Street networks and the description, explanation and prescription of urban landscapes

La influencia de las redes de calles en la descripción, explicacion y diseño del paisaje urbano

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Abstract: This paper addresses the description, explanation, and prescription of urban landscapes. While recognizing the importance of plot patterns and building arrangements in shaping the historico-geographical structure of cities, the focus is on the configuration of street networks. It argues that current methods of quantitatively measuring street networks can be improved, particularly in identifying homogeneous geographical patterns created by specific types of streets. To this end, it explores the most effective ways to assess the spatial configuration of street networks by analyzing the relationships among edges (streets), nodes (intersections), and angles. Four fundamental metrics are introduced –griddedness, order, diversity, and complexity– all derived from a proposed measure called the Gfactor, which represents the average angle between adjacent streets at an intersection. The method is applied to the case of Tehran, providing empirical insights. The paper concludes by discussing the specificity of the object and method, as well as the broader applicability of the approach, moving from a specific case study to more general contexts.

Keywords: urban morphology; urban form; planning; street networks; pattern recognition.

Resumen: Este artículo aborda la descripción, explicación y prescripción de paisajes urbanos. Si bien reconoce la importancia de los patrones de parcelas y la disposición de los edificios en la configuración de la estructura histórico-geográfica de las ciudades, se centra en la configuración de las redes de calles. Argumenta que los métodos actuales de medición cuantitativa de las redes de calles pueden mejorarse, en particular para identificar patrones geográficos homogéneos creados por tipos específicos de calles. Para ello, explora las formas más efectivas de evaluar la configuración espacial de las redes de calles mediante el análisis de las relaciones entre líneas (calles), nodos (intersecciones) y ángulos. Se introducen cuatro métricas fundamentales: reticulación, orden, diversidad y complejidad, todas derivadas de una medida propuesta denominada factor G, que representa el ángulo promedio entre calles adyacentes en una intersección. El método se aplica al caso de Teherán, aportando perspectivas empíricas. El artículo concluye analizando la especificidad del objeto y el método, así como la aplicabilidad en un contexto más amplio de esta aproximación, pasando de un estudio de caso específico a contextos más generales.

Palabras clave: morfología urbana; forma urbana; planeamiento; red de calles; reconocimiento de patrones.

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INTRODUCTION

Urban morphology is the study of the physical form of human settlements and the processes through which that form changes over time, shaped by various agents and dynamics.[1] Pattern recognition plays a central role in this field. Notable examples include the concepts of plan unit and morphological region, developed within the historical-geographical approach to urban morphology.[2] Plan units are town-plan complexes composed of streets, plots, and buildings that exhibit morphological homogeneity, distinguishing them from adjacent areas.[3] A morphological region refers to an area characterized by unity in town plan, building fabric, and land and building use, which differentiate it from its surroundings.[4] Pattern recognition is also central to the process typological school, which introduces concepts such as the aggregate, a historically self-regulated system that evolves organically in space and time; the basic tissue, referring to the recurring spatial structure found throughout the urban organism; and special tissues, which are aggregates shaped by specialized building types.[5]

Identifying and distinguishing morphologically homogeneous areas requires engaging with the diversity of urban morphological elements. This paper proposes a method for analyzing these elements with the aim of delineating areas of morphological uniformity. As a starting point, the street network – arguably the most permanent component of urban form – is selected for analysis. In this context, distinguishing homogeneous areas based on varying street network patterns offers a solid foundation for planning practice. Nonetheless, it is acknowledged that research should integrate additional elements of urban form, such as plots and buildings, to provide a more comprehensive understanding.

Traditionally, the street network – serving as the backbone of urban transport – was primarily analyzed as a system designed for traffic flow. In recent decades, however, new approaches to configurational street network modeling have emerged, offering valuable insights for morphological research. These models can be categorized into four types: i) transport network models, ii) multifaceted models, iii) hierarchical models, and iv) alternative models.[6]

Transport network models conceptualize the street network as a spatial system of connected linear elements with a continuous and enduring presence in space.[7] Multifaceted models interpret the street network as a setting for human behavior – a two-dimensional field shaped by three-dimensional characteristics.[8] Hierarchical models classify the street network into main and subsidiary streets, allowing for the development of street typologies based on configurational properties, with a strong emphasis on the role of connectivity.[9] Finally, alternative models conceive the street network both as an aggregation of individual segments and as an integrated spatial whole, fragmented into successive components such as axial lines or street segments. This category includes a range of approaches – from models that distinguish streets by name,[10] to those that define street-like elements based on angular continuity, whether through axial lines and street segments,[11] or continuity lines.[12] Street network models can be classified based on how the network is represented.[13] In the so-called primal approach, the network is modeled as a graph in which those streets are represented as edges and junctions as nodes. In the dual approach, the representation is reversed: intersections are modeled as edges, while entire streets are represented as nodes.

While the categories and examples discussed offer valuable insights, few directly address the specific goal of this research: differentiating urban areas based on the shape of the street network. Achieving this requires a model that explicitly captures the shape of the network. Hierarchical models contribute by clarifying street patterns as morphological elements, but they rely on an abstract understanding of hierarchy that does not fully reflect shape. For instance, in such models, a winding street may be evaluated similarly to a straight one, even though formal distinctions like curvature are essential for identifying different urban forms. The

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axial map model, developed within the configurational approach, also plays a role in morphological analysis. However, it tends to overlook shape and form and instead reduces the street network to a graph-based structure primarily suited for analyzing aspects such as connectivity and accessibility. The primal-dual classification of street network models provides a useful framework for conceptualizing the problem. While both approaches rely on graphs – abstract topological representations of networks – they fall short in capturing geometric variation and pattern-based differences in street shape and form. Against this background, it is argued that to distinguish between different urban areas based on street network configuration, a combined understanding of both geometrical and topological aspects is essential.

THE MORPHO METHOD

Morpho is a quantitative method for analysing street networks, plot patterns, and building arrangements,[14] and for exploring how the density of these elements of urban form relates to socioeconomic diversity and environmental sustainability.[15] While previous applications of Morpho have contributed to a more comprehensive analytical framework, this paper explores its specific potential to geometrically and topologically differentiate street networks contributing for the definition of morphological homogeneous areas. In a recent study, Morpho has already focused on the density of the street system.[16]

Although previous studies of the street network provide valuable quantitative information about the urban landscape, they do not capture the geometry or spatial configuration of different parts of the network. This limitation has led Morpho to further engage with the analysis of patterns and types of street networks. For example, intersection density may imply street block size, but it does not differentiate between distinct street patterns or configurations. Similarly, street density relates to the size of the block and its accessibility but does not reflect variations in network form. Both Internal connectivity and external connectivity deal primarily with access and permeability. The link-node ratio begins to reveal differences in network configuration, as it reflects the dominance of crossroad-type intersections, offering some insight into the structural characteristics of the network.

In this research, two sets of measures are used. The first set includes nine measures to describe the overall network: street length; the frequency distribution of street length; the length of the longest street; the density of nodes within the surface unit; the frequency of node edges; the (cloud-like) density of each type of node; the total density of the streets; the link-node ratio of the whole area; and the internal connectivity of the entire network. As a second set, this research also uses: intersection density; street density; link-node ratio; internal connectivity; external connectivity; and permeability.

In addition to these, four fundamental metrics addressed in this paper are applied and all rely on a common factor that expresses how a network node aligns with the overall geometric form of a junction. The first, griddedness, refers to the extent to which a network resembles a pure gridiron pattern, with perpendicular junctions and equal-length street segments. The second measure, order, refers to the extent to which a network follows a dominant pattern, whether geometrical or non-geometrical. The third, diversity, expresses the range and plurality of geometrical and non-geometrical patterns within a given network. The diversity of nodes (with three, four, or more edges) may represent different types of network configurations. The fourth measure, complexity, refers to the extent to which a network deviates from a recognizable or legible pattern. Here, the focus is on junctions with either a conventional number of edges (three or four) or with a high variation in edge angles. These measures are calculated according to the Gfactor, or the geometricity of a node, which can be used to assess the extent, which a node-edge configuration matches to a perpendicular geometric organization. Indeed, the Gfactor is defined as the average geometricity of the angles at each node, indicating how close each angle matches to a right angle (i.e., from a rectangular form).

MEASUREMENT OF GRIDDEDNESS, ORDER, DENSITY AND COMPLEXITY

These four fundamental measures are calculated based on the geometricity of a node – that is, how closely its geometry and its connected edges approximates the ideal form of a junction. This is quantified by the Gfactor, defined as the average geometricity of the node's internal angles. The geometricity of an angle (Gα) expresses how far the angle deviates from a right angle. Angles are considered more *geometrical* when they are close to 0°, 90°, 180°, and 270°. This closeness can be measured by finding the angle's remainder when divided by 90° (mod (90, α)), which produces a value between 0° and 90°. Values of 0° or 90° represent the most geometrical cases, while 45° represents the least geometrical. Geometricity increases as the absolute difference between this remainder and 45° increases. The value is calculated using the formula:

$$\mathrm{Ga} = |\bmod(90, \alpha) - 45|$$

Griddedness measures how much the nodes in a network deviate from an ideal rectangular form. For each node, the G-factor is calculated as the average of the *Ga* values of its angles, indicating how closely the node's geometry aligns with a grid-like, right-angled structure. A higher G-factor means that the node and its connected edges more closely resemble a rectangular configuration. To evaluate the network as a whole, the G-factor of each node is used to compute the Griddedness (GN) within a spatial unit (e.g., a 400 × 400 m cell). Griddedness (GR) is defined as the average G-factor of all nodes within that unit. The formulas are:

$$\mathrm{GN} = \frac{\sum_{\mathrm{i}=1}^{\mathrm{n}} \mathrm{G}\alpha_{\mathrm{i}}}{\mathrm{n}}$$

$$\mathrm{GR} = \frac{\sum_{\mathrm{j}=1}^{\mathrm{m}} \mathrm{G}_{\mathrm{Nj}}}{\mathrm{m}}$$

Order in a network describes the extent to which the configuration of its nodes follows a consistent geometric pattern. For example, if all nodes conform to a complete rectangular grid, the network exhibits order. The same applies if they follow a triangular grid, or any other repeating arrangement in which each node has a similar geometric relationship to its connected edges – as quantified by the G-factor. Mathematically, order is measured as the standard deviation of the G-factor values of all nodes. Within a spatial unit (e.g., a 400 × 400 m cell), the order of the network is given by the standard deviation of the nodes' G-factors in that unit. A higher Order value (OR) indicates greater variation in node configurations, and thus a lower degree of adherence to a single, dominant geometric pattern. The formula is:

$$\mathrm{OR} = \sigma = \sqrt{\frac{\sum_{\mathrm{j}=1}^{\mathrm{m}} (\mathrm{GN}_{\mathrm{j}} - \mathrm{G}_{\mathrm{mean}})^2}{\mathrm{m}}}$$

Diversity measures the variety and balance of junction types within a network. It is calculated using the geometric mean of the proportions of each junction type, normalized by the highest proportion among them. This technique captures both the range of node types present and how evenly they are distributed. FN is the frequency of junctions with *a given number* of edges, and T is the maximum number of edges observed between any two nodes in the network. The formula is:

$$\mathrm{DN} = \frac{\mathrm{FN}_{\mathrm{max}} - \prod_{\mathrm{i}=1} \mathrm{FN}_{\mathrm{i}}}{\mathrm{FN}_{\mathrm{max}}}$$

Complexity reflects the presence of *non-ideal* junctions and the extent to which they deviate from an ideal grid configuration. For each junction type, the contribution to complexity (CX_i) is calculated as the product of: the frequency of that junction type (i.e., the number of nodes with a given number of edges), and the difference between that junction type's griddedness value and the highest possible griddedness (45). Here, *i* denotes the number of edges of the junction type. The overall network complexity is obtained by summing CX_i across all junction types.

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TEHRAN

An introduction to the Iranian capital

The history of urban transformation in Tehran – similar to many other Iranian cities – can be conceptualized as encompassing six stages: i) the Isfahan school of civic design, ii) the Tehran style of civic design, iii) modern discontinuity, iv) the beginning of modern urban planning, v) the period of growth after the Iran–Iraq War, and vi) contemporary planning.[17] Around 250 years ago, Tehran was an 'organic' walled town shaped by the traditional elements of Iranian cities – the castle (*arg*), neighbourhoods (*mahallahs*), square (*meidan*), and *bazaar* – and was under the rule of the Qajar dynasty. The city grew on the remnants of the Safavid era and followed what is recognized as the Isfahan school of civic design.[18]

In 1920, the Ghajar kingdom was replaced by the Pahlavi kingdom. The first Pahlavi king, Reza Shah, initiated a new process of modernization across the country. Traditional Iranian urban fabrics underwent extensive transformations, which included the insertion of long, straight streets into existing built areas. During the reign of his successor, Mohammad Reza Shah, many modern urban forms were introduced into the fabric of Iranian cities – highways, boulevards, public buildings, and towers, to name a few. These interventions marked the early influence of modern urban planning in the country.[19]

After the Islamic Revolution, and particularly over the last four decades –following the Iran–Iraq War– Tehran has experienced intense urban growth. The city's current plan includes interventions in the street network at various scales, ranging from widenings and setbacks in small alleys to the superimposition of major new highways.

The current street network of Tehran is a heterogeneous combination of various styles and historical layers, reflecting successive phases of urban transformation. It includes remnants of the Safavid-era network, the manipulated street structure of the Qajar period, the initial modern interventions introduced during Reza Shah's reign. These developments were guided by the first modern urban plan, post-war expansions, particularly in the form of simple gridiron layouts and highways, and former rural areas and informal settlements that have been absorbed by the city's outward growth.

The historic part of Tehran at the beginning of the Qajar period consisted of five main sections within the city walls: i) the Castle (Arg) with its walls and surrounding defensive ditch, ii) the *Bazaar*, iii) the Oudlajan neighbourhood (northwest and west), iv) the Sangelaj neighbourhood (east); and the Chal Meydan neighbourhood (southeast) (Figure 1). During the reign of Nasereddin Shah, the city's area expanded to five times its original size. Lands outside the walls were incorporated into the urban fabric and divided by straight streets. These new areas were developed with neighbourhoods primarily in the north and south, while gardens occupied the eastern and western sections (Figure 2). The old street network was altered in some parts, particularly in the northwest. In the early Pahlavi period, a map known as *Khiabankeshi* (meaning 'street making') reveals a preference for geometrical configurations as the ideal approach to creating a 'modern' Tehran (Figure 3). Straight streets were introduced through the old organic fabric to impose a sense of discipline on the irregular urban landscape.

During the Second Pahlavi period, the historical part of the city evolved as a continuation of the style established in the First Pahlavi period. While only a few new major streets were constructed, many large plots of land around this area – particularly the gardens developed during Nasereddin Shah's reign – were subdivided into a gridiron-like pattern with several straight streets (Figure 4). After the Islamic Revolution, Tehran implemented two detailed urban plans, in 1991 and 2012. A significant impact of these plans, beyond the creation of new streets, was the opening of dead-ends and the widening of the narrow ones to facilitate

Figure 1. Brezin Map of Tehran, 1827.

emergency vehicle access and personal car circulation, even within the historical parts of the city (Figure 5). The street network in Tehran's historic core is thus a palimpsest of successive developments: rooted in the Safavid era, structured during the Qajar period, modernized in the Pahlavi era. This paper argues that a thorough evaluation of the street network, based on comprehensive quantitative measures, can contribute to a deeper morphological understanding of the historical city fabric.

Application of Morpho to Tehran

Morpho is applied to the case of Tehran using the street network shapefile provided by the Municipality for the Tehran Detailed Plan 2012 (based on the 2005 AutoCAD version of the city's 1:2,000 detailed maps produced by the Iran National Cartography Centre). The shapefile includes street axes, which were generated through an automated mapping technique. However, due to the limitations of this automated process, the

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Figure 2. Abdolqaffar map of Tehran, 1903.

data required refinement for use in this research. The original file contained a large number of unnecessary nodes; therefore, only junction and essential nodes necessary to capture street curvature were kept.

More than 9,000 streets were identified within the study area. Street lengths range from around 5 meters – typically in dead-end segments – to over 5 kilometers. The longest street follows the alignment of the former city wall, which was built more than a century ago. The mean street length in the study area is approximately 75 meters.

The street lengths in the study area are categorized into nine classes (Table 1). The highest frequency falls within the 20 to 50-meter range, accounting for nearly 40% of all streets – primarily short alleys or deadends. Streets shorter than

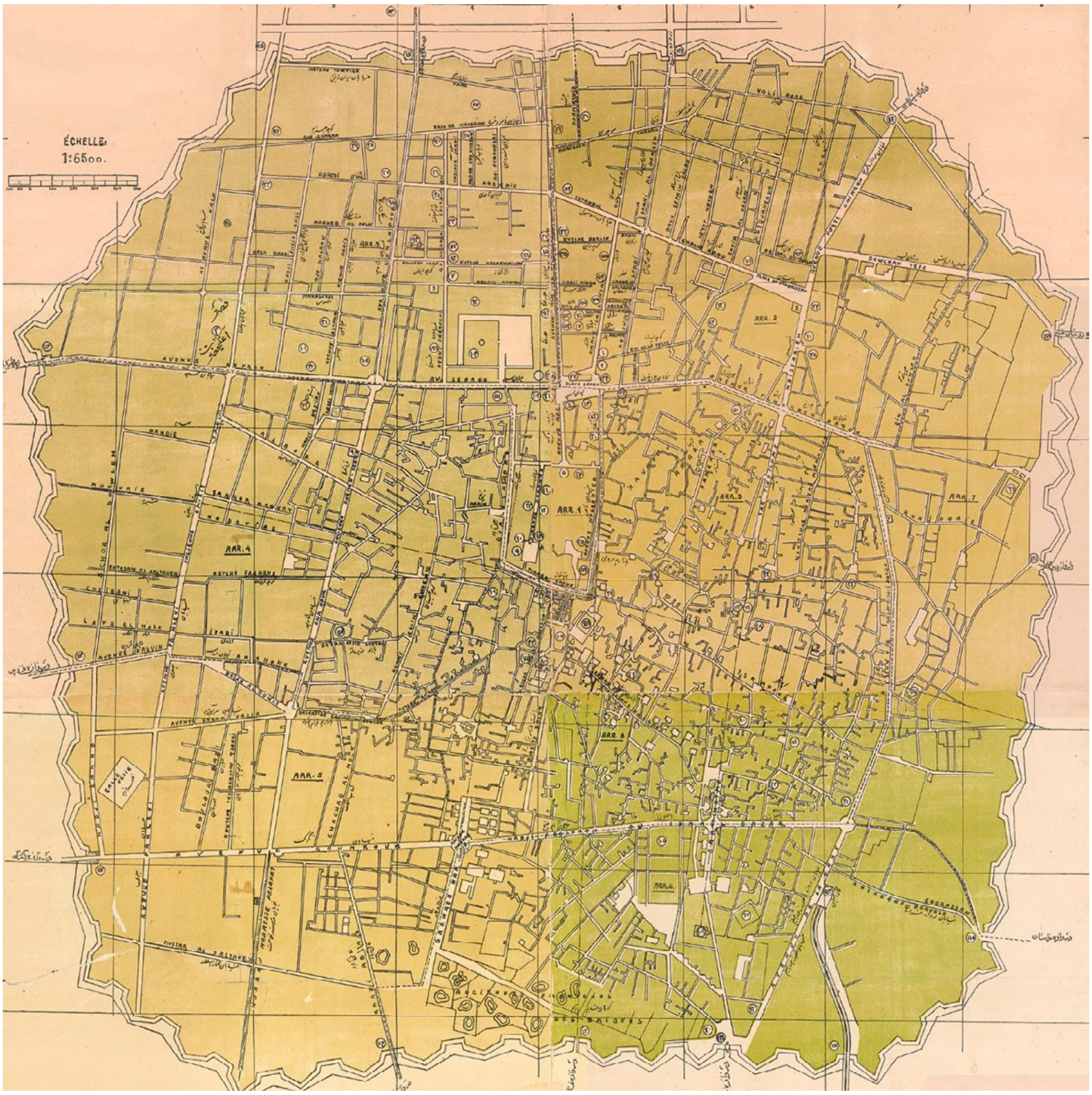

Figure 3. Plan de la Ville (Khiabankeshi) 1930.

20 meters represent approximately 25% of the total. While more than 80 of these are extremely short (under 6 meters), most fall between 6 and 20 meters. Approximately 20% of the streets are between 50 and 100 meters in length, including some longer alleys and deadends. Another 15% fall within the 100 to 250-meter range, typically classified as short streets or long alleys. Only less than 5% of the

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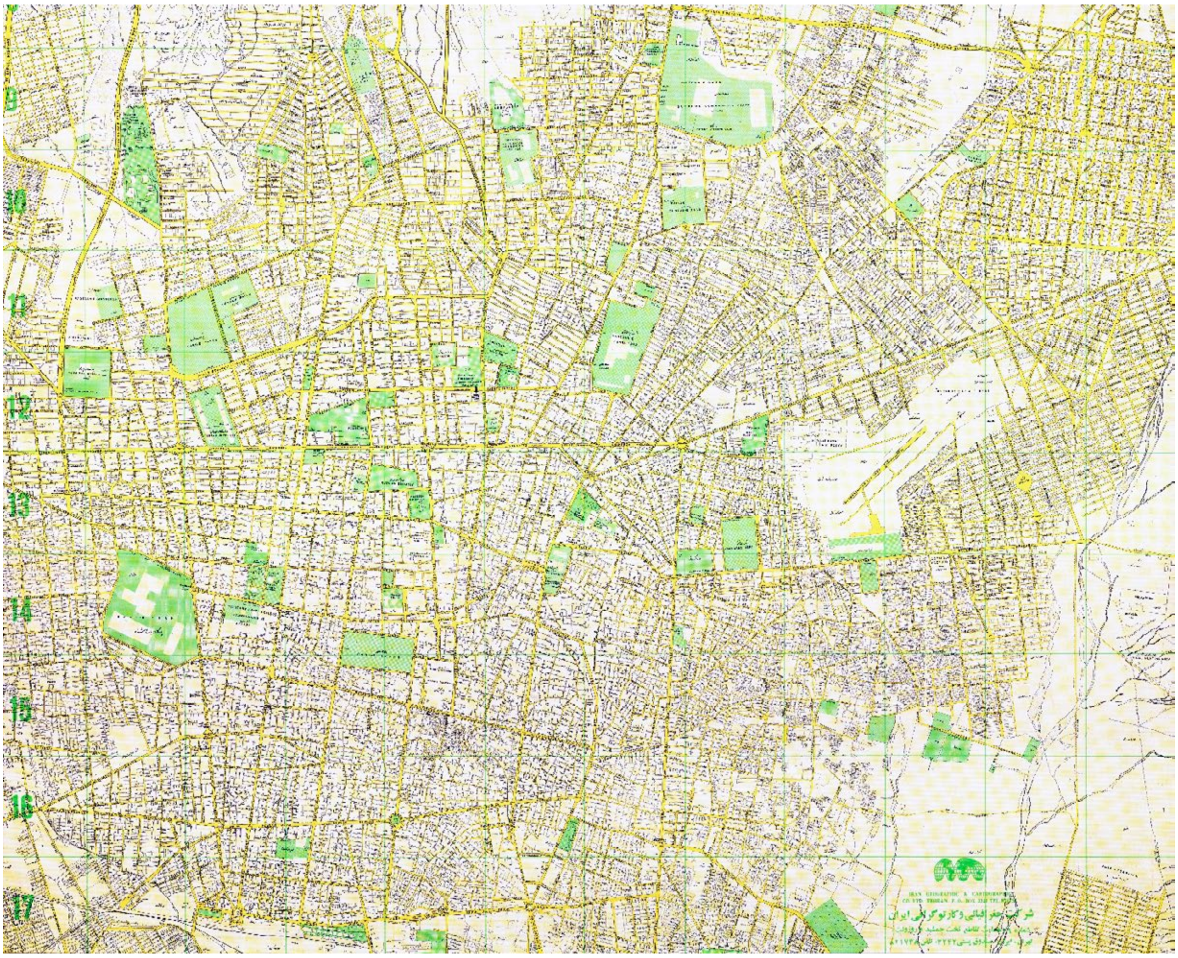

Figure 4. Sahab Map of Tehran, 1976.

streets exceed 250 meters, and these are considered the long streets within the historical fabric. The longest street, Enqelab Street, is over 5 kilometers long and is located along the northern edge of the historic area. It was constructed in the 1920s, following the demolition of the former city wall.

Table 2 shows the frequency of different node types in the street network. The most common junctions are three-edge nodes, which account for 40% of all nodes. Because the map was refined to include only essential nodes and connections, two-edge nodes represent direction changes along streets and comprise about 33% of the nodes. Approximately 25% of the nodes are dead-end alleys (nodes with a single edge). Due to the superimposition of regular crossroads and direct streets onto the historic fabric, four-edge junctions are relatively rare, making up just over 3% of nodes. Other node types, with five or six edges, are very rare, representing less than 0.5% of the total nodes.

Figure 5. Street network of the historical part, 2012.

Nodes with dimension one (dead-ends) are concentrated mostly in the Tahmasbi area, despite the presence of the citadel and the 1930s park built over the Sangelaj neighbourhood. Most direction-change nodes (two-edge nodes) are in the Bazaar and Oudlajan areas, reflecting the antiquity of these districts and their relative resistance to modern interventions. Nodes with three edges are predominantly found in

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Table 1. Frequency of street lengths.

Street Length (SL) (meters)	Count	%
SL<6	84	0.9
6 ≤ SL <20	2074	22.7
20 ≤ SL <50	3440	37.6
50 ≤ SL <100	1839	20.1
100 ≤ SL <250	1315	14.4
250 ≤ SL <500	299	3.3
500 ≤ SL <1000	79	0.8
1000 ≤ SL <2500	11	0.1
2500 ≤ SL	8	0.1
Total	9149	100

Table 2. Frequency of street node types.

Street node dimension	Count	%
1	5963	24.7
2	8325	33.0
3	10154	40.6
4	809	3.2
5 and 6	10	0.6
Total	25263	100

the southern half of the study area, consistent with the fact that the southern area contains more than twice the number of nodes compared to the northern half. Other node types are scattered throughout the study area (Figure 6). Finally, regarding the node-link ratio and internal connectivity of the area: the former is slightly above 1.0, while the latter is 0.76, calculated by considering nodes with two links (Table 3).

The values of the griddedness indicator range from 35.3 to 44.0 and are classified in ArcGIS using equal intervals, reflecting the linear influence of street angles on grid patterns. The lowest values (the first class on the map) appear south of the citadel, to the west and southwest, especially in the direction of the bazaar. This distribution corresponds to the antiquity of the bazaar and its surrounding areas, with values between 35.3 and 37.0. Two other cells in this class correspond to areas near the train station, characterized by curvy long streets in vacant lands that lack any discernible order. The second class extends from the bazaar area toward the north and west, covering the southern part of the Safavid Sangelaj neighbourhood and sections of the western Safavid Oudlajan neighbourhood. The third-class cells surround these first two classes and cover central, western, and southern parts of the study area. The two higher classes, indicating a more grid-like network, are predominantly found in the north (south of Enqelab Street) and the west (along Valiasr Street). Enqelab Street was the first to be built, while Valiasr Street was developed after 1920. The street patterns in these areas exhibit variations of the grid form, with some deviations (Figure 7).

The order values range from 0.0 to 12.7. The classification of cells is based on natural breaks in the data, with classes rounded to the nearest integers due to the closeness of their values. The lowest order values are generally found south of Enqelab Street, the most recently developed area in the study. The second class, with values between 3.0 and 5.0, is scattered around the study area, indicating neighborhoods developed more recently than the oldest parts. Cells with values between 5 and 7 are dispersed from the periphery toward the center, suggesting these areas are either newer than the central parts or have experienced significant changes to the original structure. The fourth class, with values between 7.0 and 9.0, is primarily located east of the central part, corresponding to some of the oldest residential neighborhoods. Similar historic areas in the west and south have undergone more changes over time. Finally, cells with the highest order values (above 9.0) are concentrated around the bazaar and its vicinity – particularly east and west, south of the Sangelaj neighbourhood and west of Oudlajan – mirroring the pattern observed in the previous indicator (Figure 8).

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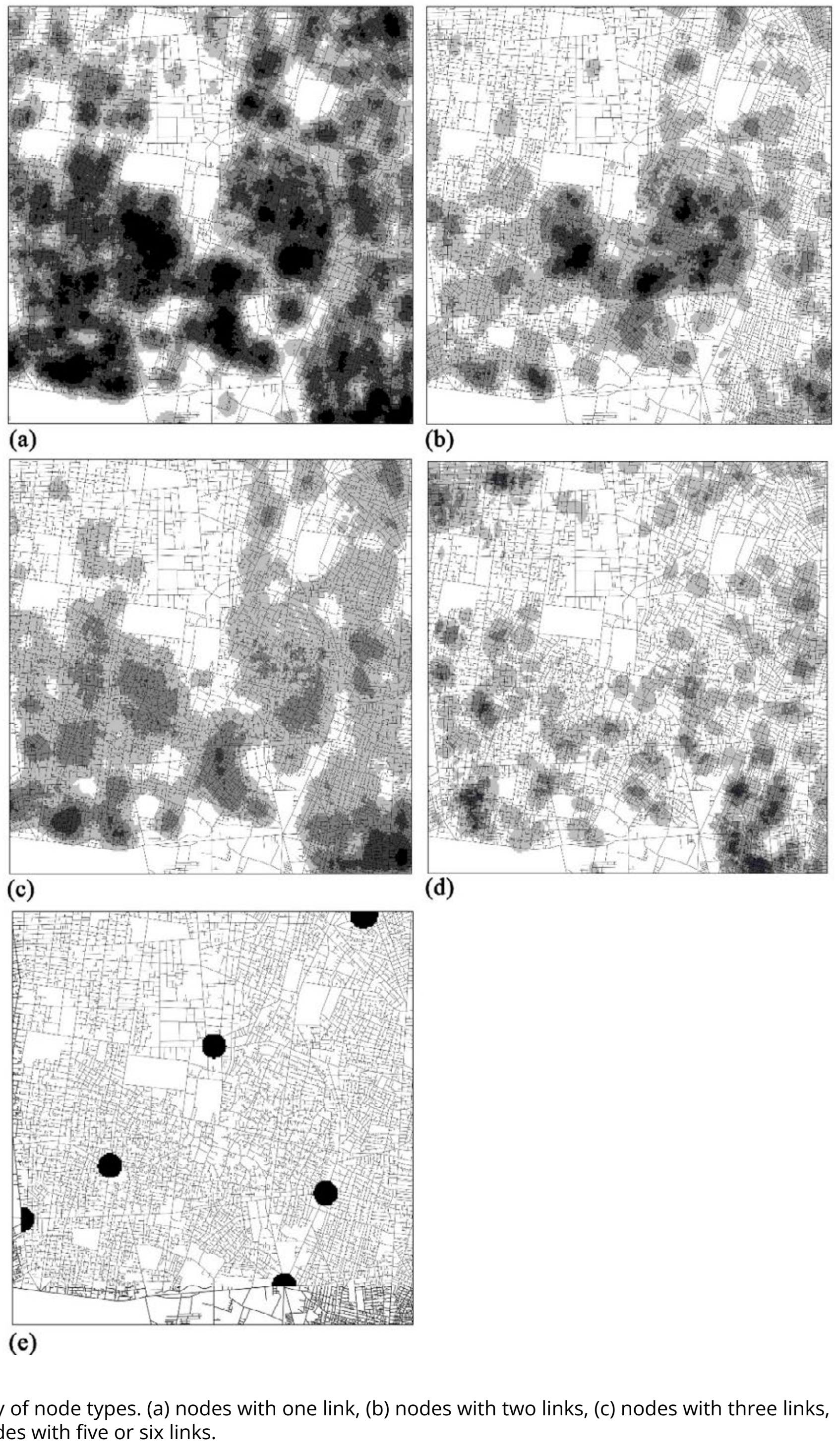

Figure 6. Density of node types. (a) nodes with one link, (b) nodes with two links, (c) nodes with three links, (d) nodes with four links, and (e) nodes with five or six links.

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Table 3. Geographical distribution of intermediate measures.

Measure	Highest Value			Lowest Value		
	Count	Ratio	Location	Count	Ratio	Location
Node Density	≤ 47	19%	From north to center	206 ≤	3%	South east (slums)
Street Density	≤2500	15%	From north to center	5700 ≤	9%	South east (slums)
Link-node Ratio	≤0.6	15%	Centre (bazaar and neighborhoods)	0.9 ≤	3%	Not identifible
Internal Connectivity	≤0.6	15%	Scattered	0.9 ≤	1%	Scattered
External Connectivity	≤1	20%	From north to center	2.5 ≤	2%	South east (slums)

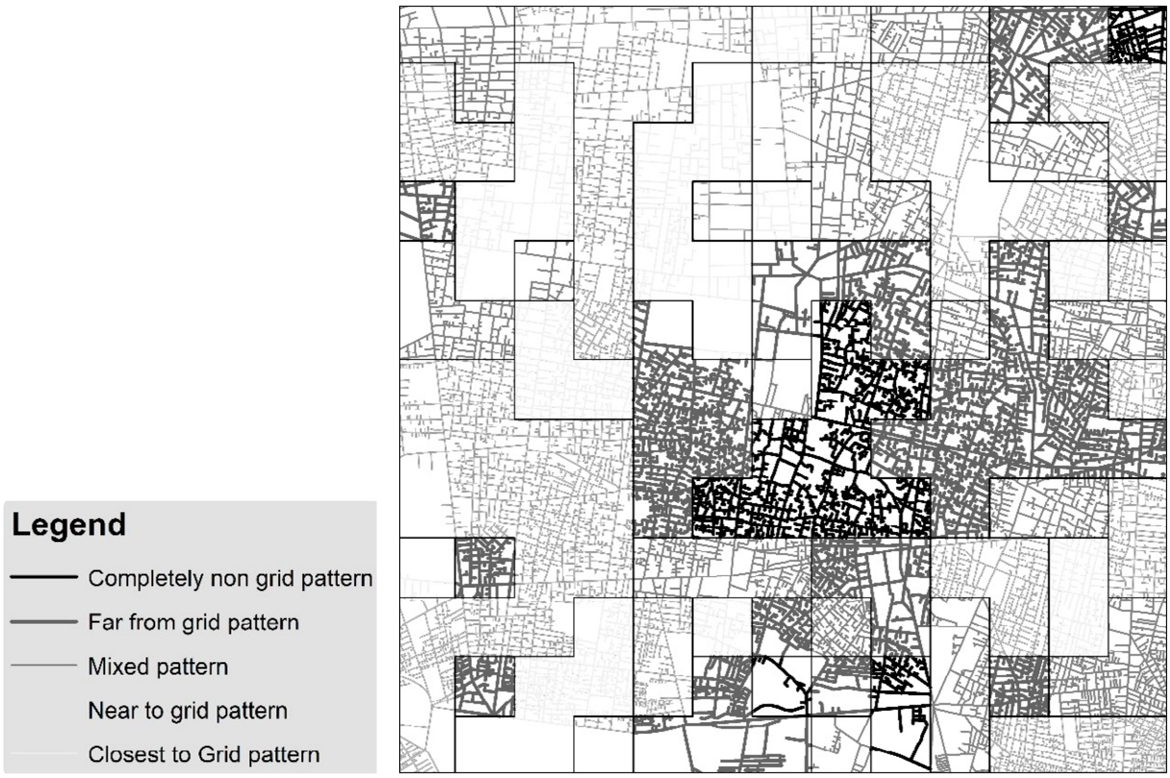

Figure 7. Griddedness.

In general, the southern half of the study area is significantly more diverse than the northern half. The diversity values of the street network range between 2 and 78, and are grouped into five classes based on natural breaks. The first class (values between 2 and 12) appears mainly in the northern side, around Enqelab Street and Baq-e-Melli (Central Garden), an area characterised by a wide grid pattern of street blocks. This institutional area was formerly the Ministry of War and its parade ground, and

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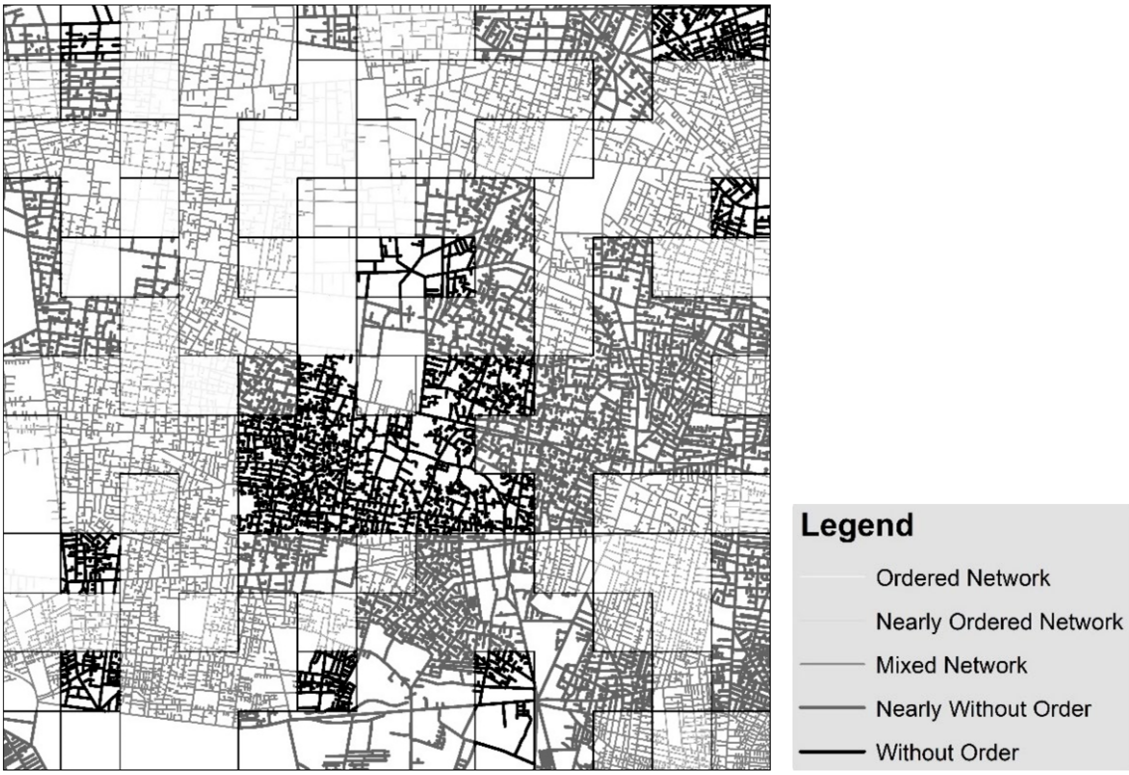

Figure 8. Order.

currently includes the Foreign Ministry, National Museum, and University of Art. Additionally, vacant lands belonging to the national railway in the southern part also fall into this low-diversity category. The second class, with values between 12 and 22, is also mainly located in the northern half, covering street blocks with simple geometrical forms. Third-class cells (values between 22 and 34) are scattered throughout the study area, representing both large ancient street blocks and more recent small blocks. The fourth class (values between 34 and 49) includes street blocks in parts of ancient neighbourhoods as well as recent developments with irregular forms and numerous dead ends. Finally, a few cells belong to the fifth class (values between 49 and 78), which are located in dense southern sections, mostly slums characterised by unplanned and spontaneous street networks (Figure 9).

The complexity values range from 0 to 10,000 and are divided into five classes. The first class (values less than 1,500) corresponds to cells covering vacant lands in the southern part of the national railway area and areas with near-grid street patterns and large street blocks. These street blocks are mostly located in the western half of Enqelab Street, around Baq-e-Melli, and near the Golestan Palace. The second class, with values between 1,500 and 2,750, includes cells in the northwestern part of the study area, where the street network has developed more recently, with medium-sized rectangular street blocks or non-rectangular but regular forms. The third class (values between 2,750 and 4,500) covers more than 35% of the study area. These cells include medium-grain networks with regular block shapes and a few irregular forms

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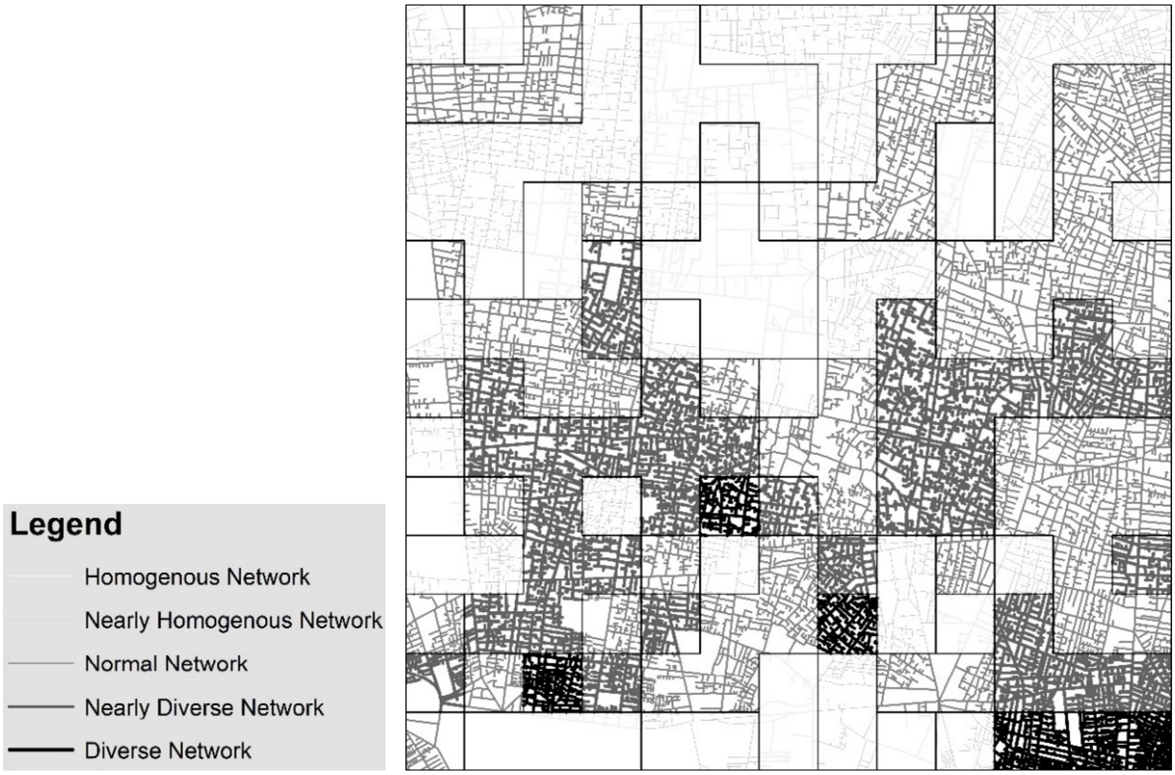

Figure 9. Diversity.

composed of large blocks that, despite their irregularity, can be abstracted into regular forms. The fourth class (values between 4,500 and 6,000) includes limited areas characterised by medium-sized, irregular blocks. The fifth class, with values above 6,000, covers parts of the Bazaar, Oudlajan, Sangelaj, and some slum areas. These parts feature fine-grain, irregular street patterns, often with non-regular street block shapes, small blocks, and a high number of dead-ends (Figure 10).

CONCLUSIONS

Applying Morpho to Tehran revealed and quantified the distinctive features of its street system, reflecting patterns common to both Iranian and broader Islamic urban traditions. The measurement of griddedness, order, diversity, and complexity enables a rigorous description and explanation of what this system is, how it has changed over time, and how it might evolve in the future. By revealing how unusual or incompatible some of the forms introduced under a globalized planning framework appear within the local context, the analysis reinforces the need for future interventions to acknowledge and recover the physical forms of the past, contributing to the preservation of the city's character and identity. Despite cultural and geographical differences the method also offers insights for street systems in non-Islamic contexts, since the structural role of streets and paths —in organizing urban forms and supporting flows— in human settlements is universal.

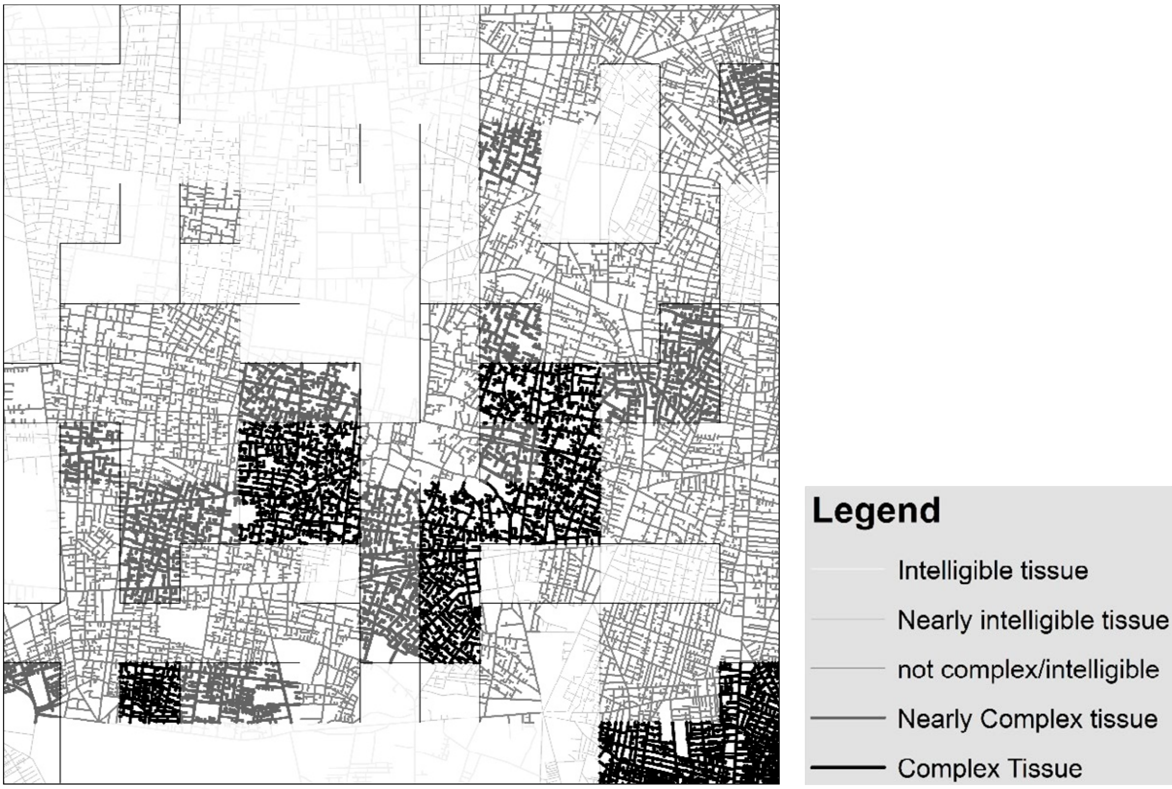

Figure 10. Complexity.

Tehran was analysed using an exploratory and still incomplete version of Morpho, a method focused on the structural elements of the physical form of human settlements. Yet, by *momentarily* disregarding plot patterns and building arrangements, the analysis enabled a more comprehensive understanding of both the object (Tehran's street system) and the method (Morpho). At the core of this exploration lies the argument that the description, explanation, and prescription of street systems must account for both their topology and their form or geometry – otherwise, there is a risk of producing only partial and insufficient understandings.

The description and explanation of street systems (reinforced by this exploratory study), plot patterns and building arrangements on the ground (the classic version of Morpho) is a powerful tool for analysis. It is able to differentiate the primary distinctions in urban landscapes, and to expose how each ground plan and urban landscape is related to a specific socioeconomic and environmental performance.[20]

But, acknowledging the key role of street system, plot patterns and building arrangements is fundamental not only to urban morphology, but also to planning practice. Understanding how each street, plot and building articulate with their surrounding area and with the broader city, as well as distinguishing different parts within the street system, is crucial for pattern recognition, a core competence of urban morphology. Since no city is uniform, it must be analysed and designed through the continuous articulation between the parts and

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the whole. As such, the morphological knowledge built by these studies can be used as a basis for different types of planning and design documents. Zoning ordinances, form-based codes, urban design guidelines, and various kinds of planning and design documents that deal with the incremental transformation of urban landscapes can benefit from the use of pattern recognition in defining homogeneous zones for decision making on the future of urban forms. This investigation seeks to contribute to these essential goals.

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