International Design and Art Journal

IDA: International Design and Art Journal
ISSN: 2687-5373
Volume: 7, Issue: 2 / 2025

Research Article

Urban metamorphosis in historical town Harput: Analyzing morphological changes with diverse approaches

Asst. Prof. Dr. Rüya Ardıçoğlu[1*]

[1]Fırat University, Faculty of Architecture, Department of City and Regional Planning, Elazığ, Türkiye.
rardicoglu@firat.edu.tr

*Corresponding Author

Received: 13.11.2024
Accepted: 04.08.2025

Citation:
Ardıçoğlu, R. (2025). Urban metamorphosis in historical town Harput: Analyzing morphological changes with diverse approaches. *IDA: International Design and Art Journal, 7*(2), 188-202.

Abstract
This study analyzes the morphological transformation and physical character of a historical settlement that underwent dramatic urban metamorphosis, using Harput as a case study. Two different time periods have been compared to shed light on this transformation. The research is significant for addressing morphological changes in historical settlements and for using multiple analytical methods. Street systems, street blocks, and plots have been analyzed using the Conzenian approach, Space Syntax, topological analysis, and Marshall's town plan taxonomies. Employing various methodologies allowed for a more comprehensive evaluation of urban morphology. In conclusion, findings from these methods validated each other, and integration, connectivity, and regularity levels of the town plan increased. The once-organic and irregular street pattern evolved into a more geometric and regular structure. This transformation, particularly in street typology, triggered changes in other urban elements, leading to plan units that are more uniform in size and shape. Hence, the study highlights the hierarchical influence of street patterns on urban form. It provides valuable insights into the urban evolution of Harput and can inform future planning, conservation, and development practices. Ultimately, these analyses aim to be a guide for future applications and conservation as well.

Keywords: Historical settlements, Space syntax, Topological analyses, Urban metamorphosis, Urban morphology

Extended Abstract

Introduction: Cities are complex systems composed of interdependent spatial and physical elements. Understanding the relationships among these components—from individual elements to the entire urban structure—is essential in urban morphological studies. Urban morphology is a discipline that analyzes the physical form of cities, emphasizing how their structural components emerge, evolve, and interact over time. Among these components, streets are recognized as the most stable element of the urban fabric. In comparison, buildings are more susceptible to change, while plots show relative stability. Streets play a pivotal role in shaping other urban elements such as blocks, plots, and building typologies. The geometry of the street network directly influences the size and configuration of street blocks, which in turn determine the layout of plots and the typology of buildings. Therefore, streets function as the primary organizing element in urban form, generating a hierarchical chain of influence throughout the spatial structure. Changes in the street system inevitably trigger transformations in street blocks, and these transformations propagate down to the level of plots and buildings. To analyze these urban elements, over the past century, multiple analytical approaches have been developed in urban morphology. The two primary paradigms are the historical-geographical and architectural approaches. M. R. G. Conzen's historical-geographical methodology remains foundational to the discipline. Meanwhile, the emergence of computational tools has introduced novel approaches such as Space Syntax, developed by Hillier, which combines spatial analysis with technology to assess accessibility and spatial configuration.

Purpose and scope: This study aims to analyze the morphological transformation of a historical urban settlement that underwent significant physical and spatial change, using a multi-method analytical framework. A central research question is how changes in one urban element affect others, revealing the hierarchical and interdependent nature of urban morphology. The case study is Harput, a historical town with a layered urban history. Two distinct time periods were selected for comparative analysis: the late 19th century (1890s) and the mid-20th century (1960s). The 1960s represent a turning point in Harput's urban development, marked by the implementation of a new master plan that significantly altered

its spatial structure. Comparing these two time periods provides insight into the nature and impact of urban metamorphosis in a historical context.

Method: 1. The analysis is structured according to the Conzenian model, which identifies three primary urban components: streets, street blocks, and plots. 2. Space Syntax Analysis: The first analytical phase employs the Depth map software to measure spatial indicators such as integration, connectivity, and choice for both time periods. Grid axiality is also calculated to assess the regularity and coherence of the urban layout. 3. Topological Analysis: The third phase involves Marshall's topological approach, which uses geometric and mathematical parameters to analyze the connectivity and structure of street networks. This empirical method quantifies spatial regularity and intersection types, contributing to a deeper understanding of morphological order. 4. Typological Classification: The next phase applies Marshall's ABCD typology, which classifies urban plans into four types based on their degree of regularity and structural form. This classification provides a comparative framework for identifying shifts in Harput's urban character between the two time periods. 5. Block and Plot Analysis: Finally, street blocks and plots are analyzed in terms of their size and shape. Blocks are categorized as small, medium, or large, and plot dimensions are measured to identify patterns of transformation. This analysis examines how changes in street geometry influenced the configuration of subordinate elements.

Findings and conclusion: According to Marshall's taxonomy, the 19th century plan of Harput corresponds to Type A, characterized by an organic and irregular structure shaped by topography and historical development. This classification is supported by Space Syntax and topological data, which show low integration, low grid axiality, and a limited number of X-intersections, all of which indicate a spatially fragmented and irregular layout. By contrast, the 1960s plan represents a Type C layout, reflecting a more regular and geometric structure. The results indicate a significant increase in integration, connectivity, and the number of X-nodes, which suggests improved spatial coherence. Although grid axiality values in both periods remained below 0.25, the increase in the 1960s confirms a move toward greater regularity. In topological terms, the reduction in T-intersections and the increase in X-intersections contributed to enhanced spatial integration and network efficiency. The transformation of the street system not only redefined connectivity but also influenced the shape and size of street blocks. In the 1890s, blocks were irregular, amorphous, and varied in size due to the organic street layout. In the 1960s, the blocks had become more uniform and modular, except for some large blocks allocated for specific land uses such as schools, green spaces, or heritage sites. A similar trend was observed in plot morphology. The standardization of street geometry led to more regular and similarly sized plots, reflecting the hierarchical influence of street systems on subordinate elements. This shift toward homogeneity in urban form illustrates a broader pattern of planned urban development in contrast to the organically evolved structure of the previous era. In conclusion, the morphological evolution of Harput demonstrates a clear transformation from an irregular, topography-driven urban layout to a planned and regular structure. This change was primarily driven by alterations in street geometry, which initiated a chain reaction affecting blocks, plots, and ultimately building patterns. The study confirms the hierarchical relationship among urban components and highlights the critical role of streets in shaping overall urban form. The integration of multiple analytical approaches—Space Syntax, topological analysis, and morphological typologies—offers a comprehensive framework for understanding urban transformation. These findings contribute valuable insights for contemporary urban planning, conservation, and design, particularly in historically sensitive contexts. Morphological analysis, as demonstrated in this study, can serve as a guideline for future interventions that aim to balance historical continuity with modern development needs.

Keywords: Historical settlements, Space syntax, Topological analyses, Urban metamorphosis, Urban morphology

INTRODUCTION

Cities can be defined as complex objects that are composed of several elements. It is significant to define the relationships between the urban elements from the part to the whole. At this point, urban morphology is an important field to deal with the complexity of cities by using fundamental physical elements in a hierarchical view (Oliveira, 2022: 9). Each settlement is established with different configurations of urban elements (streets, street blocks, plots, and buildings). Therefore, these fundamental elements of urban form generate the urban landscape of the settlements. The configurations and features of urban elements, such as size, form and density, are distinctive parameters for the morphological character of the cities.

Urban morphology is a field of study that aims to define the city in physical aspects. It is defined as the study field that focuses on the formation of human settlements and the process of their transformation (Moudon, 1997: 4). According to Kropf and Malfroy (2013), the goal of research on urban morphology is to elucidate the mechanisms that result in the production and alteration of forms that create the physical environment. In addition, it addresses the interactions and configurations of urban components at different scales from the past

to the present. Research on urban morphology is divided into three groups. The researchers in the first group focus on the spatial changes of cities from past to present with using maps, plans, photographs, and written sources. These studies are mostly carried out to shed light on the current situation by revealing urban evolution in cities and settlements with a strong historical background (Whitehand & Larkham, 2000: 4). Especially, the metamorphosis of urban form in historical settlements is a sign of significant transformation of cities.

Urban settlements are exposed to physical changes over time due to various factors. Urban development, increasing population, necessities of transportation lines, economic, social, or political reasons can cause to metamorphosis of urban form. Therefore, historical development processes and transformation of urban elements have born the necessity of physical analyses and typological classifications. In morphological terms, streets are the most stable urban element. In contrast to streets, buildings can be exposed to transformation more easily, and plots have more stability than buildings (Oliveira, 2022: 17). Hereby, streets are the most distinctive urban elements because they influence the street blocks, plots, and buildings. In other words, street geometry defines the size and form of street blocks and also affects plots and building typologies. Therefore, streets are the main dominant element of the urban form that has a dramatic impact on other urban elements. Since the alteration of the street system, the size and form of street blocks have to reshaped. Then, by the transformation of street blocks, the size, form, and density of plots and related to plots building typologies are inevitably changed. Hence, there is a hierarchical chain between urban elements.

Since each urban element has a relationship to the other and the transformation of someone could influence others, understanding morphological evaluations of cities provides a guide for future designs. Gebauer and Samuel (1983) also consider urban morphology as an analysis method used to determine urban design principles and theories. According to Oliveira (2021), in order to comprehend what practice is, it is important to describe the physical characteristics of urban forms and integrate morphological theories, concepts, and methodologies in design and planning.

Approaches and methodologies of urban morphology have been developed during the last century. The two basic approaches are historical-geographic and architectural, and these have still developed in different ways. Conzen's methodology of the historical-geographic approach is the fundamental base of urban morphology. According to Conzen (1960), the urban landscape is the most significant indicator of physical analysis. Thereby, morphological analyses have been developed within the urban landscape according to the Conzenian approach. Also, a post-modern urban architectural approach has been developed (Bilsel, 2018: 36) and many of studies focus on urban structure, plots and block forms, typo-morphology and transportation systems. Additionally, methodologies on urban morphology have developed in the last decades with technological developments. By virtue of technological improvements, the theory of "space syntax", which is a significant analytical tool of morphological analysis, was developed by Hillier, who combined technology and spatial analysis. Apart from these methodologies, taxonomies of urban form and evaluations of urban elements have been used as a physical analysis of urban patterns.

In this context, this study aims to analyze the morphological changes and define the physical character of a historical settlement that has been dramatically exposed to urban metamorphosis by using diverse approaches. Also, how do physical changes of urban elements affect each other? is a question to be answered. These kinds of studies, analyzing the morphological evaluation of historical settlements, is a main research field of urban morphology. Within this scope, Harput, a historical town that dates back centuries, was chosen as the case study. Two different time periods have been analyzed and compared to each other. These are the town plans of Harput from the 19th and 20th centuries. Even though the town's background extends before 19th century, the oldest visual sources (maps, plans, and photographs) are from the 19th century. On the other hand, the 1960s represent a turning point in Harput's urban development, marked by the implementation of a new master plan that significantly altered its spatial structure. For these reasons, comparing these two time periods provides insight into the nature and impact of urban metamorphosis in a historical context.

There are different types of urban elements such as streets, street blocks, plots, and buildings, thus, each urban element requires different methodologies and approaches for analysis. For this reason, for a comprehensive analysis and to explain the hierarchical relation between urban elements, different methods have been used in the same study. In the study, the headings of analyses have been defined according to the historical geographic

approach of Conzen. Hence, street systems, street blocks, and plots have been analyzed. Even though in Conzen's approach, buildings and their relationship with plots are important parameters, due to the lack of data on buildings of the 19th century, this heading could not have been handled in the study. The analyzing of the street system, that is, the most distinctive urban element that shapes other elements, has been analyzed with the Space Syntax method, Marshall's topological approach, and Marshall's town plan taxonomy. Using Depth map software, integration, connectivity, and choice analysis have been found, and using Marshall's approach, the topological analysis of town plans was done. The grid axiality value was measured to understand the regularity of town plans. Furthermore, the town plans have been classified and interpreted according to Marshall's taxonomies. Also, the size and form of street blocks and plots have been evaluated and compared to each other. While these analyses aim to define alterations of urban forms, they also aim to be a guide for the conservation and revitalization of historical settlements.

Material

The main material of the study is the historical Harput settlement. Additionally, literature sources, master plans of Harput, photographs, and Depth map software are auxiliary materials of the study. As the case study, Harput is located on the north-east of the city of Elazığ, south of the Upper Euphrates Division of Eastern Anatolia, Türkiye. It was the first city core of Elazığ, and before the establishment of today's city, Harput was the main settlement in that region. With the light of excavations (in the 20th century and also the excavations of the inner castle since 2005) and archeological research, the establishment of Harput dates back to the Neolithic era (Kiziroğlu, 2022: 32) and Hittite and Urartu civilizations (Ardıçoğlu, 1997: 7, Sevin et al., 2011). Throughout history, it had been a significant settlement in terms of trade, culture, education, and military. Especially by virtue of its strategic location, Harput became a significant settlement as a defensible military zone. Due to its topographical features and being located on top of a hill, the settlement was called *Carcathiocerta,* which means *stone castle* or *castle town* (Ardıçoğlu, 1997: 19). Then, the name of Carcathiocerta evolved to Harput during the time. It was the center of that region and worked as an important junction of transportation and trade route (Silk Road) and also the Roman Empire's military garrison in east border. In the 11th century, Harput became an important Turkish garrison and settlement. Until the middle of the 19th century, it continued to develop in terms of trade, education, culture, and military facilities. It hosted different civilizations, and different ethnicities lived there. Therefore, its urban form was shaped according to social, topographical, and climatic features.

In the urban layout of the 19th century, there were organic street patterns, cul-de-sacs, and narrow streets. The street typology was formed according to rough topography, and there were open public spaces between historical buildings. Nevertheless, since the middle of the 19th century, it has started to lose its strategic importance and has become an inadequate area for urban development. In that, it was unable to respond to the necessities of the growing urban pattern and railway transportation. The 19th century was the developing era of railway transportation; thus, Harput had improper topography for growing urban fabric and developing railway lines. Hence, the urban metamorphosis was started, and dramatic development occurred with the construction the railway. For this reason, by the middle of the 19th century, settlement started to shift to the plain to its south side, where topographical features were suitable to both growing urban development and railway facilities. Due to being shifted to plain because of the railway, a new settlement was found around the railway station. Hereby, some public services, such as; hospitals, military barracks, and government offices, shops were built on a new settlement (KTB, 1983) and then dwellings were shifted to Elazığ from Harput. Because of the shifting settlement, the rate of population in Harput decreased, and it became a historical district of the newborn city of Elazığ. On account of decreasing population, most of civil houses were demolished to use their materials to construct new houses in Elazığ; therefore, few of them could reach to present (Öztürk, 2013: 1060). Hence, both the old settlement and historical monuments such as; baths, castle, mosques, churches and tombs became neglected during the middle of the 20th century.

In the 1950s and 1960s, for the revitalization of Harput, making a new urban plan came into question. Also, some restorations for historical monuments were started. In those decades, a new urban layout was made for Harput that had a different morphological character than the historical layout. The new plan preferred long and strict lines, and it has fewer organic street types than the previous. Also, the form and size of street blocks and plots were altered by the new urban plan. The new plan caused urban metamorphosis, and it generated new

street typologies, street blocks, and plots that are different from the historical layout of the 19th century. In addition, with new plan decisions, the land use of the area was altered. With new plan decisions, historical places, educational buildings, restaurants, and fewer dwellings were coming forward. Therefore, it started to work as a less populated and historical district of the city of Elazığ. Madran (2009: 76) indicated that, even though this area is accepted as a planned settlement, the new plan's spatial organization seems disrespectful to the historical/traditional physical pattern. Therefore, due to altering street typologies of the settlement, the traditional urban pattern was lost and depended on the altered master plan; the plot system had to be changed. It caused not only the loss of the historical urban pattern also born cadastral problems as well.

On May 30, 1985, Harput was started to be protected, and the castle and its surroundings were registered as the *1st Degree Archeological Site* by the Ministry of Culture and Tourism of Türkiye. On January 1, 2005, it was declared a *Cultural and Tourism Conservation and Development Zone* by the Council of Ministers (Öztürk, 2013: 1056). Add to this, the site was to be on the list of UNESCO World Temporal Heritage List in 2018 (UNESCO, 2018). Today, new archeological excavations in the inner castle and restorations of monuments have been continued. However, even though the area has a strong historical, cultural, and archeological background, it does not work just as a historical settlement, but also it is a livable district of the city with a smaller number of dwellings, restaurants, a school, and a convention center. Apart from protected zones, new constructions can be built for new functions, and most of the historical buildings are used as museums, boutique hotels, or restaurants. In Figure 1, the photographs of Harput from the 19th century are shown. In these old photos, different districts, density of dwellings, traditional houses, mosques, churches, American Euphrates College (in the third photo), French and German Schools are seen. Unfortunately, only a few structures have been able to reach the present. As seen in present photographs (Figure 1), just monuments and a smaller number of dwellings could survive.

Figure 1. Harput photos, 19th century (above), present (below)

METHODOLOGY

In this paper, the methodology consists of five stages. In Figure 2, the flow chart of the methodology is shown. The first stage is defining the headings; the second, third, and fourth stages are related to the analysis of the street system in different methods. The last stage is the classification and assessment of street blocks and plots.

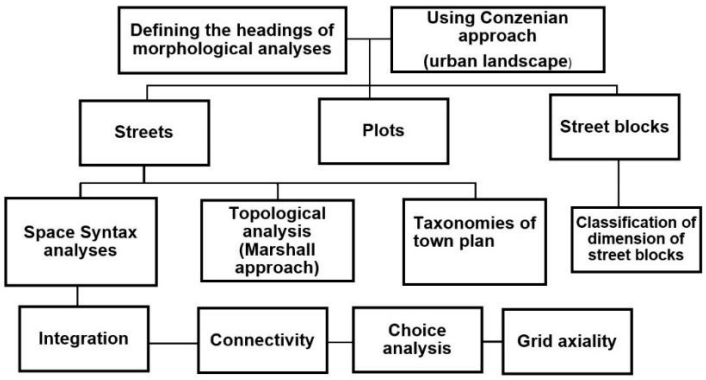


Figure 2. Flow chart of methodology

- The first step is the determination of the analysis headings. These headings have been defined according to the historical geographic approach of Conzen, one of the significant and fundamental approaches of urban morphology.

Conzen focused on the formation and transformation of physical components of cities throughout history. His approach put into center the urban landscape and it was divided into subtitles. According to the Conzenian approach, the town plan is one of the significant headings and it is analyzed into subtitles: streets, street blocks, plots, and buildings (Conzen, 1960). Among these titles, streets, street blocks, and plots have been defined as headings of morphological analyses in the study. Whitehand (2007: 3) states that these headings are the basic components of urban morphology. They were defined according to the Coznenian approach because his analyses aimed to define urban metamorphosis, especially in historical towns, and these studies aim to understand morphological evolution. Slater (1983) states that, in the Conzenian approach to creating a rational analysis method, the entire historical process of the town should be addressed in research. In Conzen's approach, there are different combinations of plan units and subunits formed by these components. In other words, it is stated that a morphological character of the city emerges with the combination of these sub-components (Kropf, 2009: 105-120). Ünlü and Baş (2015: 16) remark that Conzen points out in his studies that the urban pattern becomes apparent as a result of the relationship between the plot, building, street block, and street as urban form components at micro, meso, and macro scales.

In the next steps, as one of the main headings of the study, street system analyses have been done with three different ways (second, third, and fourth stages). The results in this context have been evaluated as the findings that will be used in the conservation or redesign of the existing morphological character and urban landscape.

- The second step is using the Space Syntax method. By using Depth map software, analysis of integration, connectivity, and choice of both the 19th century town plan and the 20th century was done. In addition, grid axiality was calculated for both time periods to interpret the regularity of the town plan.

Space syntax focuses on the morphological structure of a city and the relationships between morphological structure and spatial usage. According to Hillier (1998: 1), the target of space syntax is to combine formal definitions of spatial features with an experimental observation that makes connections with statistics. It helps to understand both the urban transformation processes of a town and the suitability of the new forms. In this context, it is used not only for past evaluations to analyze the urban evolution, but also for the conservation or development projects for the future to be made, and for solving problems in current situations. Yamu et al. (2021: 1) state that, to calculate the configurative spatial links between streets in the built environment, the space syntax technique expands on graph theory from discrete mathematics. For instance, the collection of connections between streets creates an interaction matrix, which can be thought of as a topological or binary graph. On this matrix, different operations can be performed, such as determining the shortest paths between any two links, which are then used to determine how important or accessible each link is in relation to the others (Batty, 2022).

The movement is shaped according to spatial arrangements, connectivity of places, and the grid level of the town. Therefore, the street lines that generate the movement are signed with axial lines. The spatial formation of these axial lines is formulated with axial lines, and axial values are calculated for quantitative data (Hillier et al., 1983: 47-63). The integration of a plan system is found by calculating and averaging the direction changes required to reach from one place to another for all places in the system. Integration value indicates accessibility of the place (Topçu & Kubat, 2007: 4). By finding integration of a system, the most preferable or less preferable lines, density of streets, and mobility can be measured. Integration value and integration maps are prepared by using the Depth map software throughout the morphological structure of the settlement. Connectivity is measured according to the number of connections of each line. If lines intersect many streets, the connectivity should be high. Segment map analyses are used for choice data. The segment maps analyze the shortest paths that can pass throughout all other areas in the system (Hillier et al., 1987: 217-231). It is a significant analysis for estimating possible pedestrian and vehicle movements.

Grid axiality is a value regarding the grid level of the town plan. It is a measurement based on the grid plan level of a settlement, and it is considered a measure of regularity. In addition, the grid plan level of the area is a parameter that indicates the level of movement of users and the degree of connection between spaces. Its value is between 0 and 1. The value that is close to 1 means that the spatial layout is close to a grid plan type. In contrast to it, a low value indicates that the degree of axial deformation is high. Add to this, if the grid axiality is 0.25 or above, these settlements are accepted, they are in the grid plan system, and the regularity is high. If it is 0.15 or below, it indicates there are grid deformations in the plan system and the settlement has a complex form (Hillier & Hanson, 1984). Grid axiality is calculated with the formula shown below.

Grid axiality = (√ (street blocks) x 2) + 2 / number of axial lines (Hillier & Hanson, 1984).

- Thirdly, Marshall's (2005:96) topological analysis is used for defining the street system. Marshall's approach was developed to determine the morphological structures of cities. This topological method is highly empirical and based on mathematical and geometric parameters. Additionally, thanks to this method, it is possible to determine the typology of a space and to determine the topological similarities or reveal differences between spaces and textures.

This technique was developed to better understand the morphological character or transformation of cities. Marshall developed a diagram and method for the classification of urban typologies using X and T intersections, street blocks (cells), and cul-de-sacs data. The open space systems of urban pattern are expressed with abstract diagrams regardless of nodes, connections, actual length, and size within the framework of Topology, a branch of geometry (Kürkçüoğlu & Ocakçı, 2015: 368). According to the ratio of X and T intersections, as well as the ratio of cells and cul-de-sacs (dead-end streets), the urban plan typology can be determined. According to ratios, the urban plan system can be T-tree, T-cell, X-tree, or X-cell typology according to the number of intersections, dead ends, and cells.

- The fourth step of the paper is analyzing the street system using Marshall's taxonomy of town planning. Marshall (2005: 88) classified the urban plans into four groups, which are called the ABCD typology. The ABCD typology can be explained in terms of composition and configuration. Figure 3 shows ABCD types of town plans and their features of intersection, such as X-T intersections or cul-de-sacs and connectivity.

Marshall (2005:89) explained the ABCD types as below;

Type A refers to irregular and short lines, mixed character of X and T intersections. It contains cul-de-sacs, and this plan type generally has moderate connectivity.

Type B refers to regular, orthogonal, and rectilinear streets. This type does not have cul-de-sacs; X-intersections are seen dominantly, and it has high connectivity.

Type C refers to a mixture of regular and irregular street forms, curved or rectilinear lines. It has a mixture of X and T intersections and a cul-de-sac and has moderate connectivity.

Type D is based on consistent road geometry, branching roads like a tree, and has low connectivity due to a lack of X-intersections. Cul-de-sacs and T-intersections are dominant in this type.

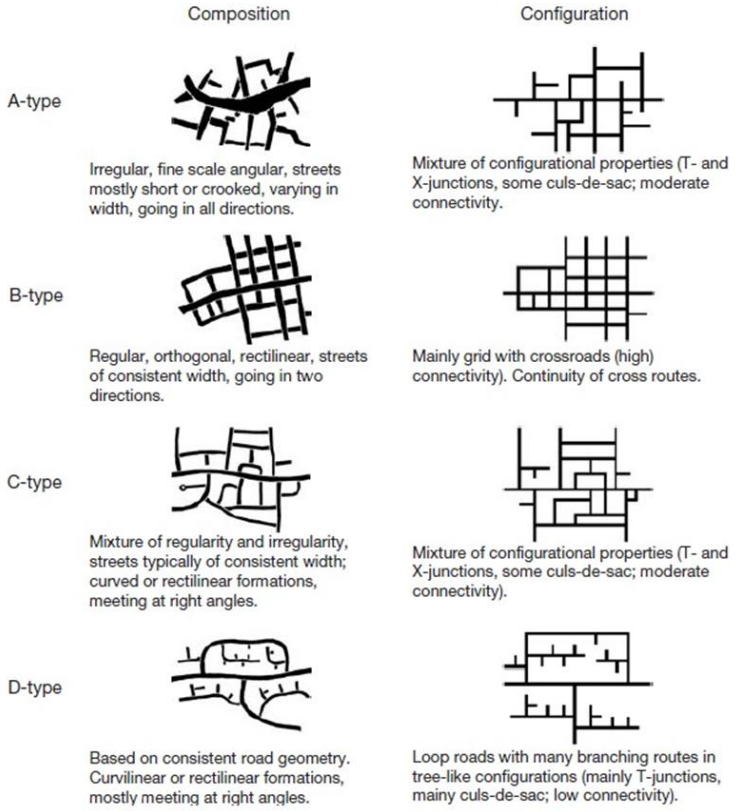


Figure 3. Marshall's taxonomy of ABCD

- As the fifth step, the other urban elements of the Conzenian approach (street blocks and plots) were classified and analyzed in the study. The influence of altering street forms was analyzed by measuring the dimensions of street blocks and classifying them as large, medium, or small for both periods. Also, the changes in size and form of plots were defined. With these measurements and classifications, the transformation of street blocks and plots can be defined, which depends on street geometry.

Classification of the dimensions of street blocks was done into three groups: large, medium, and small. Small blocks refer to 0-1000m^2, large blocks are defined as 8000m^2 and above. Medium-sized blocks are defined as M1 and M2. M1 refers to block sizes between 1000 to 4000m^2, M2 refers to block sizes between 4000 to 8000m^2.

- At the end of the analysis, all findings about all urban elements (streets, blocks, and plots) have been evaluated together, and their interactions with each other have been explained. Findings from using different methods in the study have been combined and interpreted together. Furthermore, the benefits of using different methods for analyzing urban elements and the importance of addressing all of them (street, block, plot) together have been explained according to findings.

RESULTS

The analyzed headings, street system, street blocks, and plots of two different periods of Harput were evaluated into four titles. Hence, the results of the study consist of four headings to represent morphological analysis of the street system, street blocks, and plots. The first one is the space syntax analysis, which includes: integration, connectivity, choice analysis, and the value of grid axiality. The second one is the topological analysis of the street system according to Marshall's approach. The third one is the classification of the settlement plans according to Marshall's town plan taxonomy for understanding the alteration of urban form. The last heading is the analysis of street blocks and plots with measurements and classifications to address the influence of the transformation of street geometry on other urban elements.

Street pattern / Space syntax analysis

The street system of both the 19th century layout (1890s) and the 20th century layout (after 1960s) was analyzed in Depth map software, and the integration, connectivity, and choice analysis of the two periods were mapped and measured. By using Depth map software, the maps of integration, connectivity, and choice analysis are represented in Figure 4. In addition, the minimum, maximum, and average values of this analysis, such as Integration HH, Connectivity, Mean Depth, RA, RAA, Choice R400, and Grid Axiality are shown in Table 1.

Table 1. Measurements of space syntax analysis

	19th century			**1960s**		
	Min.	**Max.**	**Average**	**Min.**	**Max.**	**Average**
Integration HH	0,568	1,66	1	0,736	1,92	1,27
Connectivity	1	12	3,85	1	12	4,63
Mean Depth	3,92	9,59	6,13	3,11	6,52	4,37
RA	0,398	0,639	0,529	0,442	0,703	0,577
RAA	0,599	1,75	1,051	0,520	1,35	0,830
Choice R400	75	16749	2534	7	6359	1359
Grid Axiality	0,116			0,130		

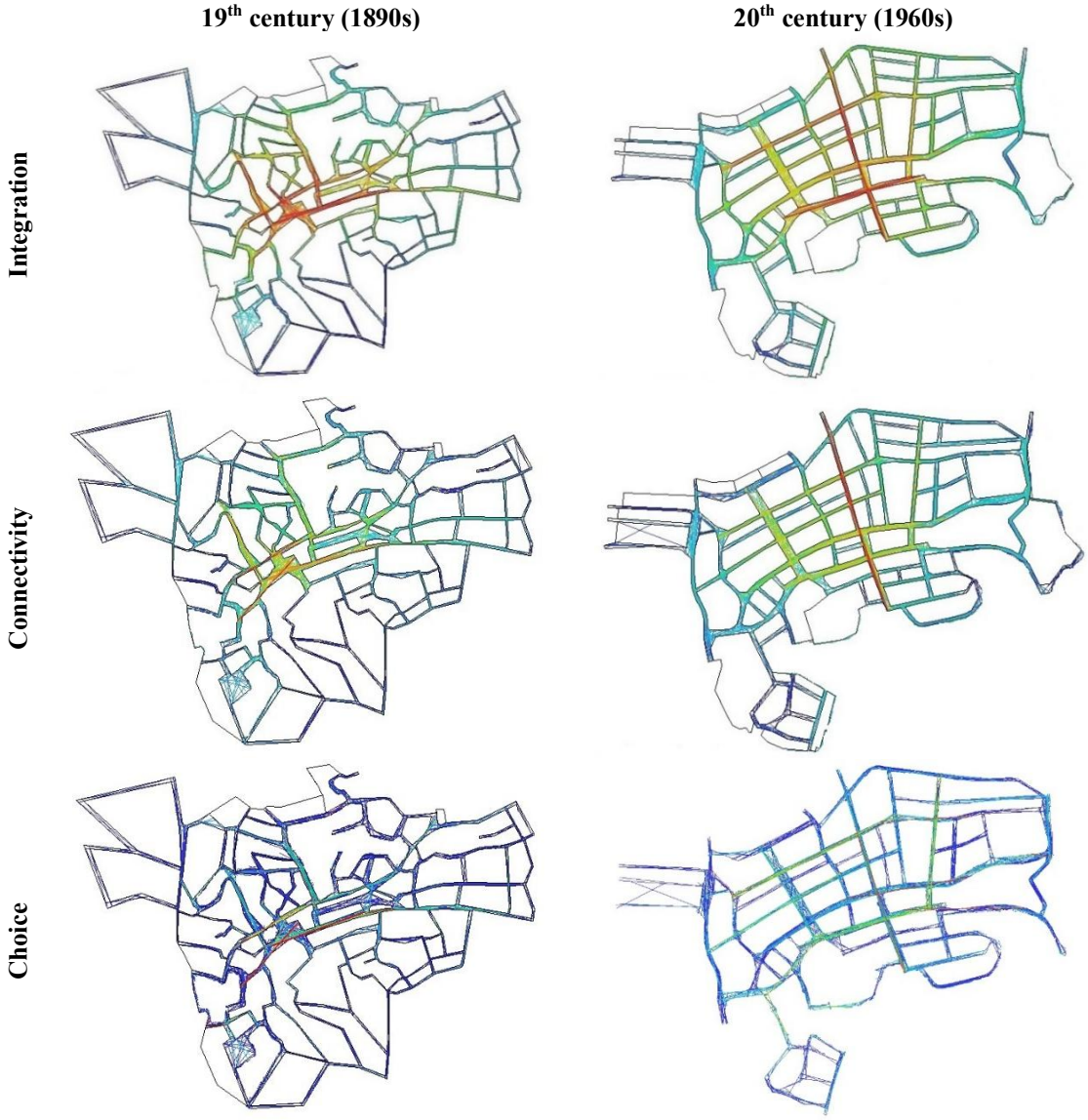


Figure 4. Space syntax analysis maps

According to the integration map and average values of Integration HH, the new plan that was done in the 1960s has a higher integration level than the historical layout. In both maps, the streets that are located in the East-West direction have the highest integration. Even though the form, line length, and connections of East-West streets were changed in the new plan, it continues to be one of the highest integrated lines. Similar to this street, another main street of the area is located in the North-South direction. In both maps, there are the highest integrated lines in the North-South direction. However, the line length and connections of that line were altered in the 1960s plan, and it became a stronger line in terms of integration. In the historical layout of the 19th century (1890s), apart from those highly integrated lines, streets did not have a high level. Mostly, these streets had low integration, and the level of integration decreased towards the periphery. Different from the historical layout, in the 1960s plan, the integration level is moderate, and yellow lines indicate the moderate integration level. Hereby, it refers that the integration of the center of settlement increased during the 20th century, and it has low integration just in the peripheries.

Similar to integration, the average value of connectivity increased in the 20th century after the new plan, and the most connected lines are in the North-South direction. Therefore, this line became the main street of the new plan with its strong integration and connectivity. Different from integration, the connectivity of the new plan varies according to the streets. Even though the 1960 plan has moderate integration for the whole, the connectivity is not moderate for the whole. Just North-South Street has strong connectivity, and few streets have moderate links with other streets that represent yellow lines in the map. Throughout the periphery, the connectivity level decreases because of the lack of street connections. In the historical layout, connectivity was lower than in the new plan, and just the center of the settlement, there was moderate connectivity. In contrast to integration and connectivity, the choice analysis showed that the choice level was higher in the historical layout than new plan. The choice analysis was made according to a radius of 400 (R400) for a local evaluation. According to segment maps, choosing possibilities of streets are shown, and in both maps, there are no high choice values. In historical layout, the highest integrated streets that are parallel to each other and located on East-West have a moderate choice level. In the 1960s plan, the most integrated streets are represented with yellow/green color and which refers moderate choice level. Apart from these streets, other streets have a low choice level.

The grid axiality is an important value that refers to the regularity of the plan structure with calculating street blocks and streets. Grid axiality level was measured for two periods, and it was found to be 0,116 for the historical layout and 0,130 for the 1960s layout. This value is under 0,25 for both periods, and it refers to the plan structure is not close to the grid plan system, and its regularity is low. Nevertheless, although in both periods the plan structures are under 0,25, indicating there are high grid deformations in plan structures, in the new plan the grid axiality level increased. Hence, it means that although the plan is not accepted as a grid, it gets close to a grid layout.

Marshall's topological analyses and town plan taxonomy

In addition to space syntax analysis, the street systems were analyzed according to Marshall's approach, and their topological evaluations were done. Figure 5 shows topological maps of Harput. The maps represent the T and X intersections and also cul-de-sacs (dead-end streets). In Table 2, the number of T and X intersections, cells (street blocks), cul-de-sacs, connections, and routes are shown as the topological results. Furthermore, in the same table, the topological diagrams of the 19th and 20th centuries' layouts are shown.

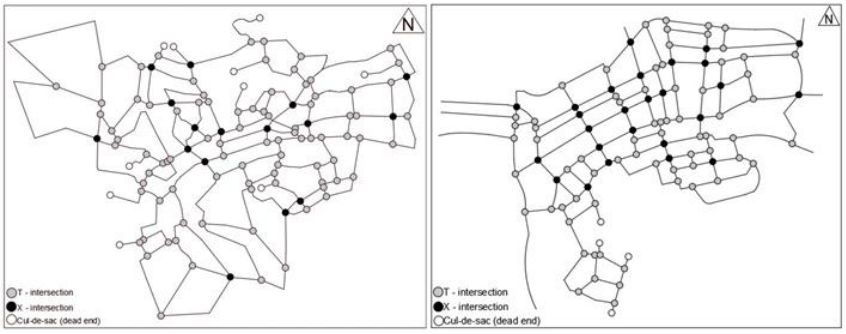
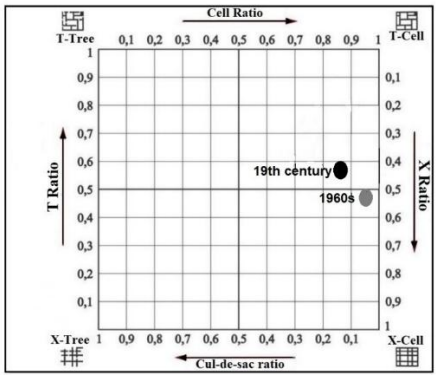


Figure 5. Topological maps /20th century layout (right), 19th century layout (left)

Table 2. Topological results and diagram

	19th cent. Layout	1960s Layout
T – intersection	88	69
X – intersection	16	26
Cell	66	68
Cul-de-sac	10	4
Connection (L)	148	142
Intersection (J)	104	95
Route R=L-J	44	47



The crucial change of topological features is in the ratio of X and T nodes. In both periods, the settlement plans are close to the cell structure because of the excess ratio of cells. In both layouts, even though there are cul-de-sacs, due to the exceeding ratio of cells, structures are accepted in the cells. The ratio of cell structure increased in the 20th century because of the decreasing ratio of dead-end streets. In terms of X and T nodes, the historical plan structure had plenty of T intersections and thus, it is close to the T-Cell structure. In contrast to the historical layout, in the new plan structure, the ratio of X intersections increased, and it gets closer to the X-Cell structure.

Apart from topological findings, the urban forms were also classified according to Marshall's taxonomy. According to Marshall's classification of town plans, the historical layout is close to Type A, and the layout of the 20th century is close to Type C. Type A refers to the organic layouts that have many dead ends and low connections. Type C has a connector main roads and street system developed around the main lines. While the historical layout had irregular and short lines like Type A, the new urban layout gets closer to Type C as it decreases irregular and short lines. However, it still contains regular and irregular streets, though regularity gets high. In terms of intersections, the historical layout (Type A) had dominantly T-intersections and also a mixed character of X-T and cul-de-sacs. In new urban layout (Type C) has a mixed character in terms of X-T and cul-de-sacs, like the historical layout. However, as X-intersections increased, the number of cul-de-sacs decreased, and street forms became more rectilinear.

Street blocks

The form and size of street blocks depend on the street typologies. Thus, the street typology shapes the street blocks and their features. Hereby, while the street system is transformed, street blocks have to be reshaped. For this reason, because of the urban metamorphosis in the historical urban layout of Harput, the dimensions and forms of street blocks have different features. Figure 6 shows both the street blocks' forms and the classification of dimensions. In Table 3, the classification of street block dimensions and the ratio of block types are shown. In the analyses, the dimension of blocks was evaluated into three types: small, medium (M1/M2), and large. The findings indicate, in both periods, most of the blocks have a medium dimension between 1000 to 8000m^2. Most of the medium-sized blocks are between 1,000 and 4,000 m^2, which is defined as M1. In both periods, the M1 ratio of blocks is higher than M2. Hence, it indicates the major blocks' dimensions are between 1000 and 4000m^2 for two periods. While comparing layouts, after the new plan, both small and large types of blocks decreased, and the ratio of medium type blocks increased. It is an important sign for generating similar plan units and similar block types to each other. Because in the 20th century, in terms of both dimension and form of blocks, they became similar to each other. In contrast to the 20th century, in the historical plan, the blocks had a variety of forms and sizes.

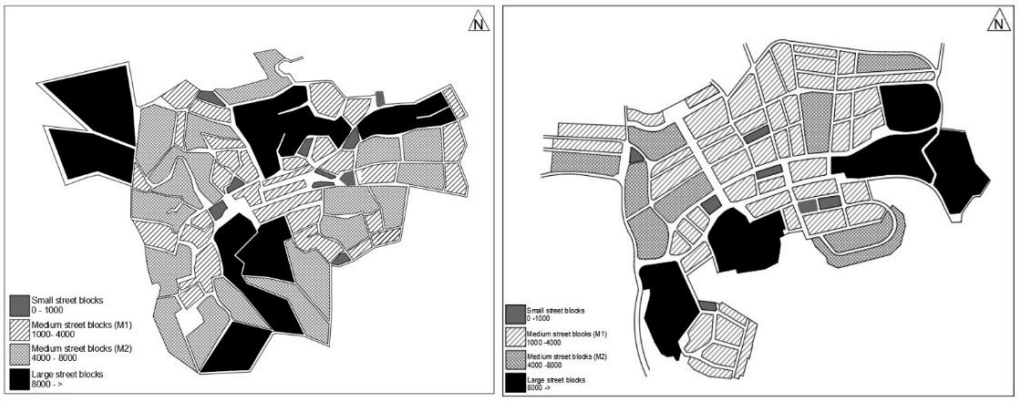


Figure 6. Classification of Street blocks / 1960s (right), 1890s (left)

Table 3. Ratio of dimension of street blocks

	Small	**Medium**		**Large**
	0-1000m²	**M1**	**M2**	**8000m² - >**
		1000-4000m²	4000-8000m²	
19th cent. Layout (1890s)	15,2%	47%	27,2%	10,6%
		74,2%		
20th cent. Layout (1960s)	10,5%	67,1%	16,4%	6%
		83,5%		

Plots

The transformation of street blocks affected the plot's character. Since the old period maps could not be read completely, only some of the plots could have been drawn and evaluated in the historical layout of the 19th century. According to reached data from the historical layout, the plot size ranged between 100m² and 500m². Most of the plots were suitable for a single house. The smallest plot that has been measured was 25m²; thus, these kinds of plot sizes were not provided for enough construction of buildings. Hence, from this data, it can be estimated that some houses covered more than one plot. Also, these very small plots could be a result of property rights. In terms of plot form, although the blocks had organic forms, plots had regular forms such as rectangular or foursquare form. In the new plan of the 20th century, the plot sizes are similar to previous period. The plot dimensions differ between 200m² and 450m² in general. Different from the previous layout, the smallest plots were removed completely, and the smallest plots are not under approximately 200m². Regarding both dimension and form of plots, the new layout was planned to be balanced, in that dimension and form are similar to each other. The large plots of the 1960s layout have specific land uses: green area/parks, education/school zone, or a historical site that has historical monuments. While altering plot character depends on street and block geometries generates not only a new physical plot pattern, it also changes cadastral features and ownership status.

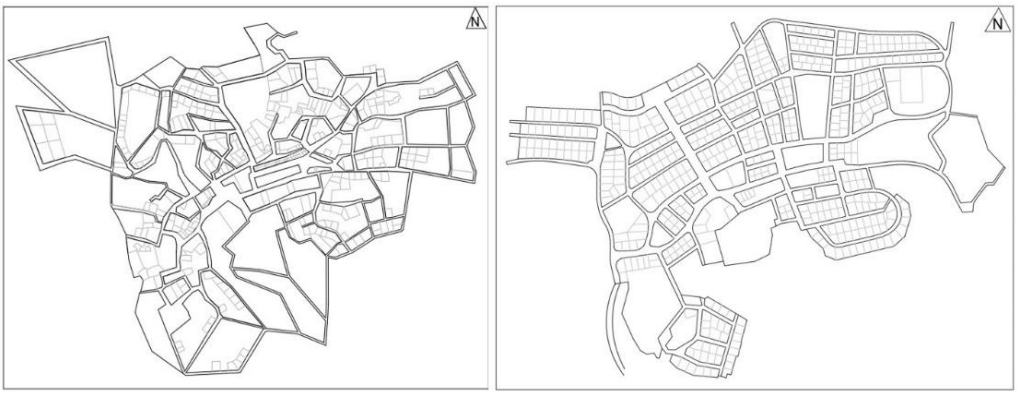


Figure 7. Plots / 1960s layout (right), 1890s layout (left)

CONCLUSION

Evaluation of findings

The study has important outputs for indicating hierarchical influences of urban elements. The findings point out that the transformation of urban elements, especially street typology, has a chain effect that causes other urban elements to transform as well. This paper also remarks, urban metamorphosis in historical towns has a crucial role in the sustainability of historical identity. Due to physical transformations in Harput, the historical identity could not be sustained. The study also has essential findings since it sheds light on morphological evolution and the historical background of the settlement with different methods.

Especially, analyzing and interpreting the street forms with both Space Syntax and Marshall's topological analysis provides a comprehensive evaluation. These two methods that provide for analyzing street patterns have both common and different points. Movement, regularity, and connectivity analysis of Space Syntax were interpreted with topological findings. Hence, validation of some data can be done by using two methods. For instance, topological results were interpreted with grid axiality and connectivity. On the other hand, while Space Syntax focuses on movement, regularity, density, and integration of streets, topological analysis addresses the issue by intersections, cells, and cul-de-sacs. Thus, for the same urban element, different evaluations could be done. While these two methods focus predominantly on streets, for a holistic analysis of urban elements, measurements, and classifications of blocks and plots were also handled in the study. Their results were associated with findings of the street pattern. It is concluded that there are different types of urban elements; for this reason, to comprehensively analyze and explain the hierarchical relation between them, different methods should be used in the same study.

In terms of the case study, the plan structure of Harput was dramatically changed in the 1960s. The plan had been changed easily as civil architectural buildings had been demolished over time, and only monumental buildings remained standing. When the street structure was interpreted together with Space Syntax and topological analyses, it was seen that the plan structure became more regular over time. Although the grid axiality value was below 0.25 in both periods, the increase in the value in the 1960s indicates, the regularity level of the plan increased. In addition, in topological analysis, decreasing the ratio of T-intersections increased the ratio of X-intersections in the new plan, which was interpreted as another reason. The increase in X nodes is also associated with an increase in the connectivity level. On the other hand, the increase in X-nodes has been interpreted as a factor that increases the integration and connectivity levels of the settlement. This finding shows that the accessibility level and X nodes can be directly proportional. One of the surprising results of the study is that, despite the organic plan structure of the 19th century, the number of dead-end streets is low, and the topological structure was a cell form in both periods. Another surprising result is from choice analysis. The segment maps (choice analysis) have a lower degree in the 20th century's layout than the historical layout. This result shows that although organic plan structures are more complex, they provide more possibilities for movement.

While evaluating the layouts according to Marshall's taxonomy, the historical layout is Type A, and it refers to organic and irregular plan structures. These morphological features of Type A validate the topological data, grid axiality value, and integration value of that time period. Type A layouts are organic and irregular plan structures; thus, the low value of grid axiality, integration, and a low number of X-nodes support to this plan structure. According to Marshall's taxonomy, the new layout is Type C. When comparing the morphological features of Type C with Space Syntax and topological analysis, it is seen that the level of integration, regularity, and X-nodes increased, which reflects a more regular plan type like Type C. In contrast to Type A, Type C contains generally geometrical street blocks and plots that have similar forms and size. It shows the transformation of Harput's layout from Type A to Type C.

Since the morphology of street blocks depends on the street typology, they were completely changed with the transformation of the street typology. While the street blocks in the 19th century were generally amorphous and had different sizes due to the streets being shaped according to the topography, in the 1960s, they emerged with similar forms and sizes. Merely the large street blocks in the new plan seem different from other blocks because of their specific land usages, such as historical sites, school zones, or green areas. The increasing ratio of medium-sized blocks in the 20th century indicates, the plan units are becoming similar in terms of size and

form. This is one of the main differences between the historical and modern layout of Harput. It is an essential alteration of urban form because each street block works as a plan unit; therefore, the similarity or variety of them influences and shapes the plots and building typologies. In other words, the similarity or diversification of street block typology causes the similarities or differentiations of plots and building typologies. Hence, the modern plan layout of the 20th century was formed mostly with homogenous plan units.

The plots have geometric forms in both periods, even though the street blocks did not have completely geometric forms in the 19th century. The main difference plots of between two periods is the minimum dimension of the plots and the estimated building coverages. In contrast to the 19th century, the minimum dimension of plots in the 20th century is not below 200m^2. Thus, this means that building coverage was differentiated during the time.

Recommendations

These findings can be used for future planning and design practices. These kinds of morphological analysis are targeted to be a guide for future applications. Within this scope, understanding of the current situation and transformations has vital importance to show how new plans and design codes should be produced. This town not only works as a historical urban settlement of the city, but it also works as a livable district of the city that contains schools, a convention center, mosques, restaurants, and green open spaces. Hence, especially these kinds of historical towns that continue to work as today's urban places are continued to physical and functional alterations. In other words, urban metamorphosis is continuing in these kinds of towns, which work as a part of today's cities. For this reason, making the most convenient planning and design decisions in these areas, both previous and current morphological analyses have to be used for integrating them into today's cities, with conservation of historical identity as well. For instance, with the help of integration, connectivity, and choice analysis, land use should be decided or changed. New functions can be added according to these results.

Also, for revitalizing the historical identity, the traces of historical urban layout can be used in future designs and plans. Because with the transformation of the town plan, the urban memory was lost. For this reason, for revitalizing the urban memory, some of the significant physical elements of the historical layout can be used as a trace for future designs. For instance, historical paths/streets, open spaces can be revitalized in future designs. Moreover, these data could be a guide for conservation applications. These kinds of morphological analysis should be integrated into processes of planning and design for reaching continuity of both historical identity and also integrating with today's urban fabric. Lastly, if some data on buildings of previous periods can be reached, these results can be used as a base for future analysis, such as analyzing relationships between blocks/plots and architectural typology or the influence of social and climatic factors on urban form.

Author's Contributions

The author contributed 100% to the study.

Competing Interests

There is no potential conflict of interest.

Ethics Committee Declaration

This study does not require ethics committee approval.

REFERENCES

Ardıçoğlu, N. (1997). *Harput tarihi.* Elazığ Eğitim, Sanat, Kültür, Araştırma, Tanıtma ve Hizmet Vakfı Yayınları.

Batty, M. (2022). Integrating space syntax with spatial interaction. *Urban Informatics, 1*(4). https://doi.org/10.1007/s44212-022-00004-2

Bilsel, C. (2018, October 31-November 2). *Urban morphology and architectural approaches on reproduction of urban spaces: Paris* [Conference presentation]. II. Symposium of urban morphology, ITU, İstanbul.

Conzen, M. (1960). *Alnwick, Northumberland: a study in town-plan analysis*. Institute of British Geographers.

Gebauer, M., Samuels, I. (1983). *Urban morphology: An introduction* (Joint Centre for Urban Design Research Note No. 8). Oxford Polytechnic.

Hillier, B. (1998). *The common language of space*. Bartlett School of Graduate Studies, University College London. www.spacesyntax.org (26.02.2008).

Hillier, B., Hanson, J. (1984). *The social logic of space*. Cambridge University Press.

Hillier, B., Hanson, J., Peponis, J., Hudson, J., Burdett, R. (1983). Space syntax: A new urban perspective. *Architects Journal,* (178), 47-63.

Hillier, W., Hanson, J. and Peponis, J. (1987). Syntactic analysis of settlements. *Architecture et Comportement/Architecture and Behaviour, 3*(3), 217-231.

Kiziroğlu, İ. (2022). Harput ve çevresi tarihi. *Tarih Araştırmaları Dergisi*, *41*(72), 31-53.

Kropf, K. (2009). Aspects of urban form. Urban Morphology, *13*(2), 105-120. http://dx.doi.org/10.51347/jum.v13i2.3949

Kropf, K., Malfroy, S. (2013). What is urban morphology supposed to be about? Specialization and the growth of a discipline. *Urban Morphology, 17*(2), 128-131.

KTB. (1983). *2863 Kültür ve Tabiat Varlıklarını Koruma Kanunu.* Republic of Türkiye Ministry of Culture and Tourism. www.kultur.gov.tr (28.03.2023).

Kürkçüoğlu, İ. E., Ocakçı, M. (2015). Kentsel dokuda mekânsal yönelme üzerine bir algı-davranış çalışması: Kadıköy Çarşı Bölgesi. *Megaron Journal*, *10*(3), 365-388.

Madran, E. (2009, 5-9 June). Geçmişten günümüze Harput mimarisi Paneli/Forum, Elazığ. TMMOB Mimarlar Odası Elazığ Şubesi.

Marshall, S. (2005). *Streets and patterns.* Spon Press.

Moudon, A.V. (1997). Urban morphology as an emerging interdisciplinary field: Morphology. *Urban Morphology, 1*(1), 3-10. https://doi.org/10.51347/jum.v1i1.4047

Oliveira, V. (2021). *Morphological research in planning, urban design and architecture.* Springer.

Oliveira, V. (2022). *Urban morphology an introduction to the study of the physical form of cities* (Second edition). Springer International Publishing.

Öztürk, T. (2013, 23-25 May). *Harput'ta yapılan restorasyon çalışmaları* [Sempozyum sunumu]. Geçmişten Geleceğe Harput Sempozyumu, Elazığ.

Sevin, V., Arslan Sevin, N., Kalsen, H. (2011). Harput iç kale Osmanlı mahalle kazısı 2008 yılı çalışmaları. *KST*, 373-392.

Slater, T. R. A. (1983). *Medieval new town and port: The plan analysis of Hedon, East Yorkshire*. Department of Geography. University of Birmingham.

Topçu, M., Kubat, S. (2007, 12-15 Haziran). Morphological comparison of two historical Anatolian towns [Conference presentation]. *6th International Space Syntax Symposium*, İstanbul.

UNESCO. (2018). *Historic city of Harput*. UNESCO. https://whc.unesco.org/en/tentativelists/6349/ (14.04.2024).

Ünlü, T., Baş, Y. (2015, 22-23 October). Mersin'de morfolojik süreçlerin değerlendirilmesi [Conference presentation]. *Türkiye Kentsel Morfoloji Sempozyumu*, Mersin.

Whitehand, J. W. R. (2007, 12-15 Haziran). Conzenian urban morphology and urban landscapes [Conference presentation]. *6th International Space Syntax Symposium*, İstanbul.

Whitehand, J. W. R., Larkham, P. J. (2000). *Urban landscapes: International perspectives*. Routledge.

Yamu, C., Van Nes, A., Garau, C. (2021). Bill Hillier's legacy: Space syntax a synopsis of basic concepts, measures, and empirical application. *Sustainability, 13*, 3394.

Figure References

Figure 1: Author's personal archive (above photos),

Anonymous. (2025). Harput'un tarihi. https://harput.web.tr/harputun-tarihi/ (02.05.2025) (below photos)

Figure 3: Marshall, S. (2005). *Streets and patterns*. Spon Press.

Author's Biography

Rüya Ardıçoğlu received the bachelor degree at Bilkent University, Department of Urban Design and Landscape Architecture in 2012. The master degree was received in 2014 and her PhD study was completed in 2019 at Ankara University. She works as an assistant professor at Fırat University Faculty of Architecture. She had been at Universidade do Porto in 2024 as visitor researcher. Her research interests are urban design, urban morphology, spatial analysis, accessibility, urban landscape and historical environments.