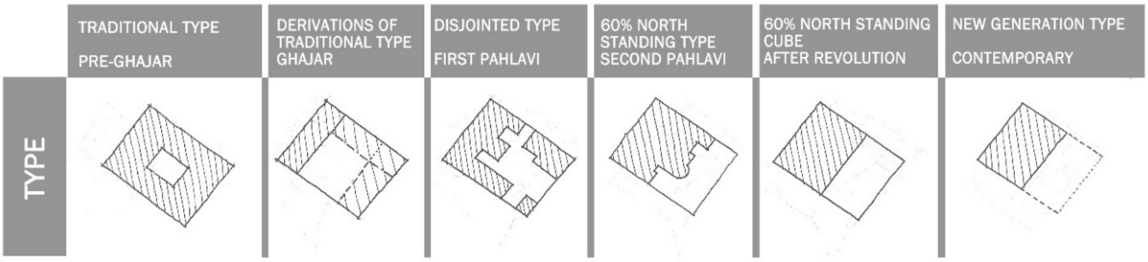

Figure 16. Chronological change in the relation between plot and building in Tehran.

Figure 17. The relationship between buildings and plots in Keshavarz Boulevard (right) and Gandhi Street (left).

Conclusions

The paper offers a quantitative morphological analysis of contemporary urban landscapes in Tehran – districts 6 and 7. The analysis is supported by Morpho methodology, focusing on the most permanent elements of urban form (streets, street blocks, plots, and block-plans of buildings) and addressing density as a major characteristic to distinguish different patterns of combination of these structural two-dimensional elements.

The analysis has revealed some findings on the physical form of Tehran's districts 6 and 7. In the overall, the street system of these districts has low permeability. The districts are mainly made of small street blocks holding a high density of plots; meaning small street blocks (promoting accessibility and interaction), and small plots (many plots, potentially held by many agents with different urban strategies, which can be an indicator of diversity). The analysis of coincidence between building and plot frontages focused on two different axes – Keshavarz Boulevard and Gandhi Street. Non-coincidence, or mostly non-coincidence, is two times higher in Keshavarz Boulevard. One reason for this, bearing in mind that the two streets have different directions, is the planning system, proposing a new building coverage and a new position of buildings in the north part of plots.

The integration of small plot size, the small block size, and the types of coincidence of building frontage to the plots show formal indiscipline in the study area. Small plots are generally occupied with buildings built by different agents with diverse forms. Besides the short distance between the street junctions resulted from the small blocks and a building code (setting the place of a new building on the north side of its including plot), this factor makes a jagged built form. This form expresses itself in north-south and east-west streets differently. In north-south streets (as blocks generally include two parallel lines of plots), the distance between perpendicular accesses is filled with a double sequence of building facade and yard wall that gives a serrate form to the street façade. In east-west streets, the buildings on the north side of the street setback from the street, and the façade is made of walls and fences. However, on the south side, building frontage is coincident with plot frontage. Therefore, the configuration of these streets becomes asymmetric. As in the Iranian planning system, a new building commonly should be placed in the north of the plot, the high value of non-coincidence, or mostly non-coincidence cases in east-west streets, seems natural. Further comprehensive studies might reveal more detailed results about the relationship between building frontage, plots, and streets.

The results of the analysis can also be used for a more detailed study of the different parts that make the case study. As expected, the case study area is made of different parts. For instance, the south-east part, near Imam Hossein Square and closer to the historical kernel, seems to hold the highest density for streets (street intersections), street blocks and plots. On the contrary, the south-west area, near Laleh Park, seems to gather the lowest density for streets, plots and buildings.

This study identified different types of urban fabrics. The study area is considered a transition area between an old city and contemporary developments. Therefore, it includes different types of fabrics, including traditional and contemporary forms simultaneously. As this transition is a result of the country's urban history in the previous century, and due to a general tendency of the study of urban form in Iran to investigate historical cities, further detailed research can develop a body of knowledge about the neglected contemporary urban forms of Iran.

The paper also extends the scope of the Morpho methodology. This Iranian exploration offers a rather diverse geographical and cultural context for a methodology that has been conceived for, and applied in, American and European cities. It tests the robustness of the methodology itself, and it motivates the inclusion of new measurement procedures to understand the specific nature of some elements – notably the streets system. Future research should continue to explore these aspects.

References

Abaee, M. (2019) 'Transform-mut-ation of Tehran: Discontinuity of urban form and problems of using urban morphology in planning practice'. *26th ISUF International Conference*. Nicosia.

Ahari, Z. (2014) *Maktabe Esfahan dar* Shahrsazi*: Dastoore Zabane Tarahie Shaloudeye shahri*. Tehran: Farhangestane Honar.

Bahrambeygui, H. (1977) *Tehran: an urban analysis*. Tehran: Sahab Books.

Bonine, M. E. (1979) 'The morphogenesis of Iranian cities'. *Annals of the Association of American Geographers*, 69, 208-224.

Boomzaasgaan consulting Co. (2012), Tarh-e-Jame-e-Tehran. Tehran: Ministry of roads and urban development.

Costello, V. F. (1998) 'The morphology of Tehran: A preliminary study'. *Built* Environment, 201-216.

Conzen, M. R.G. (1960) *Alnwick Northumberland: a study in town-plan analysis*, Institute of British Geographers Publication 27, George Philip, London.

Conzen, M. P. (2009) 'How cities internalize their former urban fringes: a cross-cultural comparison', *Urban Morphology* 13, 29-54

Conzen, M. P. (2018) 'Core concepts in town-plan analysis', in Oliveira, V. (ed.) *Teaching urban morphology*. Cham: Springer.

Esfanjary, E. (2015). 'The longevity of Persian urban form: Maibud from late antiquity to the fifteenth century'. *Urban Morphology*, 19, 57-71.

Ferdosian, F. (2002) *Modern and Traditional Urban Design Concept and Principles in Iran*. Tehran: Simaye Danesh.

Habibi, M. (1999) *Az Shar ta Shahr*. Tehran: *Daneshgahe*.

Iranian Supreme Council of Culture and Art (1977) *Atlas-e-farhangi-e*-shahr-*e-Tehran.* Tehran: Ministry of Culture.

Karimi, K. (1998) 'Continuity and Change in Old *Cities'*, unpublished PhD thesis, University College London, UK.

Lak, A., & Hakimian, P. (2019). 'Collective memory and urban regeneration in urban spaces: Reproducing memories in Baharestan Square, city of Tehran, Iran'. *City, Culture and Society*, 18, 100290.

Madanipour, A., 2006. Urban planning and development in Tehran. *Cities*, *23*(6), pp.433-438.

Memarian, Q. (2006a) *Ashnaee ba Memarie maskoonie Iran: Gooneshenasie Daroongera*. Tehran: Sorooshe Danesh.

Memarian, Q. (2006b) *Ashnaee ba Memarie maskoonie Iran: Gooneshenasie boroongera*. Tehran: Sorooshe Danesh.

Morris, C. (1963) *Cities*. New York: Helen and Kurt Wolff.

Oliveira V (2013) 'Morpho, a methodology for assessing urban form', *Urban Morphology* 17, 149-61.

Oliveira, V. (ed.) (2019) *JWR Whitehand and the historico-geographical approach to urban morphology*, Cham: Springer.

Oliveira, V. (2020) 'The ground plan as a unifying concept', *Journal of Urban Research and Development* 1, 45-59.

Oliveira, V. and Medeiros, V. (2016) 'Morpho: combining morphological measures', *Environment and Planning B: Planning and Design* 43, 805-25.

Oliveira, V., Medeiros, V. and Corgo, J. (2020) 'The urban form of Portuguese cities', *Urban Morphology* 24, 145-66.

Remali, A. M. and Porta, S. (2017) 'Street networks and street-blocks in the city centre of Tripoli', *Urban Morphology* 21, 161-179.

Sami, A. (1951) *Pasargad, Ghadimitarin payerakhte* shahanshahie *iran*. Tehran: Bonyade Farsshenasi.

Schmidt, E.F. (1953) *Persepolis*. Chicago: Chicago University Press.

Shaterian, R. (2011) *Tahlile Memarie Masajede Iran*. Tehran: Nopardazan.

Slater, T. R. (1990) 'English medieval new towns with composite plans'. In: Slater T. R. (ed.) *The built form of Western cities*. Leicester University Press, Leicester, p 71-74

Whitehand, J. W. R. (1972) 'Building cycles and the spatial pattern of urban growth'. *Transactions of the Institute of British Geographers* 56, 39–55.