Framework for Analysing Urban Form by Using Historico-geographical and Configurational Approaches on the Case of Famagusta Commercial Street Network

Mitra Allahmoradi

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Prof. Dr. Ali Hakan Ulusoy
Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Doctor of Philosophy in Architecture.

Prof. Dr. Resmiye Alpar Atun
Chair, Department of Architecture

We certify that we have read this thesis and that in our opinion it is fully adequate in scope and quality as a thesis for the degree of Doctor of Philosophy in Architecture.

Assoc. Prof. Dr. Nevter Zafer Cömert
Supervisor

Examining Committee

1. Prof. Dr. Vitor Oliveira
2. Prof. Dr. Fazilet Duygu Saban
3. Assoc. Prof. Dr. Nevter Zafer Cömert
4. Asst. Prof. Dr. Vedat Çağanağa
5. Asst. Prof. Dr. Pınar Uluçay

ABSTRACT

Coordinating and comparing different approaches to urban morphology is recognized as one of the most important lines of research in urban form. This study places emphasis on two different analytical approaches to urban morphology: the historico-geographical approach based on Conzenian tradition and the configurational approach based on space syntax theory. However, considerable efforts have been made to coordinate and combine different approaches to urban morphology. This thesis presents a complementary framework by applying the historico-geographical and configurational approaches, comparing them, and proposing a coordinated combined methodology to achieve a better comprehension of the evolution of the urban form, specifically, the street formation and transformation of Famagusta city. The results confirm that the combination of these two approaches is capable of providing an enhanced understanding of the historical transformation of urban form. Fundamentally, the historico-geographical character and configuration of the town are determined by socio-economic activities. Within this context, both approaches identify the historical patterns of urban form as the key element to comprehend the relationship between socio-economic activity and urban form, which are both configurational and historical. Also, this complementary framework is tested on Famagusta commercial street network in order to apprehend the framework with better understanding.

Keywords: Morphological approaches, historico-geographical approach, configurational approach, space syntax, street network, Famagusta

ÖZ

Kentsel form çalışmalarında farklı morfolojik yaklaşımların karşılaştırmalı araştırmaları günümüzdeki çalışmalarda önem kazanmıştır. Bu tez, kentsel morfolojik çalışmalardaki iki farklı analitik yaklaşımın; MRG Conzen geleneğinden gelen tarihi-coğrafi yaklaşım ve kofigurasyon geleneğinden gelen mekan dizin teorisini bir birini tamamlayıcı yöntemle ölçülmesini hedefler. Bu çalışmanın diğer hedefi ise kentsel morfolojiye yönelik farklı yaklaşımları entegre ederek karşılaştırmayı hedeflemektedir. Bunun yanında bu karşılaştırmalı yöntem tarihi coğrafi ve konfigurasyonel yaklaşımların kentsel formun üzerine etkilerinin gelişimini de bu yöntemler üzerinde araştırır. Bu bağlamda, iki yaklaşımın entegre edilmesi ile, kentsel formun tarihsel dönüşümünün daha iyi anlaşılmasının sağlanabileceği Gazimağusa ticari sokak örüntüsü üzerinde test edilerek her iki yöntemin bir birini tamamlayarak kentin ticari sokaklarının tarihi-coğrafi yöntem ile morfolojik gelişimi ve mekan dizini yöntemi ile sosyo-ekonomik faaliyetlerin analizi yapılmıştır. Bu bağlamda, her iki yaklaşımın kentsel formun tarihsel örüntülerini, sosyo-ekonomik aktivite ile kentsel form arasındaki hem konfigürasyonel hem de tarihsel bağlamda oluşturulan ilişkiyi kurmak için gerekli verilerin sağlandığını göstermektedir.

Anahtar Kelimeler: Morfolojik yaklaşımlar, tarihsel-coğrafi yaklaşım, konfigürasyonel yaklaşım, mekan dizini, sokak ağı, Gazimağusa

DEDICATION

Most significantly, I would like to express a deep sense of gratitude and appreciation to my dear parents and my brother and sisters for supporting me spiritually and financially throughout my Ph.D. study and my life in general. I owe a huge debt of gratitude to my dearest darling mom, who has always supported me like a pillar and I owe my life to her love, blessing, encouragement, and moral support. Thank you for the unconditional support and for teaching me to continuously pursue my goals. My family is my inspiration and roots to keep moving forward. My achievement is dedicated to my great Family.

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INTRODUCTION

Urban form is generally understood in terms of urban morphology as the chief physical components structuring and forming the city – urban fabrics, squares, streets, urban plots, and constructions (Oliveira, 2016). Urban formation relies on the effect of ideological flow and the historical accumulation of urban elements as social, economic, and political causes change over time. Urban change cannot be seen as separate from the urban fabric; both are the result of the history of a region and the way of life of its inhabitants (Han, 2015). Urban morphology is the examination of social settlements, their organization, and the process of their expansion and evolution. Urban morphology explores the relationships of the city's physical form, spatial configuration, and structure through four principles of urban form that imply the urban texture (Lévy, 1999) which are: buildings; plots or parcels; streets, and open space (Moudon, 1997 and Oliveria, 2013).

Urban morphology offers a variety of concepts and techniques that convey the different features of urban form, the interactions between them, and the role of us as the specialists who produce, transform and use them (Kropf, 2017). The physical form of cities affects the main socio-economic and environmental aspects of our lives. Understanding this effect depends on the availability of efficient and specific morphological approaches to deal with the main elements of the urban form. Attempts to describe, explain and dictate the various and complex physical forms of cities are

articulated through a range of morphological approaches (Oliveira, and Medeiros, 2016). Currently, there are different approaches in urban morphology, each of them concentrating on disparate facets of urban form and methods and techniques. Configurational and typo-morphological methods originate from the discipline of architecture and urbanism; however, spatial analytical and historico-geographical approaches originate from the field of geography (Kropf, 2017). Regardless of the distinctions between the major approaches that have emerged separately over the last several decades, there is a common basis for the development of comparative research. It is possible to compare different morphological approaches, focus on their features and similarities, and promote communication between them to create a complementary framework by comparing the morphological approaches and physical knowledge provided by an integrated approach.

In the past decade, there have been some efforts to combine and compare historico-geographical and configurational approaches to urban morphology (Pinho and Oliveira, 2009; Kropf, 2009; Griffiths et al., 2010; Oliveira et al., 2015; Kropf, 2017; Monteiro & Pinho, 2021; Li and Zhang, 2021). Pinho and Oliveira (2009) have studied the evolution of the urban form of Porto, Portugal over the last two centuries, combining Conzenian and space syntax approaches. Similarly, Griffiths et al. (2010) combine these two approaches, within an integrated GIS environment, to analyze the persistence of suburban centers in Greater London, UK. Other authors have explored the conceptual articulation of different morphological ideas. The historico-geographical approach is rooted in the work of M. R. G. Conzen. The town plan of Conzen as set out in his initial Alnwick (1969) investigation is to describe the geographical organization and personality of cities by the methodical examination of their constituent parts and growth over time (Kropf, 2009). Town-plan assessment

explores the configurations of streets, plots, and structures of towns (Conzen, 2018) on one hand. On the other hand, configurational analyses represented by the method of syntax allow the modeling of a city, which connects science and intuition, and can be used for city designing and planning as described by Bill Hillier (Hillier, 2009). Griffiths et al. (2010) and Oliveira (2013) have brought together the trilateral division of the historico-geographical approach (town plan, building fabric, and land and building utilization) with space syntax.

The first methodology applied to the suburbs of London evaluated the configurational and historical relationship, and the suburban built form and socioeconomic activity. The second, named Morpho, assesses the urbanity of urban areas based on the analysis of patterns of combination between streets (space syntax has a methodological utilization), street blocks, plots, and buildings (Oliveira 2013; Oliveira, Medeiros, and Corgo 2020). Recently, Kropf (2017) developed the structural overlap that allows combining the concept of the urban tissue and configurational analysis. The author emphasizes the benefits of this combination, as configuration provides a basis for identifying types of urban tissues to establish a more specific context for configurational measures. Although there are different and consolidated views to understand, explain and design urban form, urban morphology can go beyond those views through comparison and development of new composite views. Research studies have focused largely upon how the historico-geographical and configurational approaches in combination can help to better elucidate the historical process of urban form.

1.1 Research Problem

Today, one of the most important challenges in the study of urban form is to share different field boundaries, to establish the association and combination between different morphological approaches and the development of complementary approaches, and the efficient communication of different morphological approaches. There is a great opportunity to explore the complementary potential of the various historico-geographical and configurational traditions for research coordination. While substantial attempts have been made to address this issue over the last few years, the gaps remain largely unbridged. In the other words, there have been distinguished efforts to combine and coordinate the historico-geographical and configurational approaches to urban morphology.

However, a new complementary framework that can provide a combination of the two approaches is not yet fully understood, especially in the case of the historical evolution of the urban form. This gap can be addressed, in part at least, by overlapping the cartographic representation of historico-geographical analysis and configuration patterns of street networks. In this context, the challenge for urban researchers today is not how to distinguish these methods, but how to combine and coordinate them. Because of the intricate essence of cities, it is challenging to contend that any single urban morphological method can fully address all the challenges of this complexity to achieve the objectives of urban morphology. It may be that in specific situations one methodology could deal with superior information development, whereas in other situations a dissimilar approach could be more applicable. This study focuses on the potential of applying the configurational approach with the historico-geographical tradition as a complementary framework

to the analysis of the urban form of Famagusta city, to enrich the understanding of its evolution. One of the major complications in applying historical-geographical and configuration methods in association or comparison to one another is finding shared hypothetical backgrounds. Accordingly, we shall thus first consider their theoretical foundations to achieve a sounder and more efficient synthesis of the two approaches. Therefore, there is the possibility for the complementary relationship among historico-geographical and configurational methods to signify a chance for association in urban morphological studies. The lack of attention to historical growth of built-up forms in the configuration method can be regulated by the historico-geographical tradition and, in addition, the incomprehension of the role of the comprehensive analysis for the street network in the alteration of urban forms in the Conzenian method can be rectified through the configurational studies.

In particular, while analyzing the streets which are the most important elements in the urban context, the single method will not be sufficient to evaluate the morphological data about the streets. Also, it is important to know how the existence of street networks relates to traditional Conzenian work is the unexplored part of the research to which space syntax will contribute. This thesis presents a 'complementary framework' for analyzing urban form by utilizing the historico-geographical and configurational approaches of urban morphology. In particular, there is no obstacle in conceptualizing that two approaches can be combined. Rather, it puts particular emphasis on how both approaches can complement each other to better understanding the historical growth of the urban form with visions into the formation of the streets. A closer look at professional practice and scientific investigation concerning the planning and management of historic towns expressively reveals the absence of complementary approaches for urban

morphological analysis to understand the evolutionary procedure of its physical form. However, urban form has been studied in a variety of disciplines; historico-geographical and configurational approaches as a framework have never involved sufficient scientific attention to creating either literature or textbooks for the undeveloped review. Partly due to this, but also for other reasons, such as the diversity of relevant research and the inherent complexity of the subject matter, a comprehensive body of theoretical-methodological is lacking. In morphological studies, one of the most typical elements of the urban form is the street network. The main focus of configuration approach research is usually on the configuration structure of cities, especially their street networks. Traditionally, the key investigation object of the historico-geographical approach investigates foundation and development procedures through the configurations of roads, plots, and constructions created over time, and paid particular attention to the evolution of the city. Consequently, this study worked on the historico-geographical and configurational method as a single model.

1.2 Aim and Objectives

The diversity and complexity of the physical form of cities are reflected in the variety of morphological approaches to describe, explain and prescribe it. A number of approaches have been recognized to understand the urban form in recent decades that respond to the complexity and diversity of human settlements and socio-economic factors. There is a possibility to compare different morphological approaches, focusing on their similarities and specificities, and promoting connections to support each other to build a complementary framework by the comparison of morphological approaches and physical knowledge given by a complementary methodology. The overall aim of this study is to achieve a better

understanding of urban form and street networks by using the historico-geographical approach and configurational approach on urban morphology, comparing them, and proposing a coordinated combined framework. Through the comparison of morphological approaches (historico-geographical and configurational) and physical knowledge given by a combined approach, this thesis seeks to achieve the benefits of a combined view.

Given the fundamental difference between the two viewpoints, especially in terms of the complementary qualitative and quantitative existence, communication between them has been neither easy nor straightforward, resulting from their different disciplinary traditions and theoretical grounding. The proposed combination of these two approaches is based on an appraisal of their theoretical deductions to achieve a stronger and more efficient combination of the two traditions. This study addresses whether the proposed complementary framework of these two approaches enables a better comprehension of the evolution of Famagusta city and whether socio-economic activities directly affect the physical form of the city. Accordingly, it is suggested that this complementary framework helps a further comprehension of the morphology of the street network at different geographies and can provide a base to develop comparative studies. In addition, according to space syntax studies that focus on the association between urban spaces and movement, the current study attempts to assess the impacts of the street network and urban form on accessibility and movement. Within the historico-geographical approaches, this thesis also focuses on the evolutionary procedures of urban forms. Furthermore, this study investigates the street network system, identifies its effective role in the investigation of the progress of urban form, and understands how configurational studies uncover the hierarchical patterns of urban street networks. One of the basic

elements for evaluating the urban form is the street network. The configurational method takes route structure measurements to determine the characteristics of various configurations. Beyond the general aim of the study, there are four research objectives. These are:

- To investigate urban form and street network evolution through a combined coordinated methodology.
- To develop a structural overlap to combine space syntax measures with historico-geographical tradition.
- To combine these two approaches, within an integrated methodology to investigate the selected cases and compare them to achieve a better insight of urban form in relation to syntactic measures and morphological region and socio-economic activities.
- To explore the concept of accessibility in the case study through space syntax analysis.

First, First, it is crucial to understand the concept, aspects, and approaches to urban form and then understand the street patterns of the city to achieve these goals and to read the urban form via historico-geographical and configurational studies to be able to evaluate the objectives through elements of urban form. Therefore, this study expects the following study questions to be answered:

1.3 Research Questions

This study, therefore, presupposes that the primary research question should be answered:

Would it be possible to apply a complementary methodology of historico-geographical and configurational to analyzing the urban form in line with a street

network by applying the two approaches, comparing them, and proposing a coordinated combined methodology?

This study assumes that the following sub-research issues are inspired by the latest researches in the urban morphology field (Pinho and Oliveira, 2009; Kropf, 2009; Griffiths et al., 2010; Oliveira et al., 2015; Kropf, 2017; Monteiro & Pinho, 2021; Li and Zhang, 2021) aimed at combining both qualitative and quantitative approaches in the urban morphology studies:

- How to read the urban form and its expansion of the city over time through a coordinated combined methodology?
- How can a coordinated combined approach help to understand the process of urban formation and transformation?
- What is the relationship between street networks, urban form with the concept of accessibility?
- What is the association between socio-economic activity and urban form?

1.4 Methodology of Research

First, this study seeks to build a methodological structure to explore the ideas by discussing the current literature, theories, and approaches to consider urban form through a complementary approach to historico-geography and configuration. One of the main objectives of this study is to develop a mixed-methodological approach to assess the impact of the street network on the evolution of urban form. It also aims to provide additional information and insights that will help us to better understand the urban form.

Table 1 shows the methodological framework planned to respond to the research queries of this study. This exploratory study seeks to identify the significant relationships between the approaches and processes within the reviewed scope of urban morphological analysis, the historico-geographical approach, and the configurational approach. This thesis uses primary and secondary data collected through a combination of different sources of secondary research based on qualitative and quantitative analysis of urban forms and street networks. The literature was drawn from books, thesis, and articles available through online databases and published between 1960 and 2021.

The basis for qualitative research is a study of the historical period, a study of the case study maps, the shape, the size, and most importantly, a study of their origin and how their street patterns have emerged and transformed. In addition, quantitative and qualitative methods are developed by using morphological measures to analyze urban form based on a limited number of street network indices. These indices can help us to identify and distinguish the physical characteristics of the particular urban structure (arrangement of development streets, plots, and the block-plans of buildings) by using quantitative measures. Quantitative methods will be used to cover the physical aspects of urban space.

The diachronic approach to urban form aimed to develop an understanding of the explanation of the evolution of urban form. This process mainly circulates about the historico-geographical approach of Conzen's (1960) town-plan and townscape analysis. Analyzing urban forms by complementary relationships of two approaches built a methodological outline to develop the urban morphological analysis. This thesis, by applying the two approaches, comparing them, and proposing a

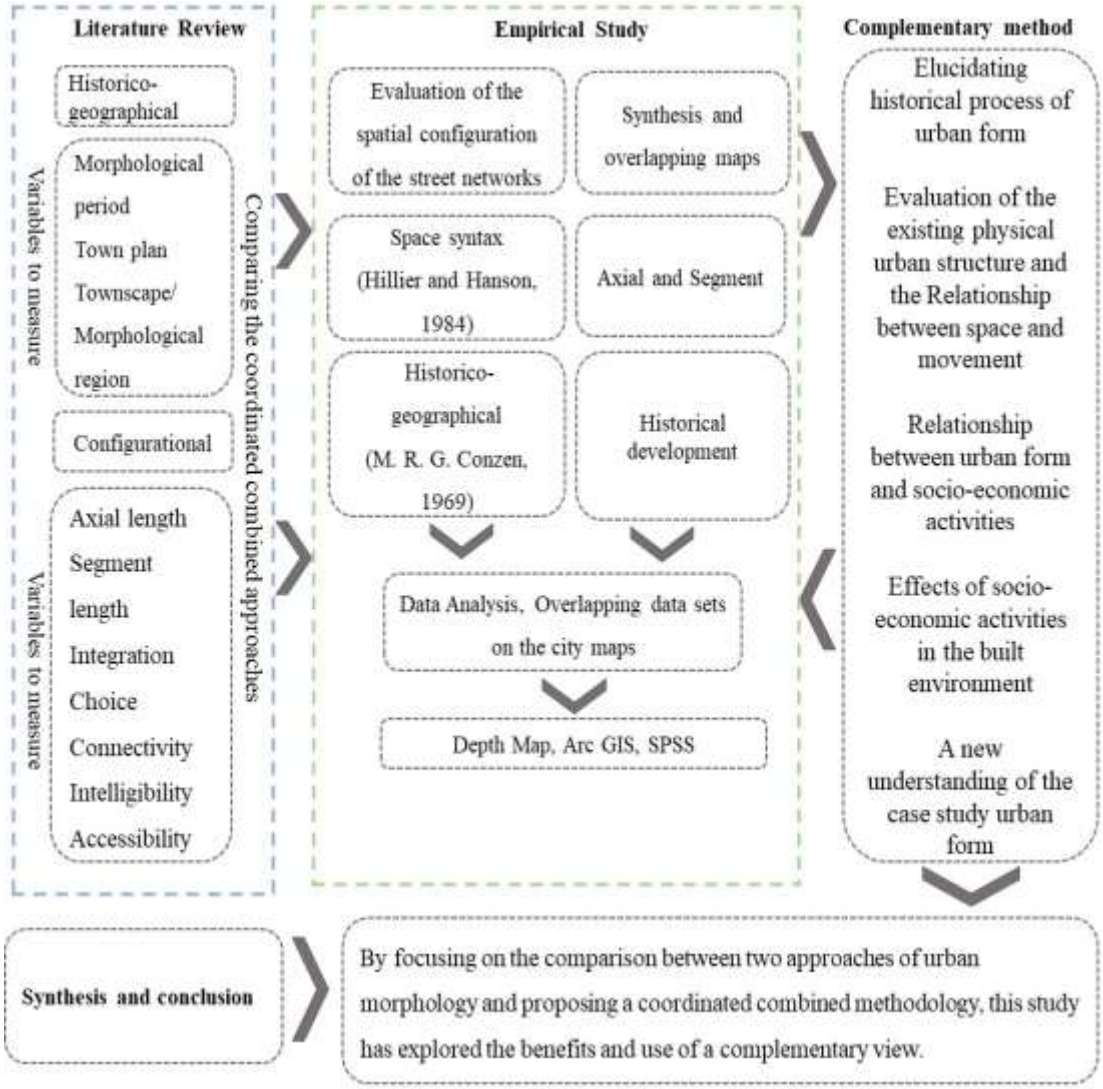
coordinated combined methodology, promises an enhanced analysis of the relations between the morphological region and spatial configuration in which it becomes possible to designate the association between the street networks, its spatial configuration, and the socio-economic activities during different eras. In other words, this study provides an understanding of how various morphological regions and plan units are associated in terms of spatial configuration.

The identification of plan units is based on the town plan features and the comprehensive examination of connective relations of the building block plans, streets, and building lines, orientation, size, shape, and combination of plots. The combination of these components describes the urban patterns that support the demarcation of the diverse morphological plan units which is the main product of the historico-geographical approach. Space syntax can efficiently evaluate the spatial configuration of the street networks. However, this method alone cannot discover all of the morphological patterns recognized in traditional morphological studies. To estimate the spatial relationships of street networks, a number of measurements are applied within the quantification of accessibility. The topological and metrics measures accordingly supply a procedure to compare street networks of cities. In addition, space syntax was used to comprehend the association between space and movement based on axial and segment maps through syntactic measures such as; integration value (to-movement), choice (through-movement), connectivity, and intelligibility (as the connection between connectivity and global integration) are the topological and metrics measurements discussed in this study. Meanwhile, since street network and urban pattern identification are essential in understanding how spatial relationships and network patterns are closely linked, a clear analysis of patterns should be made. The quantitative investigation of this study consists of two

different methods: first, the execution and analysis of axial and segment lines in DepthMap software (version 10, UCL) using space syntax theory. Secondly, this study calculates the correlation between different variables by SPSS for statistical analysis.

The space syntax technique is used to compute built-up space features and is an objective technique to measure the accessibility of spatial configurations. The examination studies the configurations of space by defining cities as a constant network of spaces. The key research approaches for the historico-geographical approach contain comparative analysis based on historical maps, plans, photographs, and examinations of the existing physical fabric (Gu & Zhang, 2014). Research in this direction focuses mostly on comprehending the process of urban transformation in an area from the perspective of historical evolution. In recent years, using Geographic Information Systems (GIS) has helped to collect data and quantitatively analyze urban morphology investigations, which can facilitate the historico-geographical approach as a complementary tool.

Table 1: The methodological framework for the research



1.5 Limitation

The morphological changes in the city of Famagusta have undergone several changes throughout history due to socio-economic, political issues, and physical factors that have affected the evolution of the city in terms of street networks and building blocks. Based on the objectives of this study, by applying the two approaches, comparing them, and proposing a coordinated combined methodology, an attempt is made to study the urban morphology throughout history under the influence of different periods, each of which had its characteristics. Therefore, this thesis is intended to examine the past, discussing the presence of urban form in order to formulate

recommendations and advice for future morphological studies in this regard. One of the restrictions of this research is the lack of availability of historical maps, data, and resources especially digital maps and data for the whole of the city. In addition, the city of Famagusta, due to its proximity to the abandoned city of Varosha from the south, will undergo significant changes in terms of evolution and speed of development of urban structure, if the city of Varosha reopens. Another limitation concerns generalizability. The results of the examination are only applicable to the three selected cases under study (i.e., Walled City, Polat Paşa Street, and Ismet Inönü Avenue). It is therefore impossible to generate worldwide responses from such outcomes.

Nevertheless, the complementary framework presented can be applied to various geographic contexts and periods to determine whether outcomes hold or not. In addition, the study does not attempt to use variables from socio-economical models and it would be separate from the scope of this investigation. A further limitation regards the Varosha district. Following the conflict outbreaks in the 1960s and the separation in 1974, the Varosha district became a closed and abandoned town and it remains until this time, entombed and largely empty. Today, after years of unsuccessful efforts at political solutions to the deadlock imposed in 1974, a new normal state seems to have descended, while Varosha remains a gap. One of the limitations of this study was the lack of access to resources, sufficient information, and maps related to this city. This area has been one of the most influential areas to expand or stop the expansion of the city in different eras.

1.6 Structure of Thesis

The dissertation involves background, theory, methodology, and implementation corresponding to the dissertation's three main sections: Chapter 2 sets out the primary study theoretical framework; Chapter 3 defines the context of two morphological approaches on which the research will carry. Chapters 4 deals with two main parts of research design: historico-geographical and configurational respectively. Chapter 5 puts forward an analyzing case study by two different approaches as the core of this research and presents the application of the method. Finally, chapter 6 evaluates the study results concerning the research objectives and finalizes the thesis conclusion:

Chapter 1 includes an overview of the thesis in particular. This involves its theoretical background, the questions that are addressed, the statements and goals of the research, and its methodology and structure.

Chapter 2 offers the theoretical framework to which this study relates. The theoretical section is dominated by the definition of the urban form and morphological studies; interpretation of different morphological approaches and the connection between them. It also describes similar studies on the combination and comparison of different morphological studies, especially historical-geographical and configuration approaches.

Chapter 3 explains the study of the historico-geographical and configurational methods in the first part, and the Space syntax approach is discussed in the second part. Then, the two approaches and perspectives are compared.

Chapter 4 presents the methodological outline for analyzing the cases and explains methods of research and space syntax techniques, the relationship between space and

movement, concepts of accessibility, connectivity, integration (global and local), and choice, describes the syntactic measures, their calculations, discussions, and debates of space syntax methodology, and selected case studies of space syntax applications.

Chapter 5 involves the historical and geographical background of the case study in general, a deeper understanding of some features of case study areas. Furthermore, it focuses on analyzing cases according to the methodological structure and discusses the case findings.

Chapter 6 as a conclusion assesses the study results concerning the research goals, and according to the predictable outcomes and contributions outlined above proposes a new method and suggestions for further studies to conduct morphological analysis.

Chapter 2

THEORETICAL FRAMEWORKS

This section is concerned with the theory or, strictly, a theoretical aspect of urban form. Specifically, the concern is the definition of urban form and fundamental components of urban form. The general objective of this chapter is to create a foundation for a consistent notional subdivision of the urban form and then propose an interpretation of these components of urban form through historical-geographic and spatial syntax methods.

2.1 Urban Form

The urban form has long been an attractive proposition for urban scholars. Understanding a human settlement or city in terms of physical configuration or a formation viewpoint is the object behind various types of study. With the inherent complexity of cities, scientists from various fields such as geography, architecture, planning, and economics have devoted themselves to interdisciplinary methods for analyzing the built environment. However, it is difficult to provide a comprehensive and accurate definition of the wide scope to which it relates. Although the term is extensively used, “urban form” in the field of urban morphology is typically understood as urban textures, urban plots, streets (and squares), and buildings (Oliveira, 2016). The urban form is the physical features of built-up areas, including settlement shape, configuration, size, density (Tsai, 2005). The urban form reflects the structure of the city's larger functional units, reflecting on both the historic growth of the city and its latest planning history; it describes the spatial pattern of different land

use, as well as the distinct rates of residential density (Rose, 1978). The urban form indicates the development of a city and its growth pattern. Based on characteristics such as transportation, density, and land use, how these characteristics affected towns would be understood to be dispersed or adjacent. It should be noted that studies of urban form rely deeply on cartographic representations such as plans and maps, which are ideal and effective models for precedent or existing cities. Former methods for interpreting and analyzing the urban form were mostly qualitative and involved subjective findings by researchers, which makes it difficult to integrate dissimilar research findings as well as provide an accurate or detailed explanation of this phenomenon. In recent years, the growth of geographic information science (GIS) and technologies has promoted the analysis of urban form and urban modeling (Batty, 2013) for exploring as well as explaining the urban form from both qualitative and quantitative perspectives. With the advancement of spatial analysis technology, emerging alternatives for assessing, classifying, and representing the spatial and socio-economic characters of the urban form have been widely adopted by "mathematical modelers" (Conzen, 2010), who come from multidisciplinary fields including architecture, planning, geography, and engineering. Kropf (2009) proposed four comprehensive sorts of urban form research, containing spatial relationships of physical properties, the interrelation among humans and physical features, movements, and land-use variations. There are also numerous sub-categories underneath each topic, with detailed classifications based on Kropf's comparative analysis on four standard analytical approaches, including spatial analytical, configurational, process typological, historico-geographical. Urban morphology, as the most prominent field of knowledge with a focus on urban form, has emerged over a century and has become an interdisciplinary and international subject (Whitehand,

2018a). The purpose of Urban Morphologists is to reveal the relationship between various aspects of the city which are driven by the interplay between economic and social forces, such as buildings, roads, squares, and monuments. The urban morphologists are primarily charged with analyzing the development of a city, from its formation years to consequent change, recognizing and dissecting its many components (Moudon, 1997). The assessment of urban form is carried out in order to get an understanding of the structure and spatial characteristics of a metropolis, town, city, and village through investigating the configurations of its components and occupation or ownership and control. Urban form is completely tied to scale and can be characterized on every scale by way of the morphological characteristics of a built-up area (Williams et al. 2000). According to Dempsey et al. (2008), these spatial disintegration levels influence the way the urban system is assumed and evaluated. From an urban point of view, the city form points to the spatial scope of the city. This denotes the land utilization (rural and city), social actions (dwelling, industries, organizations), and how they are structured and scattered in the land. On a large urban scale, Anderson et al. (1996), define urban form as the spatial arrangement of constant components. Characteristics of the form of the city on this scale consist of the type of urban arrangements, for example, Dempsey et al. (2010) stated a central district of business or a market town. At the regional level, the urban form denotes the organization of roads and transport networks, and distribution inside the city facilities, for example, schools, green areas, and hospitals. On the scale of the neighborhood, urban form refers to the shape, size, and division of urban blocks in the plot (Complex system institute of urban morphology, 2018).

2.2 Types of Urban Form

The urban form can be described as the spatial structure of individual activities at a certain phase in time (Anderson et al., 1996). The patterns of urban form are evaluated inversely based on different scholars. According to Moughtin (2005), the three chief typical urban forms patterns are the linear cities; the city arranged in the form of a grid-iron; and the highly inward-looking or centralized city. The procedure of each model plan may be modified by the principal metaphor: the city as a machine; the city as a model of the cosmos or replica; or finally the city as an organism. For example, the grid-iron layout has been utilized to communicate both the machine city and cosmic metaphors (Lynch, 1981).

Lynch (1984) identified that there are various sorts of the broad form of metropolises. Some of them are:

Linear cities develop near the sea, river, linear transportation lines, ideally public transportation, or a series of parallel lines (Frey, 2007). The form is based on an incessant transport line (or possibly a parallel sequence of them) that fronts all of the intensive uses of residence, commerce, production, and service (Lynch, 1981). The concept included a central road lined by ribbons of buildings. The road would handle both human and commodity transportation on both road and rail (Boileau, 1959). The city's form is based upon incessant transport lines throughout which are located all intensive uses of commerce, production, service, and residence. Figure 1 indicates the linear city form based on (Lynch, 1981) and the example of a linear city. It includes the linear city of Soria y Mata.

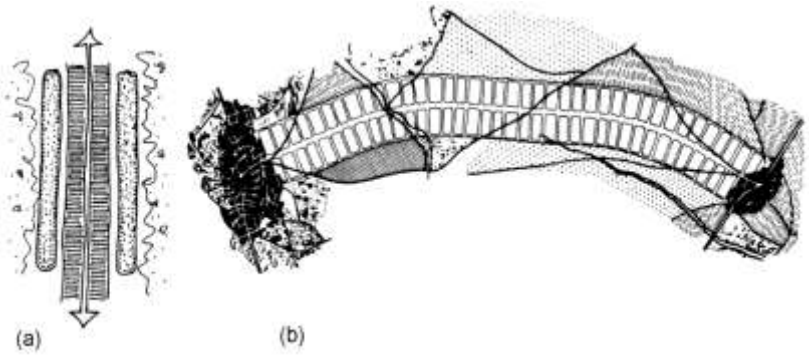


Figure 1: (a) Linear shaped city, (b) Soria y Mata city (Lynch, 1981 and Boileau, 1959)

The urban star is another city model (Lynch, 1991). It has a single high-density dominant center with mixed uses. This model provides for a dense urban core while still accommodating sub-centers and further uses at a reasonable or even low density. It also allows availability to the focal core and the open wedges between fingers. This model is fully developed in the theory of city form of Blumenfeld and is incorporated into the Washington plan. Central Redial forms are more isolated, natural, and organic, and generally spread around the core structures. This sort of plan, created from the principles of formal planning, is differentiated by its concentration of commercial, public facilities, cultural and political functions in the main center; a series of radial spines achieve its link to the hinterland. Star shape cities are centralized and more complicated. As said by Lynch, the size and of an urban star may be supposed to be wider in contrast to the core city since it contains a considerable capacity of open land, developing city size and ever-increasing. Figure 2 demonstrates two Star-shaped cities; figure (a) is based on an ideal Star-shaped city. The second plan in Figure (b) is that which was constructed for the city of Palma Nuova outside Venice typically recognized by the Italian architect Scamozzi (Morris, 2013).

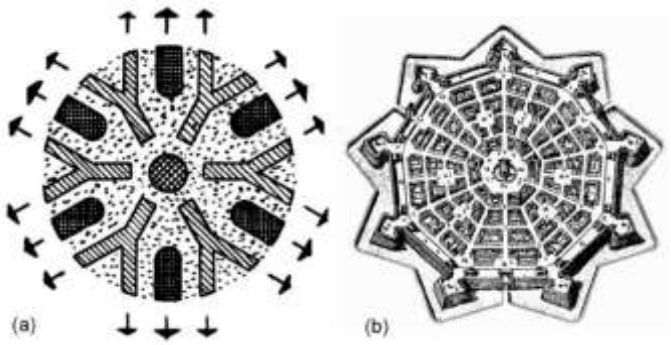


Figure 2: (a) Star-shaped city, (b) Palma Nuova town (Blumenfield, 1949 and Morris, 2013)

The core city model (Figure 3) is possibly the greatest notion of a compact or dense city in which all the city's utilities are filled into one continual form thru an intense peak of activities at the center and extremely high density (Frey, 2007). This model is parallel to the center of Paris city, which has a high density from the core to the edge and a scattering of facilities and services in the city's area to the border. This type of metropolitan is similar to the medieval city. As stated by Lynch (1985), the core city has an extraordinary density of about 350 individuals each hectare, which might cause uneasiness in the form of unfavorable climate and noise. The purpose of a central city is not clearly defined; satellites are based on industry. The industry is placed on the leeward side of each satellite. Green zones in each satellite between industry and residence and around each satellite (Blumenfeld, 1949).

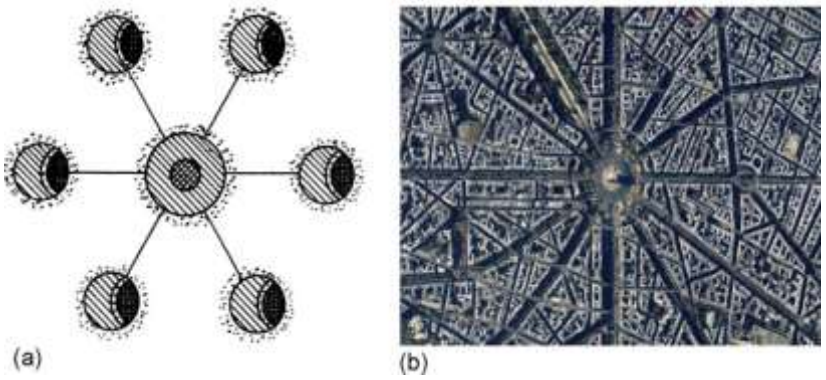


Figure 3: (a) Arrangement of the central city, (b) Urban tissues of Paris (Blumenfield, 1949 and Oliveira, 2016)

The rectangular lattice city – The fundamental concept is built on a four-sided network of roadways that divides the metropolitan area into indistinguishable blocks and be overextended in any direction. This form was applied from former times in equally charmed and galactic cities (Japan and China) and more pragmatic foundations (America and Spain) (Živković, 2018). Original gridiron layout was utilized to divide the planned areas by orthogonal street networks into building blocks. The lattice design is different in European and US cities. Morris (1994) designates that in history the lattice was organized for Roman majestic urban planning, Greek planned cities, and some US cities. The four square roads of the urban road network are long and straight for some different metropolises in the United States The lattice pattern supplies a way to examine the different urban forms. The gridiron layout starts with the different lots, that add up to blocks, and the blocks in turn add up to the city (Blumenfeld, 1949). Figure 4a shows a quadrangular net of streets that divides the urban settings into equal blocks. Rather, the form has no central points and no necessary borders. Figure 4b indicates the Barcelona city growth, which is planned into a regular orthogonal grid reminding us of the planning of Greek and Roman cities for clarity and order.

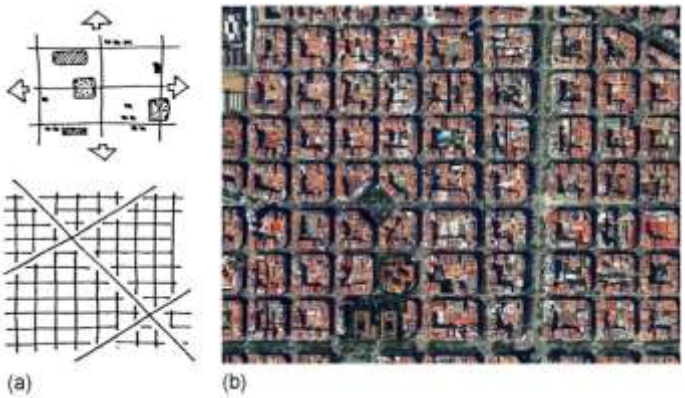


Figure 4: (a) The typical rectangular grid city, (b) The rectangular grid form of Barcelona, (b) Urban tissues of Barcelona (Lynch, 1981, Urbano, 2016)

Additional kinds of grid forms–irregular and non-rectangular grids are hypothetically significant, if of less practical value. The three-sided lattice has been proposed because it is a regular grid that adds two additional directions of through movement to the four afforded through the rectangular lattice. It is sometimes modified to create a hexagonal grid. These non-rectangular grids, while appealing as a geometric concept, create unpleasant intersections and awkward building blocks. The New Delhi layout is an example (Lynch, 1981). Irregular street patterns have been precisely engineered without geometric configurations for functional or aesthetic reasons. Figure 5a shows a non-rectangular lattice of streets that divides the urban land into no uniform blocks. Figure 5b illustrates Milton Keynes city as an example for irregular net form.

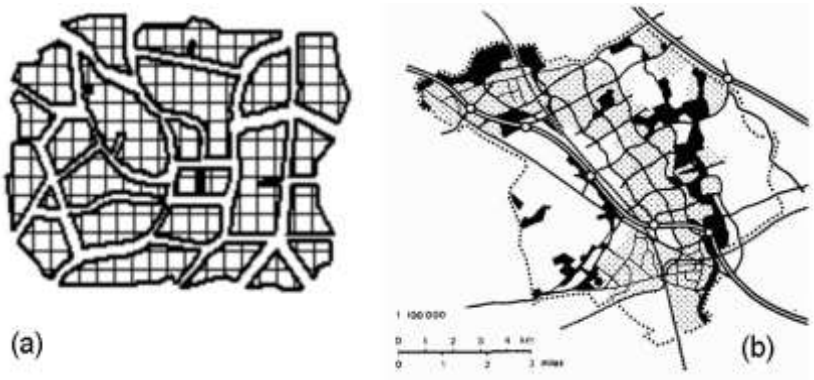


Figure 5: (a) The typical irregular grid city, (b) Milton Keynes city (Benevolo, 1980).

The satellite city model is not unrelated to the star; it is the concept of the satellite: the idea that a central city should be enclosed to some spaces thru a set of satellite groups. The general radial shape and the dominant center are preserved, but growth is transferred to communities that are well separated from the central part, instead of constantly extending outward along the radial arms (Lynch, 1981). In the model of a satellite city, a dominant city is bounded at some distance by a set of limited-sized

satellite groups. The satellites are disconnected from the central city by countryside lands and are enclosed by a green belt. A significant supporter of this urban model was Ebenezer Howard. The idea of Garden City of Howard, which is still misinterpreted nowadays, is founded on the fact the evolution of the large city is failing due to the increase in movement mobbing and the concern of accessing the midpoint. Howard (1898) offers a novel model of urban expansion, independent and autonomous but connected centers, disconnected by farming land and providing an opportunity to coexist with the natural environment. The concept of a satellite city has originated many uses, for example in the idea of Stretton's for Australian metropolises (Stretton, 1971), The final plan of Abercrombie in 1944 for Greater London (Abercrombie, 1945). Figure 6a shows the satellites model nearby a central city: Howard's vision of the Tomorrow Gardens (Howard, 1898). Figure 6b shows that the prototype of the Garden City movement was the town of Villian Garden, founded by Ebenezer Howard on the outskirts of London in 1920.

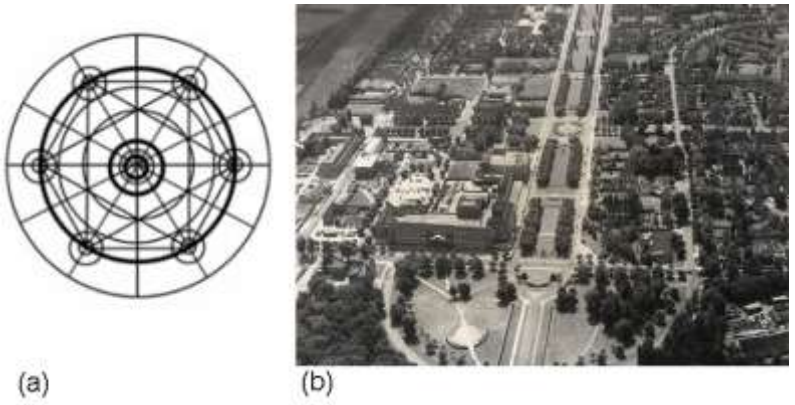


Figure 6: a) Satellites around a central city b) A prototype of a city garden on the outskirts of London in 1920 (Howard, 1898).

The urban form can be regarded and categorized as a metropolitan city and neighborhood into such concentrations from distinct geographical scales. In particular, early towns had many forms such as the "non-geometric" shape of the town. Usually,

these kinds of towns are very slow, unplanned, and natural (Kostof, 1991). Milder (2011) offers an overview of typologies of urban types, pointing out that there is a wide range of categories observed in the literature, but limiting them to the seven types, of which all other classifications are primarily subdivisions: Compact City; Radial; Linear City; Dispersed City; Polycentric City; Edge City; Fringe City; Satellite City. Frey (1999) proposes six different models at the macro level. Figure 7 shows numerous urban form patterns. After quantifying and then evaluating the expected performances of six urban models by way of development, accessibility, containment, social coordination, and so on. He concluded that in economic, social, and environmental viewpoints a regional poly-centered town is the most sustainable form. His analysis shows that the regional polycentric town achieves compactness, accompanied by nodal and linear development that incorporates open space within its boundary. The regional polycentric metropolitan is an alternative to the compact city model by way of an ideal urban form. The alternative urban form can eliminate these issues while maintaining the same degree of compactness as the compact city model. The compactness can be reached through a number of the different densities, sizes, and variety of urban development accompanied by the street network (Frey, 2007). The multi-center urban form is well known because the different sizes of compact centers are well integrated into transportation networks (Camagni et al. 2002). Marshall described street network forms that fundamentally affected the behavior of travel, distribution of dwellings and workplaces, land utilization, and urban forms (Marshall, 2015).

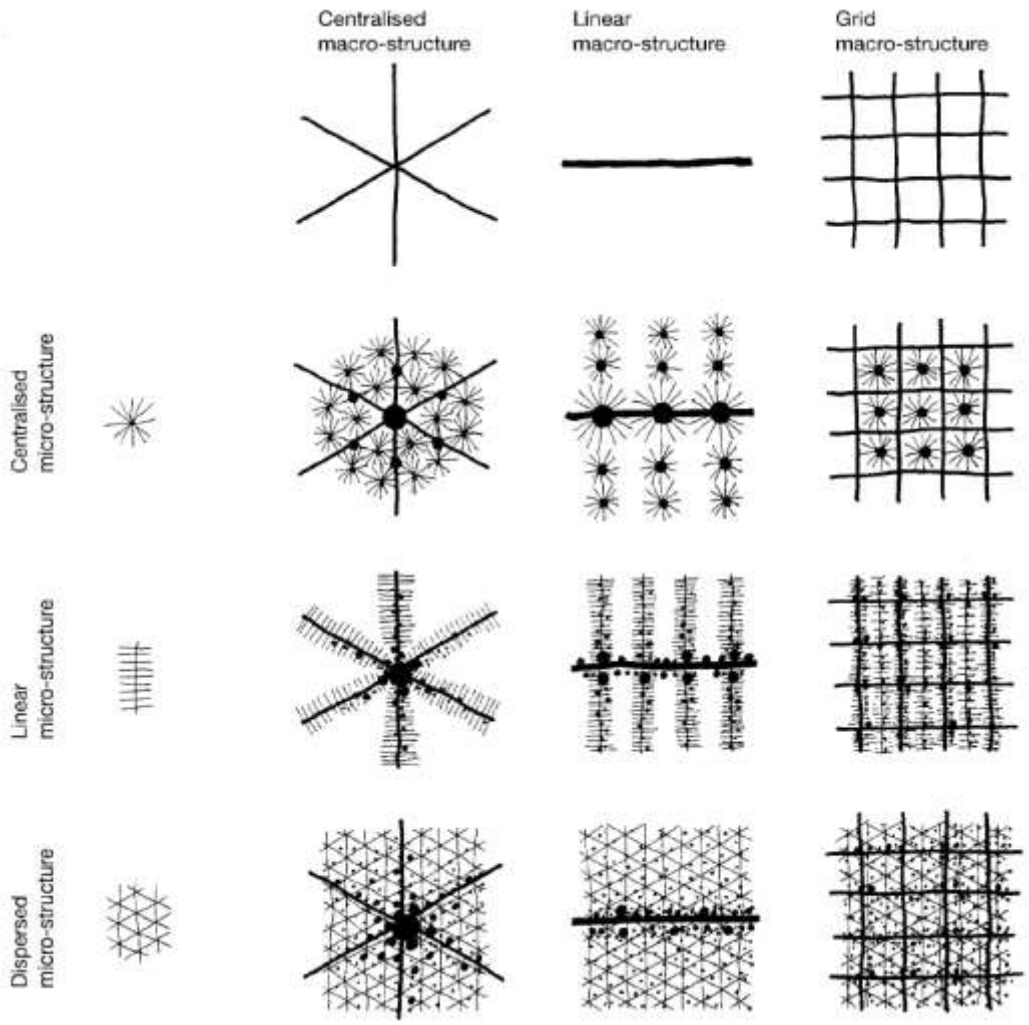


Figure 7: (a) large core city, (b) star city, (c) linear city, (d) satellites around a central city, (e) galaxy city, (f) regional polycentric city (Frey, 2007).

2.3 Urban Morphological Study

Urban morphology is the study of human settlements, their structure, and the process of their formation and transformation. It is a specialist but wide-ranging interdisciplinary field contributing to both academic research and professional practice in the built environment. Urban morphological research aims to contribute to our understanding of the built environment as a complex physical object (Kropf, 2017). Urban morphology is frequently seen as a general term for all studies on urban built form rather than a single method. The study of urban morphology describes and explains the shape, expansion, and diversity of urban environments (Kropf, 1993).

When referring to urban morphology as a method, what is generally referred to is the morphogenetic method of Conzenian tradition (especially town plan study) after the German originator of its most influential branch: M.R.G. Conzen. He was influenced by the urban topographic studies and German morphographic of the first half of the twentieth century (Whitehand 1981, 2001). The International Seminar on Urban Form (ISUF), which conducts an annual conference and publishes the journal Urban Morphology, has brought together urban morphological interests since 1994. ISUF president Moudon (1997) attempted to pinpoint trace the origins of urban morphology back to three schools of thought: German (Conzenian), French (Versailles), and Italian (Muratori and Caniggia) (Vis, 2018).

Whitehand (2007) points out that the important work of Mumford (1961) on the historical development of cities has also influenced this field. Most early morphological developments in North America were based on the work of architectural historians who focused more on cities and buildings (Whitehill, and Kennedy, 2000). At the end of the twentieth century, however, the study of urban morphology in North America gained momentum, and efforts were made to apply the notions developed in the British and European geographical tradition of urban morphology (Churchill, 2004). M. R. G. Conzen, who migrated to the United Kingdom between the two world wars and helped build the British school of geography based on German and central European geography, is often regarded as the most influential person in the British and European geographic tradition of urban morphology. Between the 1890s and 1920s, when morphological studies of landscapes and urban layouts were almost non-existent in the English-speaking world, Germany and other central European countries reached their golden age through the

work of human geographers such as Schlüter (1899) and Geisler (1918). Conzen brought this tradition of urban morphology to Britain and developed it considerably through several precisely defined concepts and tools of morphological analysis. Conzen, in his fundamental work on Alnwick (1960), characterized the three essential components of the urban landscape, in particular, town plan (additionally urban layout or ground plan), land uses, and building fabric—and talked about their overall significance for morphological examinations.

In his work on Alnwick, Conzen additionally presented a few morphological ideas, for example, the burgage cycle, urban fringe belt, the morphological region, and morphological frame. The fringe belt, in straightforward terms, is a zone of generally broad land utilized that is shaped at the edge of an urban region during a gap in outward residential development (Rashid, 2016). The investigation of urban morphology, as often as possible alluded to urban form, townscape, and urban landscape, has broad literature in three classes. Right off the bat, in the field of human geography, particularly in England, there is a "native British geographical tradition," which was intensely affected by M.R.G. Conzen. Conzen creates two of his key thoughts, the fringe belts, and the burgage cycle. The Conzenian is more inspired by the classification and description, and they exemplified the attributes of present townscapes in light of the overview.

As of late, the commonplace works added to this tradition are from. Lately, the typical works donated to this tradition are from (Whitehand, 1992, 2001a and b; Whitehand & Morton, 2004; Griffiths, et al. 2010; Whitehand, et al., 2011; Conzen et al., 2012; Birkhamshaw et al., 2012). Furthermore, in architectural and planning theory, European tradition (e.g., Caniggian School) emphasizes the components of the urban

structure, including its elements, structures of elements, the organism of structures (Sima and Zhang, 2009). Numerous researchers concerned urban morphology as prescriptive and idealistic for "ideal cities." For instance, Wright's Broadacre (1935); The Garden Cities of Howard (1965), Le Corbusier's Ville Radieuse (1981), and are noticeable instances of this genre. However, the most prominent critics from Lynch (1960), Jacobs (1961), and Alexander (1964, 1974) ask researchers to think about urban planning from an anthropological perspective, which should be founded on the perception of what works in real cities. It sowed the seeds of a mathematical methodology for evaluating urban morphology.

Alexander's (1974) work initially attempted to introduce formal numerical thoughts in the discussion. A few analysts were keen on carrying numerical tools into the domain of urban morphology, specifically, graph theory and set theory, and endeavored to connect this thought with what works in the urban design field. For instance, work concentrating on possible graph illustrations of urban form (Krüger, 1979) demonstrates the approach. Hillier and Hanson Under this foundation, the technique for space syntax were stated by Hillier and Hanson (1984), which is based on a graphical demonstration describing metropolises as systems of open space. Urban morphology has a definite interdisciplinary nature due to the complexity of this study from various areas such as geography planning, history, and architecture.

In turn, each of these fields is affected by a multitude of traditions, study programs, analytical devices, and specific research issues and study goals in particular (Oliveira, 2018). For years, urban morphology ideas and practices have been researched to know the impact of physical modifications in urban areas on the behavior of individuals and the historical process of urbanization. The work of Conzen and Whitehand would

become a key reference in United Kingdom geography in the 1960s and the following decades (Conzen 1960; Whitehand 1981, 2001). New approaches with a more quantitative nature began to develop in Britain in the last decades of the twentieth century, starting with syntactic analysis, relying on the fundamental investigates of the seminal Alnwick study (1960). The foundation and formation of each of these approaches were not in replacement of previous approaches, but in cohabitation by existing methods. Urban morphology can provide a prescriptive guide for transforming existing forms and designing new urban forms, based on an objective and evidence-based thought of the urban form (Oliveira, 2018). The origins of urban morphology can be traced back to the late nineteenth and early 20th century writings of German urban geographers. The works by Ratzel, Hassinger, Schlüter, Fritz, Geisler are the basics of a precise historical and geographical investigation of urban forms of the European cities, considering street layouts, building types and arrangements, and function locations (Hofmeister, 2004).

Traditional urban morphology schools developed new core concepts in the study of urban form after World War II in Britain, Italy, and France. For example, Conzen (1960) developed Herbert Louis' notion of the fringe-belt and investigated the town plan based on three various components of the plan: streets and their arrangements in a street system, plots and their aggregation in street blocks, and building arrangements within the street blocks. From 1926 until 1932, Conzen attended the University of Berlin in Geography, History, and Philosophy. Among the prominent academics who influenced him at the time were Albrecht Penck and Herbert Louis (1936). More than 80 years ago, the German geographer Herbert Louis, one of Conzen's mentors, recognized that the external growth of an urban area is very inconvenient in its

development: the growth of a city consists of a set of external developments of a residential area divided by noticeable gaps. In the mid-twentieth century, Conzen created urban morphological research primarily through his English city studies (Conzen, 1962, 1966, 1969; Whitehand, 1981; Whitehand and Larkham, 1992). His approach has been referred to variously as the Conzenian tradition/ morphogenetic (Whitehand, 2001b & Moudon, 1997) and the historico-geographical approach (Whitehand, 1987, 2001, 2007; Larkham, 1998; Slater, 1990; Kropf, 1993, 2009; Oliveira, 2016; Kropf, 2017).

At the same moment, a typological process method has been created in Italy by Saverio Muratori then Carlo Aymonino, later Gianfranco Caniggia, to which the labels Muratorian tradition (Moudon, 1997 & Cataldi, 2003) and process-typological approach (Kropf, 2009; Oliveira, 2016) have been applied. In morphogenetic tradition, in conjunction with field surveys and historical documentation, the plot is the fundamental unit of analysis, and its use is made of detailed cartographic sources (Whitehand, 1981). Streets are the city's framework and core and are essential for social activities (Jacobs, 1961). The process typological approach is developed particularly at the scale of individual buildings, while the morphogenetic tradition is more centered on how the forms that make up urban regions come together (Maffei and Whitehand, 2001b).

2.4 Approaches to Urban Morphology

This section introduces the main morphological approaches, which are the historico-geographical, the typo morphological approach, the syntactic analysis approach, and the several procedures of spatial analysis that include cellular automata, agent-based model, and fractal. Space syntax originates from a series of systematic processes of

arrangements built on human behavior. For instance, the movement of the individual in a specific urban setting. In addition, the historic-geographical approach led principally in Britain deals with the historical development of urban form and combined with the architectural typo-morphology researches in Italy deal with the practical typological development of urban form. Today, urban morphology has four wide approaches, each concentrating on slightly distinct elements of urban form and using distinct techniques and tools: (i) Historico-geographical, (ii) Typological-process, (iii) Configurational, (iv)Spatial analytical. Both typo-morphological study and configuration methods arise from the areas of urban planning, architecture. The geographical and spatial analytical approaches have originated from the geographical fields. Three significant related approaches to urban morphology research are not morphological but comparable to urban form studies. These are (i) Townscape, (ii) Geographic Information Systems (GIS), (iii) City image analysis. Another area of study in which morphological principles in the field of urban ecology are implemented, which is not linked to the purpose of this study (Kropf, 2017).

2.4.1 Historico-Geographical Approach

The historico-geographical approach had its roots in the twentieth century in the work of the German geographer MRG Conzen, chiefly in his book on the small town of Alnwick. The goal of Alnwick's book is to comprehend how the plan of an old town gained its geographical complexity, the concepts that may be derived to aid in the analysis of town plans, and the contribution that the evolution of a town plan provides to a regional structure of a town (Conzen 1960). This book consists of three parts: the first part presents the tripartite classification of the urban, landscape into town plan (Figure 8), building fabric, and building, and land utilization. As figure 8 shows the seminal study of Alnwick (Conzen 1960), town-plan analysis involves a progressive

and systematic division of form complexes, town-plan elements, plan element complexes, as well as the assessment of different plan units, being the individualized mixtures of the plan elements which consist streets, plots, and buildings. The emphasis of this book is on the town/ground plan including streets, plots, and the block plans of buildings. In the second part, the growth of Alnwick's urbanized area is examined based on the five morphological periods. The existing town plan of Alnwick is examined in the third section of the monograph. Conzen offers a geographical framework according to the four orders of plan divisions (similar to the notion of the morphological region) (Oliveira, 2019).

Conzen's research aims at explaining the personality of cities and their geographical composition by analyzing their vital components and developing over time (Kropf, 2009). As described in his seminal Alnwick research (1960), he starts by characteristic five universal aspects of urban form: (i) site, (ii) function, (iii) townscape, (iv) social and economic context, and (v) development. He designs a methodical interpretation of the urban landscape based on the concepts of morphogenesis and tripartite division (ground plan, building fabric, land and building utilization). Furthermore, he suggests a number of theories to describe the urban growth process, such as the fringe belt, morphological region, and the burgage, cycle (Whitehand, 2001). J.W.R. Whitehand and his colleagues at the University of Birmingham further expand the Conzenian tradition after the 1970s (Oliveira 2019). At the end of the 1970s, Whitehand began outlining the theoretical and methodological framework of the historico-geographical approach within the broader field of urban morphology.

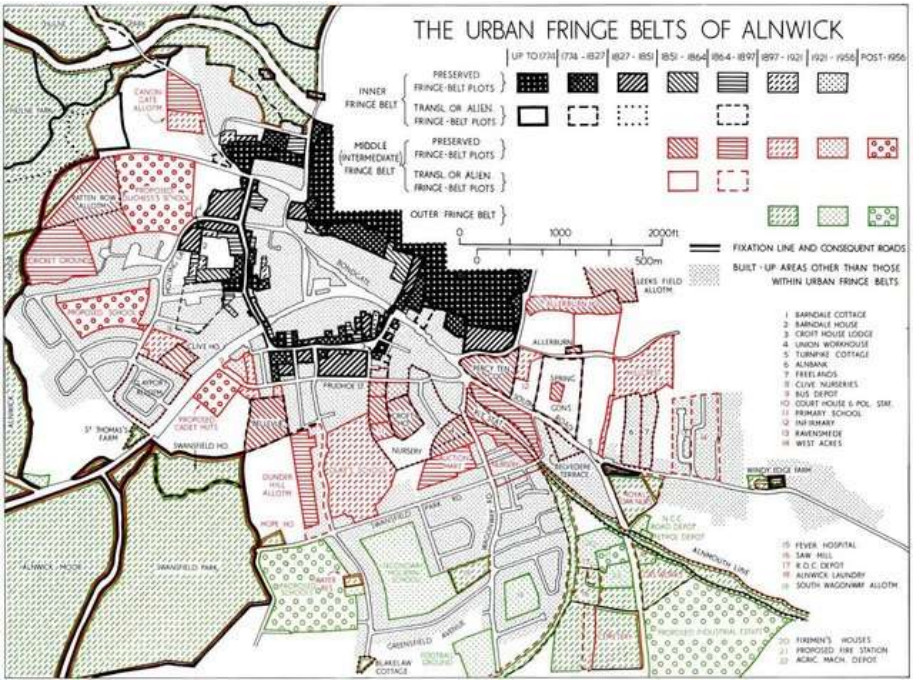


Figure 8: Types of plan units in Alnwick, Northumberland town plan analysis (Conzen, 1960)

While Conzen provided an invaluable foundation with this book and a number of other publications, it was Whitehand who structured a school of urban morphological theories, refining and proposing a number of morphological theories, concepts, and methodologies that are now widely shared by academics worldwide (Conzen, 2004; Whitehand, 1981b). Following Conzen's comprehensive plan analyses of Alnwick (1960), Newcastle upon Tyne (1962), and Ludlow (2004), the historico-geographical techniques have been extensively used to study the origins and development of British historic towns by mapping the morphological evolution of the town plan over time (Slater, 1990; Baker and Slater, 1992). Conzen's method of plan unit exploration has been used in different types of metropolitan regions and places of the world for the past 20 years (Whitehand and Gu, 2007). The historico-geographical approach can categorize a hierarchy of unit types (plan units) that reproduced the historical evolution of the urban area. The historico-geographical approach to urban morphology seeks to clarify the patterns, geographical configurations, and human

settlements characteristics through a methodical examination of their fundamental elements and growth through time. The analysis aims to explain the composite nature of settlements in terms of the essential continuing, temporary, and repeating morphogenetic developments at different stages in the hierarchy of features. In addition to identifying the various processes, this includes regionalizing the town plan and associating morphogenetic changes with the socio-economic factors that drive them (Kropf, 2017). The ideas that are developed by Conzen are mainly defined as stated by Whitehand (2009) within the morphogenetic technique, historical growth, terminological accuracy, and cartographic representation. Conzen urban landscape tripartite division includes the conceptualizations to examine the urban development process. He claimed the townscape determinants persistence distinguished in time. The use of land and buildings is mainly open to modification in the townscape. Looking at the five broad aspects in terms of classes, associations, and properties, function, and the socio-economic context are based on the relationships of 'activities' and 'use' between individuals and built form. The function is more limited to specific activities, such as, residential or commercial. Any specified function would be a part of the socio-economic framework in this regard. The site is described primarily in terms of spatial relationships and natural physical characteristics such as geology, topography, and vegetation distribution. Although a function has been recognized as a separate overall element, the townscape involves the complex of land use pattern with the plot recognized as a land-use unit (Conzen, 1969). Conzen (1960) argues the most vital single topic devoted to geographical urban morphologists is the process by which urban built-up areas have grown physically. This process has reflected the secular and cyclical change, reflecting the development of socio-economic aspects.

2.4.2 Typo-morphological Approach of Urban Morphology

The process-typological method had its foundations during the 20th century in work by the Italian, planners Saverio, Muratori, for the most part in his monographs on the operative, histories of Venice, and Rome (Muratori, 1959), and Gianfranco, Caniggia, especially in his monographs on architectural building typology and composition, written with, Gian Luigi Maffei (Caniggia and Maffei, 1979). Gianfranco Caniggia, one of the Muratori's assistants, developed the typological approach. According to Cataldi (2003), Caniggia contributes to the typological approach particularly by developing the concepts of Muratori, constructing the processual typology, and understanding the association between the history of the city with the typological process. The typological is intended at informing the architectural and urban proposals by examining their detailed structure with a sympathetic of the built environment (Caniggia and Maffei, 2001).

This school of thought aims to create a structural link between urban history and the future evolution of cities. In the development of the typological-process approach, both the notions of type and process are crucial. The notion of type provides a tool for analyzing huge numbers of buildings, while the process allows for structuring the progression of different types into a timeline (Caniggia and Maffei [1979] 2001). Muratori (1959) establishes a set of basic notions, including type, urban tissue, organism, and operative history. Muratori claims that a specific building type can only be identified within the context of a specific application in the urban tissue. The urban tissue could only be recognized in its involved setting, in the urban organism. Derivation assessment is based on the scheme of component subdivisions forming a hierarchy: elements, structure systems, and system organisms. This schema is the first

implemented to individual houses, taking as elements construction components like bricks, timbers, tiles, etc. The building materials in factors such as walls, roofs, interior floors, etc. are then associations of element systems. The structure of the components is the combination of the urban fabric of the structures, referred to as the aggregate (Figure 9). Therefore, the concept of construction and the act of building or modification are vital components of the cultural system and are different in terms of classes, relationships, and characteristics. The idea includes the relationship between the shared cultural notion and the people that hold it, and the building act includes the relationship between builders and built areas. Maffei and Caniggia, therefore, classify the following separate aspects of the urban form: (i) Physical form, (ii) use or function, (iii) building form, (iv) the act of alteration, (v) The cultural evolution or change process.

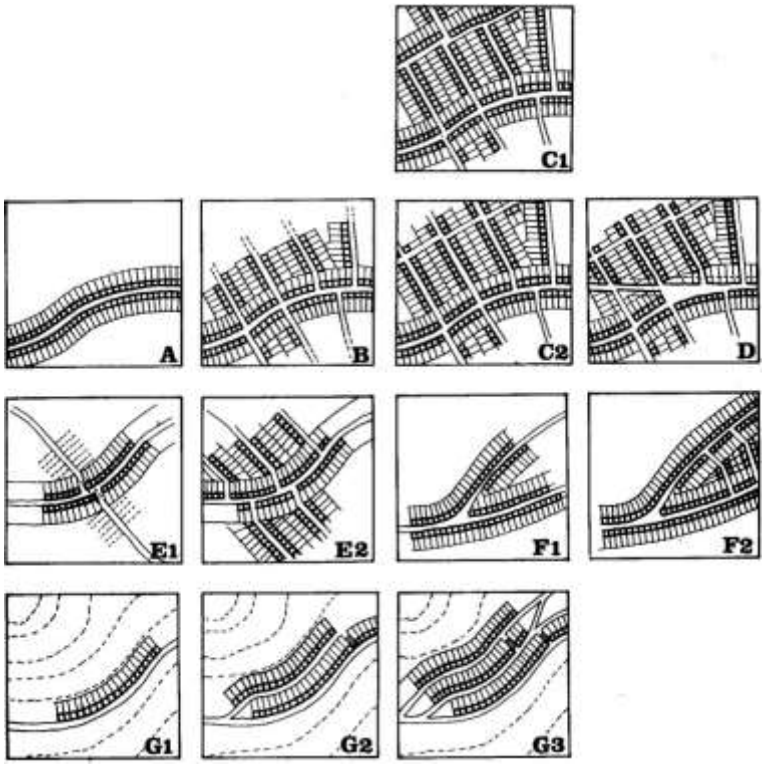


Figure 9: The formation of urban tissue or aggregates in different generalized situations (Caniggia and Maffei, 2001)

2.4.3 Configurational Approach

The ideas that constitute the configurational approach emerged from quantitative and mathematical studies of urban form and architecture in the 1960s, primarily in the United Kingdom. Enthused by the algometric researches of D'Arcy Thompson, the analytical potential of Euler's topology and theory of graphs, among further sources, the shared feature is the emphasis on the topological and geometric qualities of built form to comprehend the interrelationships among different measures and attributes, how different spatial configurations impress the use of buildings and urban environments. Besides the quantitative and the topological methods, this approach uses synthetic analysis and the knowledge of possible forms to understand the relationship between factors influencing the choice of configurations comprehended on the ground (Kropf, 2017).

The configurational approach offers other insights into the relationship between space movement and organization distribution (Larkom, 2006). Although the fundamental of a more numerical method to urban form study was established in the 1960s at Cambridge University's center of Land Use and Built Form, led by Leslie Martin and Lionel March, it received a new impetus in the mid-1970s with the establishment of Bill Hillier's Unit for Architectural Studies. The space syntax encompasses a group of procedures, techniques, and theories which employ physical space as a major social classification in the description. In the syntax of space, the word configuration often reflects the point that a network of spaces represents all the possible ways to connect space units as shown in an environment layout. A configuration signifies a state of the system describing the associations of a kind among individual spatial units. Thus, a configuration that is adjacent to the spatial units in a design can be quite distinct from

that describing permeability. Also, a weighted relationship arrangement may be significantly different than an unweighted spatial unit layout configuration (Rashid, 2019). Space syntax includes the theories and techniques applied to quantitative spatial configuration measurement and provides objectivity in urban morphology studies. The notions that describe the approach to configuration emerged in the 1960s, mainly in the United Kingdom, from mathematical and quantitative research in architectural and urban form (Thompson, 2015).

The logical potential of Euler's topology and theory of graphs, amid numerous other sources. Two important components of the space syntax approach are the attention on the space and connections among the space and movement. This concentration on the space emphasizes the restrictions among the developing space syntax and other methods in influential texts of Hillier and Hanson (1984). They supposed that these methods discussed space in terms of its determinant levels. Others discussed space alone and not the connections between buildings and urban regions that determine the syntax of spaces. In the syntactic analysis, an innovative view of the city and architecture is presented, emphasizing the urban spaces in which people proceed and socio-economic activities take place. The configurational space is a more sophisticated term than a spatial correlation that takes only dual spaces into account. The space syntax shows certain advances in associations among movement and urban space, both vehicular or pedestrian. In the social logic of the space book, Hillier and Hanson (1984) argue that configuration is the main factor of the scattering of movement flows.

The street networks structure determines the movement as the shape of the street networks of movement, also creates the land utilization distribution. The probable

result of movement patterns in an urban system, before considering the effects of any regulatory regime, is what Hillier describes as the theory of “natural movement” (Hillier et al., 1993). Second, he argues that the distribution of land use patterns is due to their dependence on movement in the urban network. The result of changes in street connectivity, in part to attract more people, shows that this, in turn, tends to attract retail and other types of uses, which depends on the volume of pedestrian traffic and therefore the density of pedestrian movement and uses is increased (Hillier, 1996).

The effects of movement upon the urban street network provide an interesting relationship with location theory from a syntactical point of view. There are two main components of human movement that consider spatial accessibility in the built environment. Visually, if the main street is connected to the back streets, people will cross the main streets more than the back streets. The main street is easier to access than other streets, supposing that it is more accessible. The back streets also have great potential to reach or pass through, but theoretically to a lesser extent than the main street (Hillier and Van, 2007). This is what is typically known as to-movement and through-movement in space configuration in Space Syntax. If the effects of land use on movement are considered, these two components are important in place theory. For each trip, the person selects a destination (to-movement potential) and a set of spaces to reach that destination (through-movement potential). The examination of the spatial configuration of the city is based on the application of the minimum linear map, called the axial map. Figure 10 shows an axial map made by showing the geometry of a city's street network in straight lines. By definition, the axial line is the longest and fewest line needed to connect each street to the other streets that make up the city (Penn, 2003; Turner et al, 2005). In contrast, accessibility measurements in the space syntax

technique raised criticisms about the usage of axial lines and depend on topological distances rather than containing metric components in their measure (Ratti, 2004; Hillier and Penn, 2004; Porta et al, 2006). Since then, researchers have examined the limitations of axial lines (Peponis et al., 1998), which have led to new advances in syntactic techniques; therefore, new measures including topological and metric components were proposed.

Figure 10: The axial map as an illustration of space (Marcus, 2018)

Among the new developments, space syntax transformed the use of axial lines into the use of segment lines and introduced a detailed analysis for accessibility called segment angular analysis (Turner, 2000, 2007). The angular analysis of the segment considers the same principle of the axial line with the difference of the analysis of the axial lines into segments. Figure 11 shows the procedure of creating a street segment network. Each axial line is broken down into segments at the points where axial lines intersect. It is argued that Segment lines provide a more accurate estimate of the shortest paths

calculated with the least change in angle of direction (Turner et al., 2005), which makes it possible to measure not only topological dimensions but also metric and geometric distances across and throughout the street network.

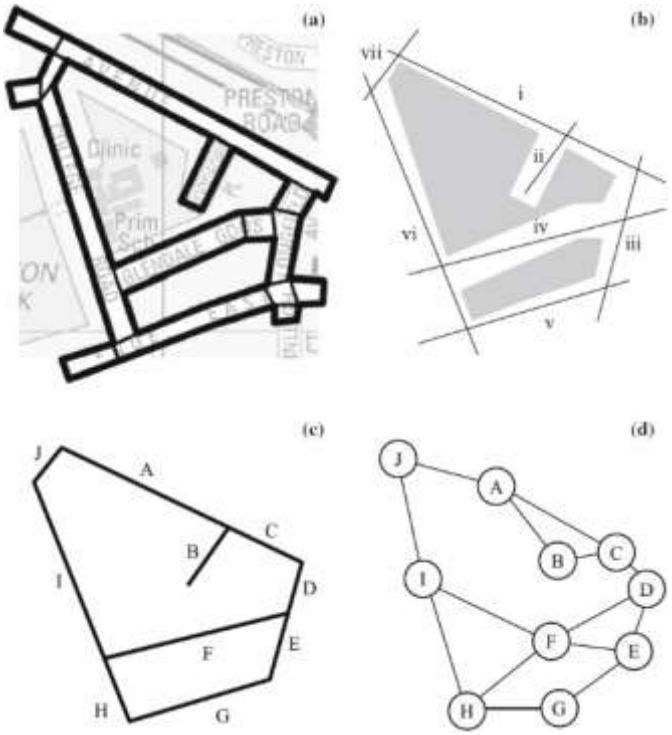


Figure 11: a) the open space of the applicable space is drawn and divided into a convex space; b) an axial map is generated by locating the smallest network connecting to these convex spaces by straight lines; c) a street segment map is created by dividing axial lines at intersections; and d) each street segment becomes a vertex, with edges indicating its direct connections to other vertices (Summers & Johnson, 2016)

Figure 12 shows the topological distance that assigns a value for every change of direction or turn between a segment and its neighboring segments. Space syntax represents the urban morphology configuration approach, which aims to understand the spatial layout of the settlement by using various analytical methods. The theoretical foundation of the approach on the settlement scale is the connection among the spatial structure and movement functions. Movement is the basic correlation of the spatial configuration (Hillier, 1996). Hillier considers configuration as emerging, resulting from local procedures as a global structure. As regards the concept of form, space

syntax requires a different perspective due to its emphasis on space and spatial configuration, rooted in building assessment (Hillier and Hanson, 1984). The notions and analytical methods concentrate almost completely on a structure's voids, mainly on the streets within a settlement, although some consideration is given to the spaces within a plot around buildings. The approach of Hillier offers a principal effect on the concept of configuration that has moved to center stage (Hillier, 1996). A configuration description also delivers the opportunity to consider specific measurable characteristics of the represented scheme; connectivity indexes, asymmetries, spatial possibilities are all measurable characteristics of a spatial configuration (Krafta 1997).

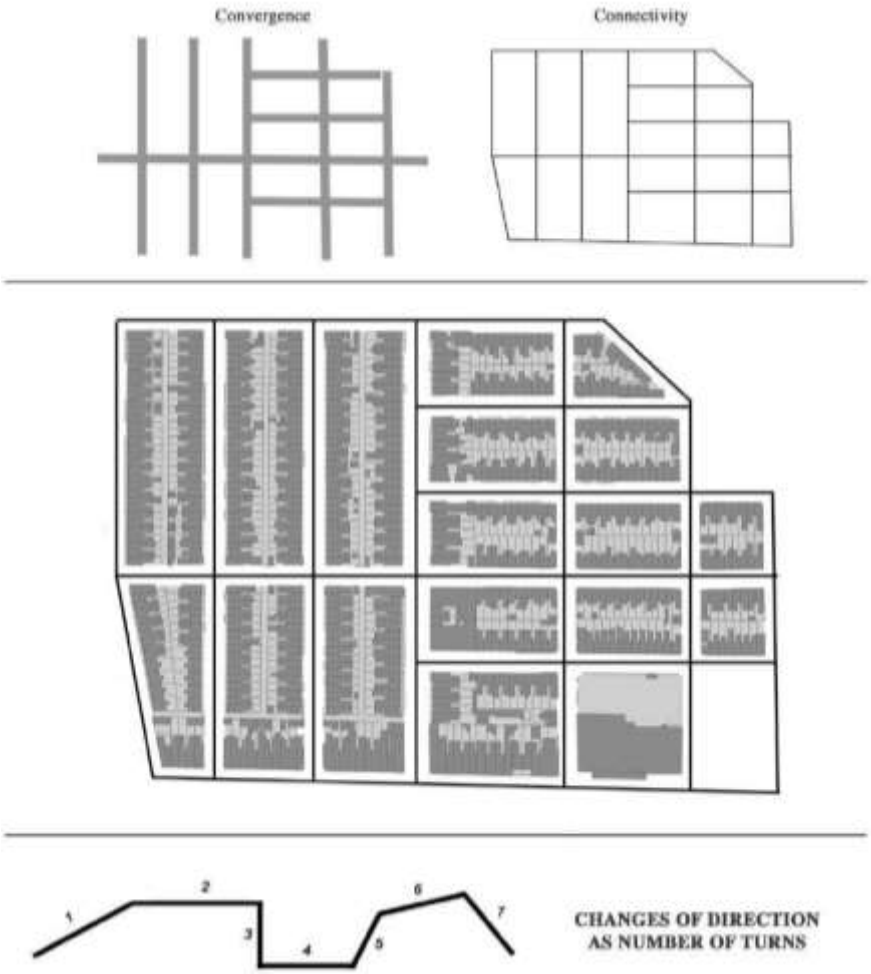


Figure 12: Defining topological distance in the street configuration (Narváez, 2015)

Ultimately, the spatial configuration can affect complex social processes by influencing the pattern of street movement and the potential for economic activity generation. Several studies have already shown that the spatial street configuration plays a tremendously important role in determining variations in movement concentration (Hillier 1996, Penn, et al., 1998). Based on the evaluation of several natural cities growing, Hillier claims that movement is governed and generated by spatial configuration and therefore governs the special use and the possibility for encounters among individuals.

2.4.4 The Spatial Analytical Approach (Spatial Analysis)

Batty (2007) uses a variety of techniques and models including the fractal, the cellular automata, and the agent-based models to comprehend the spatial structure of urban environments as complicated, emerging phenomena where the global organization is based on local practices (Kropf, 2009). Importantly, in what is represented, there is ambiguity concerning form and use. Much of Batty's job deals with modifications, development, and land-use segregation (Figure 13) as well as the migration or diffusion of occupant populations based on a range of criteria yet the 'morphologies' that develop from the models most clearly looks like the spatial distribution of urbanized areas within a sub-region. Moreover, Batty (2007) argues that the models are not designed to provide precise or predictive descriptions, but to strip urban development procedures to their essentials, and therefore to identify the fundamental mechanisms at work. The approach procedures a variety of mainly quantitative approaches such as calculated models, graph theory, cellular automata and fractal, agent-based models, and examination of networks. It is essential to the spatial analysis approach that towns are complicated autonomous systems with the mutual dynamic association among social and economic relatives and settlement form. Thereby, while

there is a focus on networks patterns such as social and economic exchange, transportation, energy, material, these patterns are seen as both providing rises to the physical form of towns and being essentially influenced. The approach intends to examine the dynamics of the system, its values, and interactions such as the development scaling laws, and to start to define the interactions between the values to create a more extensive image. The fundamental principles of morphology are the differentiation of components by their situation in a wider arrangement or configuration, besides the structures sympathetic (Kropf, 2017). Batty recognizes the city as an issue of structured complexity and applies the notions of creation and growth to solve that issue (Batty, 2007). Cells in a model most appropriately signify parcels or further administrative combinations depending on the data sources (Kropf 2009).

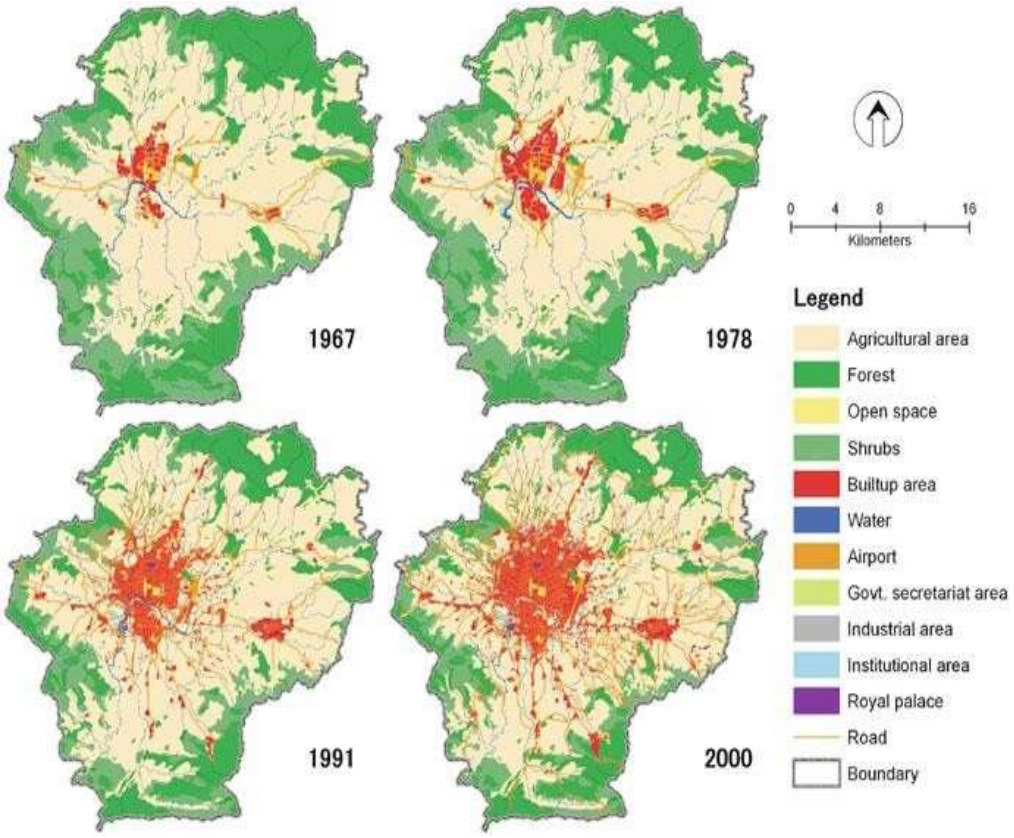


Figure 13: Land use maps (1967, 1978, 1991, and 2000) (Murayama and Thapa, 2011)

2.4.4.1 Cellular Automata

In the 1940s, game theory founders Stanislaw Ulam and John von Neumann introduced Cellular Automata. The notion of automatic computing is at the very core of Cellular Automata, like Alan Turing, a hypothetical idea through a computer skilled at generating worldwide computing (Wolfram, 2005), affected von Neumann. The neighborhood sets the extent to which cells interact spatially considering their conditions (for example, the connections among dissimilar land uses). Wolfram (1983-1984) presented these superficially easy systems could produce complex structures, containing fractals. In particular, geographers dealing with urban forms seek to understand the factors that contribute to a current form of a particular urban context and to predict future developments. Such techniques depend on customized models, that include aspects that can be used as a tool to promote decision-making, based on explanatory and predictive models.

Several computer-assisted systems aim to replicate the development of towns, including how urban structures transform in periods, among other mathematical models. Among them is a cellular automatic model that is based on a distinct dynamic modeling system as a mathematical model computing. They are arranged into procedures that represent the complexity of real systems by stacking simple rules (Antoni et al., 2019). Cellular automata (CA) is a system of spatially located and interconnected finite automata. Cellular automata frequently tessellated individual automatic measurements in space, e.g., a rectangular grid (Figure 14). In CA, an individual cell represents the discrete spatial confines of an automaton, and an individual automaton is understood as neighboring some other automata. States are associated with those cells. In CA, input is formed from the state information of

neighboring cells. The neighborhoods may take on a number of configurations: agglomerations of adjacent cells defined by their distance from an individual automaton, clusters of cells defined by their shape around an automaton, etc. Two standard neighborhood configurations are illustrated in Figure 14 the nine-cell ‘‘Moore’’ neighborhood and five-cell ‘‘von Neumann’’ neighborhood.

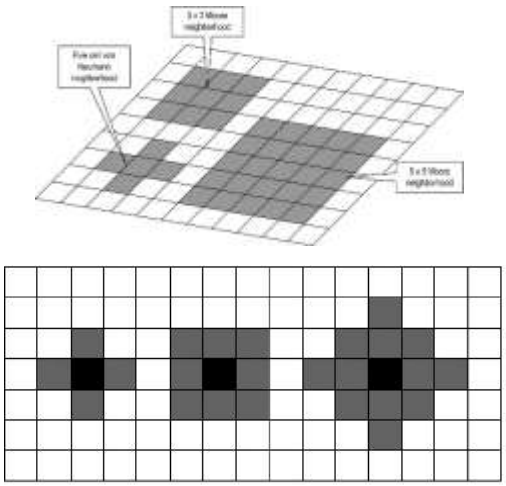


Figure 14: 2D Cellular automata neighborhood’s configurations (Benenson and Torrens, 2004)

2.4.4.2 Agent-Based Models

Geography has integrated thoughts and theories from other disciplines throughout the 20th century. These concepts have enhanced the importance of modeling and understanding the effect on distinct spatial and temporal scales of individual agents and the heterogeneity of geographic structures. Agent-Based Models allow the computation of the different agent's actions and the measurement of the system behavior over time. More usually, the development of automata methods was essential to the Agent-Based Model's progress. Automata processing information input from their environment and their features are modified by-laws governing their response to these inputs. The term ‘agent’ can be demonstrated of any sort of independent object

such as buildings or people. Each of these independent objects that can be animate or inanimate has rules that influence their interactions with other agents or their surroundings. The surrounding environment describes the space where agents perform (Crooks and Heppenstall 2012). Models based on agents often cursorily depict space, if at all. The paradigm of simulation requires a clear demonstration of spatial behavior, and its spatial interactions (Benenson and Torrens, 2004). New specific agent models find agents with the geographic characteristics of the real world, such as streets or structures (Benenson et al., 2002). These models show the possibility for modeling the information of human spatial behavior (Gimblett, 2002).

2.4.4.3 Fractals

Since the 1960s, fractal geometry has been used to determine asymmetrical yet self-similar and topological structures such as shorelines, foothills, and other types of physical occurrences (Mandelbrot, 1982). Such figures called fractals, resemble on various measures so that they separately look like the entire (Batty and Longley, 1986). There are potent connections to growth and development procedures in fractal research. Fractals generally emerge from schemes that dominate a variety of scales through a single method. The best instances happen in particle physics where crystal forms show a sequence of scales of fractal self-similarity. The pattern that determines these constructions is seen as tree-like or dendritic (Feder, 1988).

The concept of things in Euclidean geometry are three types: one dimension (line), two dimensions (plane), and three dimensions (cube). Mathematician Benoit Mandelbrot in his book ' The fractal geometry of nature ' in the mid-1970s introduced a new nature geometry based on the notion of ' fractal ' (Mandelbrot 1982), arguing for its use in various fields. Fractal geometry was introduced to the built environment in

subsequent decades. Over the past two decades, this line of studies has been further extended Joye (2011) provides an overview of the distinct ways geometry of fractal has been used to examine and generate real procedures of architecture. Lastly, fractals were used to analyze streetscapes characteristics. Jon Cooper has developed this mainly. Cooper started by using fractal modeling to analyze road perspectives that connect the calculation of the fractal aspects with the view of the visual diversity presentation level in daily urban streets (Cooper and Oskrochi 2008).

Fractal structures are also characterized by repeating the same principle of uniform distribution of elements at different scales. Theoretical fractal forms are created by repeating a specific pattern of points, surfaces, or curves at infinite scales, or by dividing or multiplying their mass by a fixed value in each iteration of the process. However, the same model of spatial distribution is not always the same: that is only the case for hypothetical patterns such as Sierpinski carpet or Fournier's dust (Tannier & Pumain, 2005). Figure 15 shows the growth of fractals and procedures for calculating its measurement can be defined by a traditional flawless model named Sierpinski's tree.

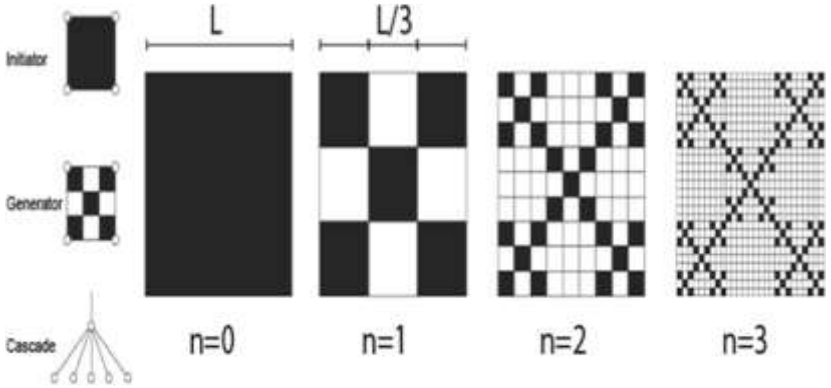


Figure 15: Tree models of a fractal growth (Batty and Longley 1994; Jia et al., 2019)

2.5 The Connection Between Approaches

This section of the chapter presents the relationship between main morphological approaches that have been established over the past decades. Urban morphology can be considered an autonomous discipline as well as an ancillary one. It has expanded its sense and techniques, while at the same moment drawing on urban and architectural history, archaeology, sociology, urbanism, architecture, urban geography, and configuration assessment from which phenomena are extracted for its reasons. The analysis of the physical form of cities, along with the agents and processes that shape their evolution over time, is known as urban morphology. Urban morphologists begin by examining the city's physical form, then narrow their focus to a few number elements of urban form (e.g. streets or plots).

They can then add more layers of information of a social economic and environmental nature to this physical base, depending on the main objectives of the study (Oliveira 2016; Kropf 2017). In other words, urban morphology is frequently used as a term that connects the form of a place with some other features of that place. For example, its historical proceedings, economy, land use, number of pedestrians, urban design, and social hierarchy (Scheer, 2017). The complexity and variety of the physical form of cities are reproduced in a diversity of morphological approaches to express, clarify and prescribe it.

According to Kropf (2009), the branches of urban form theory should support and correlate with each other. Approaches to urban morphology studies should embody a synthesis and confluence of results of other fields. Nevertheless, known differences may keep complete unification out of reach (Vis, 2018). Regardless of the distinctions

between the primary approaches that have been established independently in recent decades, there is a common foundation for the development of comparative studies and their relationships (Kropf, 2009; Moudon, 1997; Scheer, 2016). In recent decades, some comparative research of these traditions has been developed. The relationship between the historico-geographical approach, spatial analytical, and the process typological approach, which is probably the most discovered, has been structured by the progress of the International Seminar on Urban Form (ISUF) (Kropf 1993; Marzot 1998, 2005; Kropf, 2009; Whitehand 2003).

In addition, finding a correlation between the historico-geographical approach and the configurational approach has verified neither simple nor uncomplicated, and this has been mostly hindered by their dissimilar theoretical propositions and disciplinary traditions. In the past decade, there have been some endeavors to compare and combine these two methods (Pinho and Oliveira, 2009; Griffiths et al., 2010; Oliveira et al., 2015; Kropf, 2017). The process-typological and historico-geographical methods have a strong association. Both the historico-geographical approach and the process-typological approach focus on the building fabric, providing a comprehensive framework covering from micro to macro scale analysis, as well as a clear statement on the relevance of history in the development of urban forms.

On a larger scale, the spatial analytical approach provides the representation and modeling of urban patterns at the local, city, region, and even worldwide levels. This brings up the matter of the traditional urban morphology scale, which is characterized as a small scale of typical urban components (street, block, plot, building) (Larkham, 2019). Spatial analysis models may identify areas within a city or urban area. Cells in a model properly illustrate plots, parcels, and their simple arrangements (Kropf, 2009).

The historico-topographical methodology imparts to cellular automata, basically with new cellular automata techniques that can manage asymmetrical cells, a discovery of the plot as the least element of examination. Conversely, these two approaches have different perceptions of period: in the spatial analytical approach, the main focus is on anticipating upcoming urban development and growth, while in the historico-geographical approach, history has an essential part in the explanation and description of the urban form.

Lastly, the historico-geological methodology imparts to the configurational methodology an accentuation on the ground plan, especially on street networks; the historico-geographical acknowledges the significance of the block plans of buildings and plots, while space syntax is chiefly concerned with streets. Despite its focus on history, which contrasts sharply with the cellular automata's stress on anticipating future possibilities, both approaches emphasize the time dimension and the notion of the process (Oliveira, 2019). Space syntax seeks to clarify how cities work— the study of how space, movement, land use, human activity, and psychology interact to produce the complex forms we inhabit and experience is known as space syntax (Hillier, 2016). Space syntax, among other approaches, represents streets as networks rather than spaces, providing a useful supplement to traditional morphology (Larkham, 2019). Hillier (2016), in a broader sense, challenges space syntax in order to investigate the interrelationships between spatial and social networks.

Different approaches share the underlying morphological concepts of form perception in terms of configurations and understanding those configurations as the result of a reproductive process involving interactions between individuals and their environment. Identifying the relationships helps to confirm that far from being

mutually exclusive, different approaches complement each other (Krofp, 2017). Kropf (2009) suggested four general types of urban form research, containing spatial connections of physical structures, the relationship between physical features and humans, land-use changes, and flows. Table 2 describes different approaches to urban morphology. There are also a number of subcategories under each topic that are detailed classifications based on Kropf's comparative study in four methodological approaches, containing typo-morphological or typological process, configurational, historico-geographic, and spatial analytical. Each concentrates on slightly different characteristics of the urban form and uses dissimilar tools and methods.

The historico-geographical approach had its foundations in the twentieth century in the work of MRG Conzen, particularly in his book on the small town of Alnwick (Conzen, 1960). Based on his work, JWR Whitehand started to figure out a well-organized school of morphological thought (Oliveira, 2019). Conzen proposed an analytical understanding of the urban landscape based on the concepts of morphogenesis and a threefold division (ground plan, building fabric, and land and building utilization). Furthermore, he proposed several conceptions to clarify the urban expansion process, such as the morphological region, the burgage cycle, and fringe belt (Whitehand, 2001b).

The historico-geographical structure of the landscape serves as a starting point for identifying morphological regions (Oliveira, 2016). In the mid-twentieth century, another major school of thought has emerged in the field of urban form study, led by Gianfranco Caniggia. The process-typological approach can be traced back to the work of Saverio Muratori, particularly in his books on the operative histories of Venice and Rome (Muratori, 1959), and Gianfranco Caniggia, particularly in his books on

composition and building typology co-authored with Gian Luigi Maffei in the mid-twentieth century (Caniggia and Maffei, 1979). This approach examines the built environment's detailed structure and the historical process of its construction in order to inform architectural and urban concepts with a critical awareness of the built environment as a framework for development. It also aims to inform specific design proposals by using knowledge of the formative processes and evolution of building types (Kropf, 2017). The relationship between the process-typological approaches and the historico-geographical approach, framed by the development of the International Seminar on Urban Form (ISUF), is possibly the most discovered (Kropf, 1993; Whitehand, 2003).

Maffei (2009) goes back to the 1930s to find the initial relations between British geographers and Italian architects. According to the morphogenetic shared ground, the morphological period and the typological process, have been broadly compared, through developing the association among evolutionary process and historical development (Maffei and Whitehand, 2001). For the quantitative examination of spatial configuration, a new and novel system of theories and methodologies known as 'Space Syntax' evolved in the late twentieth century, and it has been praised for its scientific precision applied to morphological investigations.

This approach is a social theory of space established by Bill Hillier and Julianne Hanson at the University College London (Hillier and Hanson, 1984). In this theory, space is described as essential to social activity and it is comprehended as a configurational, sense that is inspired by network relations. By analyzing the buildings or spatial layout of cities, space syntax defines the human movement possibility and its formal and social interactions and perceptions. Specific techniques and tools are

used to help the theoretical and methodological development of this approach (Turner, 2004). This approach advanced several ways of configurational examination using axial, segment, and convex maps. In recent years, angular segment analysis has been acknowledged as a major configurational advance in capturing the social logic of space (Hillier, 2008, 2009; Turner 2007). Michael Batty's work (1985) can be seen as representative of the Spatial Analytical approach because he is involved in a wide range of urban modeling methods including GIS-based examination, cell automation, fractal models, and agent-based to understand the complexity of cities. According to Krofp (2017), the spatial analytical approach to urban morphology primarily focuses on human activities as sets of spatial connections.

The approach uses a variety of mostly quantitative techniques, such as mathematical models, especially cellular automata, network analysis, graph theory, fractals, other non-linear shapes, and agent-based models. The main point of the spatial analytical approach is that cities are complex adaptive arrangements containing a reciprocal and dynamic relationship between the physical form of settlements and socio-economic interactions. While there is an emphasis on patterns of networks and interaction such as transportation, socio-economic interchange, and physical, information flows, and energy, these patterns are considered as both giving rise to the physical form of cities and to be fundamentally influenced by it.

The goal of this approach is to discover the principles and relations that underlie the dynamics of the structures, classify the relationships between principles, and create a more comprehensive picture. Like other approaches, the basic morphological principles are the description and differentiation of components based on their position in the larger configuration or structure, and the conception of the structure is the

product of a dynamic procedure of formation and transformation. In general, the genres of these traditions can be classified into four clusters based on their concerns in various disciplines, including geography, architecture, science, and philosophy. for instance, in the field of urban geography, the Conzenian traditions act as the representative impression yet the Caniggian tradition takes the principal role in the respective of architects (Sima, and Zhang, 2009).

Despite the obvious disparities between configurational and historico-geographical approaches dealing with the study of urban form, there is a possibility to explore a relationship between both (Larkham 2006), Pinho and Oliveira (2009), or Li and Zhang (2021) found an opportunity to investigate a link between this two approaches. The historico-geographical and spatial analytical techniques both place a strong focus on the ground plan, particularly plots and land use. Plots and land usage are, in fact, two fundamental components for distinguishing morphological regions at all levels and laying the groundwork for cellular matrices' growth. Conversely, these two approaches have diverse conceptions of morphological period: In the past, history played a key role in describing and explaining the urban landscape.

In the latter case, the main concern is to predict the future of urban development. Historico-geographical and process-typological methods appear to have the strongest correlations among the four approaches. The process-typological mostly uses the building's fabric to show the fundamental types of structures, the connections among them, and how how they evolved. For the categorization of morphological regions at all scales, the two-dimensional (block plans of structures) and three-dimensional (building fabric) are essential. Both approaches use the same degree of analysis, which ranges from small to medium.

However, several methods have been developed in the process-typological approach to deal with specific morphological characteristics in large-scale studies. The process-typological and the spatial analytical, as well as the process-typological and spatial configuration, have the most fragile relationships in these sets of approaches. Although buildings may provide a link between these concepts, how they are dealt with in the three approaches appears to hinder the creation of any effective relationship. The configurational and spatial analytical approaches have a comparable degree of resolution, ranging from medium to large scale study. They also share the same view about predicting the development of urban areas. But in terms of elements of the urban form, these two approaches have nothing in common (Oliveira et al. 2015).

Table 2: Different approaches to urban morphology.

Approach	Theorists (Pioneers)	Elements	Aspects of Analysis (Focus)	Outcome
Historico-geographical approach	M.R.G. Conzen J.W.R. Whitehand Michael P. Conzen Michael Barke Vitor Oliveira Karl Kropf	Geographical structure and character of cities through a methodical analysis of their constituent elements and growth through time.	Street system Plot pattern Building pattern Land use Building fabric Plan unit Time	Hierarchical zoning by morphological homogeneity– map of morphological regions Understanding and clarification of urban landscape based on the formation process
Process typological approach	Saverio Muratori Gianfranco Caniggia Gian Luigi Maffei Giancarlo Cataldi Rob Krier Carlo Aymonino	Forms found at different levels are identified as types that are conceived as cultural entities rooted in, and specific to the local process of cultural development.	Physical form Function/ use Building fabric The act of construction/ modification The cultural process of derivation and/or development/ change time	Typological evolution of buildings over time. Understanding building fabrics based on transformation process
Configurational approach	Bill Hillier Julien Hanson Laura Vaughan Alan Penn Alasdair Turner	Spatial elements are represented through their geometric forms and how people experience them. They can be geometrically derived (point, axial line, segment, convex space, and isovist). Relationships between spatial elements can be analyzed using various measures (e.g. integration and choice).	Space/ physical form Use/occupation/ movement Street Spatial configuration	Classification of street system – map of street segments measured by integration and choice. Understanding the street system accessibility based on configuration. Analysing spatial layouts and human activity patterns in buildings and urban areas.
Spatial analytical approach	Micheal Batty Paul Longley John von Neumann John Conway Stephen Wolfram	Quantitative methods such as mathematical models, in particular, fractal, and other non-linear forms, agent-based models, cellular automata, graph theory, and network analysis.	Spatial distribution Spatial scales Focuses primarily on human activity as sets of spatial interactions	The result of this approach is to discover the underlying principles and relations of system dynamics, e.g. growth scaling rules.

2.6 Discussion on Similar Studies on Combined Different Morphological Approaches

To systematically review the research purpose of this study and identify its most important research gaps, this section discusses similar studies on combined and compared different morphological approaches, in particular, the combination of

historico-geographical and configurational approaches on urban morphology. There have been some attempts in the last decade to combine different morphological methods to urban morphology. Some authors have attempted to provide frameworks for comprehending the complexities of urban forms using composite viewpoints (Pinho and Oliveira, 2009; Kropf, 2009; Griffiths et al., 2010; Oliveira et al., 2015; Kropf, 2017; Monteiro and Pinho 2021; Li and Zhang 2021). As the journal's founder and longtime editor, Jeremy Whitehand has worked to promote multidisciplinary communication and conceptual variety through his opening editorial comments.

Simultaneously, he has long urged for the integration and development of coherence among the practical contributions to the discipline, so that its theoretical richness is more apparent to both those working in the area and those outside of it (Whitehand 2015, 2016). Most recently, Whitehand has once again turned his attention to obstacles to the incorporation of the discipline: including language barriers for many worldwide researchers, a lack of interdisciplinary incorporation of research findings, and a close gap between practice and research (Whitehand, 2018b).

As mentioned earlier, the recent publications of Vitor Oliveira on urban morphology, as well as Karl Kropf's handbook aimed at bridging the gap between researchers and practitioners, both show instructional milestones in arranging the basic and conceptual topography of the field (Conzen, 2019). Larkham (2006) points out that urban morphology has not structurally exploited the possibilities provided by the GIS (Koster 2009; Pinho & Oliveira 2009), as well as the complementarity among urban morphology and spatial syntax in particular (Sima & Zhang 2009). Before long, his calls for complementarity and integration gained wider support (e.g. Sima & Zhang 2009; Kropf 2009; Pinho & Oliveira 2009). However, in order to achieve full

integration, degrees of compatibility in the way of the urban form must be decided. The acceptance of this challenge in terms of real attempts to integrate methodologies is limited (distinguished exceptions include Griffiths et al. 2010 and Oliviera et al. 2015), indicating that there is still a lot of conceptual work to be done (Conzen, 2019). Notable efforts have been made to coordinate and combine different approaches to urban morphology. For example, Pinho and Oliveira (2009) presented some suggestions for linking the gap between different morphological approaches at theoretical, conceptual, and methodological levels. They examined the evolution of Porto's (Portugal) urban form over the last two centuries by integrating space syntax with Conzenian techniques. They described the origins of the Conzenian and Muratorian schools and also presented the basic concepts of space syntax, as well as its most important distinctive features: the focus on space, the representation of spatial relationships on the axial map, syntactic measurements in the case of Porto city. They suggested developing the articulation between space syntax and GIS-based methods. This has been investigated in various research contexts, by authors such as Jiang and Claramunt (2002) and Marcus (2007). The results of the syntactic methods in the Porto analysis, on the one hand, confirmed the main conclusions of the previous study within the framework of the ISUF framework and on the other hand, they highlighted some aspects that did not appear in the morphogenetic analysis.

Porto's morphogenetic investigation has been described in three earlier published articles. Oliveira and Pinho (2006) characterized different periods of Porto's urban growth. Oliveira and Pinho (2008) critically studied the most significant urban planning policies of the 19th century. Lastly, Pinho and Oliveira (2009) assessed the use of cartographic redrawing in the analysis of specific cities over a long period.

Figure 16 shows parts of the town plans and axes of Porto city from 1813, 1839, 1892, 1932, and 1978 (Pinho and Oliveira, 2009).

Kropf (2009) conducted a critical analysis of publications representing configurational, spatial analysis, typological processes, and historico-geographical approaches. His ultimate aim was to build a unified and composite framework in which the different approaches support each other to provide a better comprehending of the built environment. Kropf (2009) has sought to apply the combined view to urban form itself by undertaking an empirical and comparative critical examination of crucial texts from the dissimilar approaches to urban morphology.

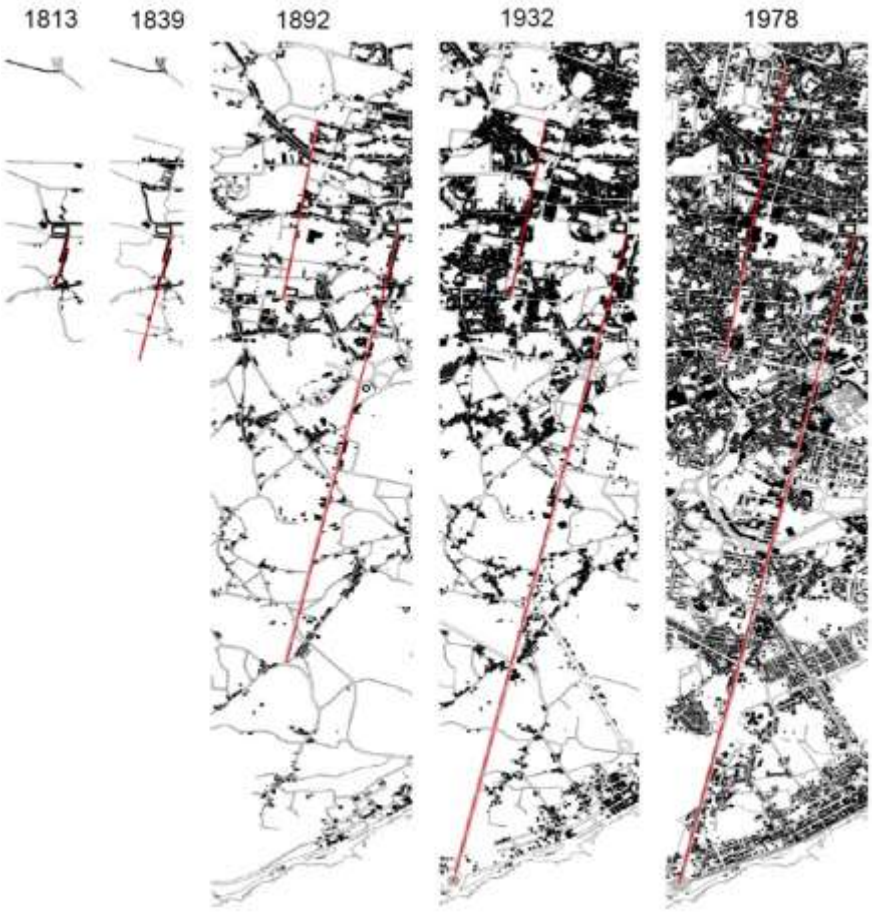


Figure 16: Axes of Porto city from 1813, 1839, 1892, 1932, and 1978 (Pinho and Oliveira, 2009).

The outcome highlights that there are at least four comprehensive kinds of aspects: spatial relationships of physical features, interrelations among humans and physical features, movement, and transformation. There are also several subgroups under each theme that are specifically categorized based on Krupp's comparative assessment with the four analytical methods identified, including hitorico-geographical, typological process, spatial analytical, and configurational. According to Kropf (2009), morphological methods to researching city space should be a synthesis of results from multiple disciplines.

These approaches work from an existing set that lacks a clear definition of integrity and its constituent objects. Using the physical form as a common reference aspect to coordinate dissimilar descriptions of urban form will be an important step to creating a more coherent understanding of human settlements. If the urban form remains incorporated, we must be content with a fascinating but eventually mysterious phenomenon. If we distinct the aspects but leave them isolated and free, we should suffice to listen to a number of unconnected conversations at the same time (Kropf 2009). According to Kropf (2009), a comparative (practical) ontology must satisfy specific characteristics. These are composed of a coherent, logical, and complete set of descriptions that are generic enough to be used relatively in all conceivable contexts, but particular enough to identify them as analytical units in the practical reality of datasets (Vis, 2018).

The gap that prevents a comprehensive understanding of the urban form has been recognized unequivocally through the absence of integration of urban morphology and the space syntax (Pinho & Oliveira 2009; Kropf 2009; Griffiths et al. 2010; Whitehand 2010). Such dissatisfaction is often accompanied by an acknowledgment of the

benefits of methodological integration, although this is still a relatively untapped resource. Boundaries have been suggested as a way to fill conceptual gaps in the study of the urban form (Vis, 2018). Kropf (2017) has developed the structural overlap, which allows the urban tissue and configurational analysis concepts to be combined. He underlines the advantages of this combination, noting that configuration provides a foundation for distinguishing types of urban tissues and establishing a more precise context for configurational measures.

Griffiths et al. (2010) attempted to combine Conzenian methods with space syntax methods in an integrated GIS environment to examine the streets of suburban centers in Greater London, UK, showing that the two approaches could complement each other but the former could not address the issues raised by the latter (Griffiths et al. 2010). In an investigation of two suburban centers, they combine an examination of morphological transformation, based on a sequence of historical cartographic bases, with the procedure of space syntax to examine the interaction of physical form with accessibility. Griffiths et al (2010) have examined how space syntax segment angular investigation can differentiate layers of the suburban in Greater London.

They identified how many suburban high streets developed in an unplanned system along roads that linked to centre of the nucleated settlement or the original marketplace (Vaughan, 2015). The space syntax data were derived from the examination of a segment graph mapping the adjacent street network of the Greater London region. Figure 17 displays a gray-scale space syntax representation of the Greater London area generated using Depthmap software. The graph signifies street network accessibility as possible through movement. Each segment is colored from black to white in relation to how many times it falls on the straight angular route that is the relatively shortest

path among all other segment pairs in the system. They claimed that the space syntax method supplements the Conzenian study by simplifying the examination of street plan in terms of its association with the local urban street network. In contrast, the quantification of accessibility embodied by space syntax graphs requires completer interpretation considering systematic historical research to establish the extent to which these graphs are meaningful in terms of socio-spatial.

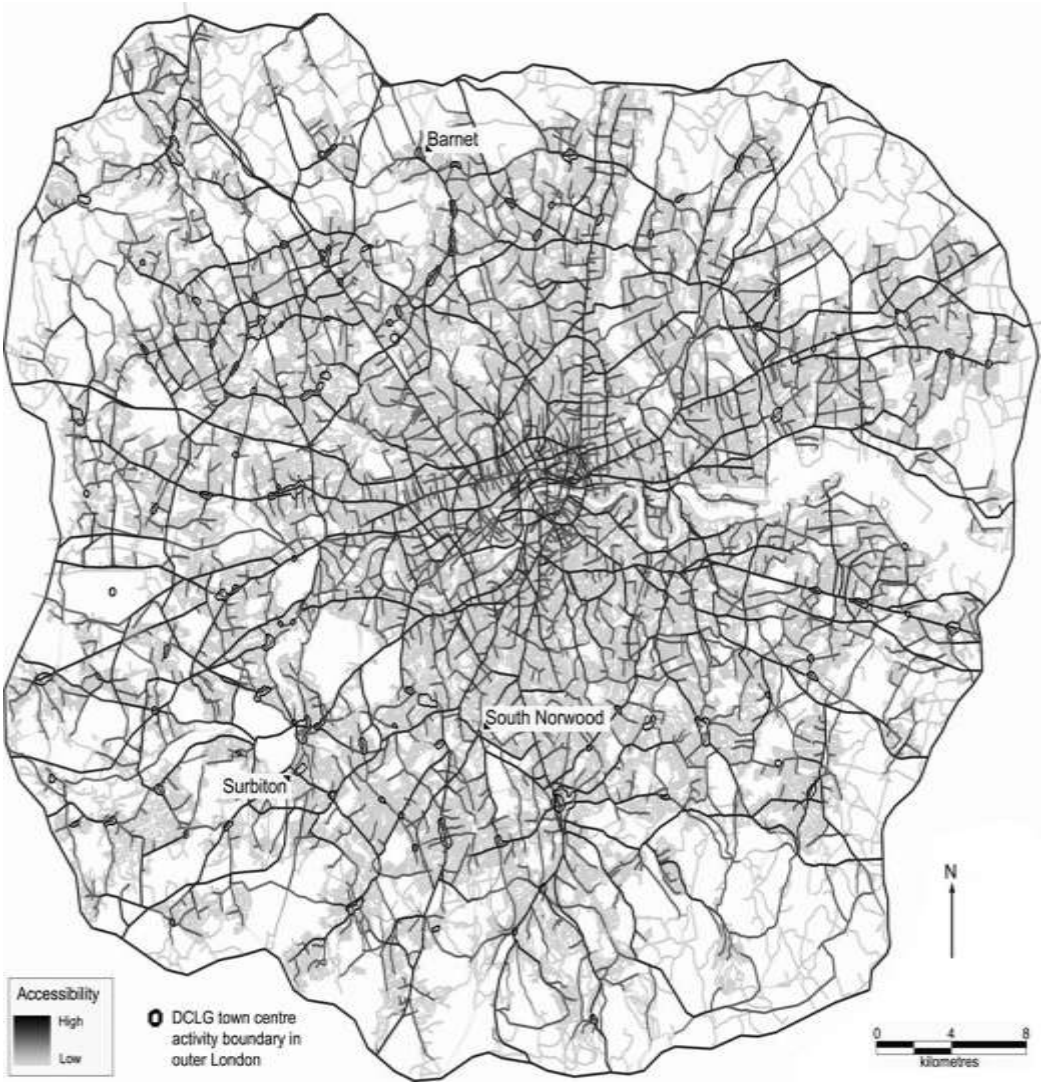


Figure 17: Greater London space syntax graph represented through movement radius-n (Griffiths et al. 2010).

Oliveira et al. (2015) advanced the line of research initiated by Kropf. They selected one impression for each approach and applied four models in the traditional gateway

area of the city of Porto, Portugal. They tried to figure out how to coordinate and combine these approaches to improve the prescription and explanation of the urban form. Oliviera et al. (2015) used the concepts of all four main theoretical approaches previously discussed in Porto, Portugal, and recognized that "morphological regions" might in the future offer the most promising means of incorporating the various outcomes of each approach (Conzen, 2019). They tried to comprehend how to integrate and coordinate different morphological approaches to develop the ability of investigators and practitioners, to designate, prescribe, and explain the physical forms of cities. They compared the essential thoughts proposed in each of the four main methods to urban morphology: the historico-geographical approach, the typological process, the configurational approach, and the cellular automata or, more generally, spatial analytical.

The concept of a morphological region has been proposed as a coordinating framework using four techniques in the study area in Porto. At Rua de Costa Cabral and its surrounds in Porto, Portugal, four morphological concepts (morphological region, spatial configuration, typological process, and the cell) were used (Figure 18). The collaborative combination of dissimilar morphological approaches offers a new perspective for the progress of urban morphology studies. They classified the chief points of interaction among the four concepts in the threefold subdivision (Table 3): time, elements of urban form, and levels of resolution.

The morphological region concept emphasizes the town plan, chiefly on land utilization and plots. land use and plots are the two essential components for the recognition of morphological regions. On the contrary, the two concepts have different notions of time: first, the importance of history in the description of urban

environments is significant; lastly, the main concern is to anticipate the future of urban development scenarios. Compared to the local scale analyses carried out in this subsection, the concept of morphological regions seems more applicable. The notions of spatial configurations and morphological regions share the importance of the town plan. Streets are critical for recognizing high and middle-ranking places, and roads alone provide a basis for comprehending high accessibility. As with morphological regions and cells, these two concepts seem to have different conceptions of time and different degrees of resolution (Oliveira, 2016).

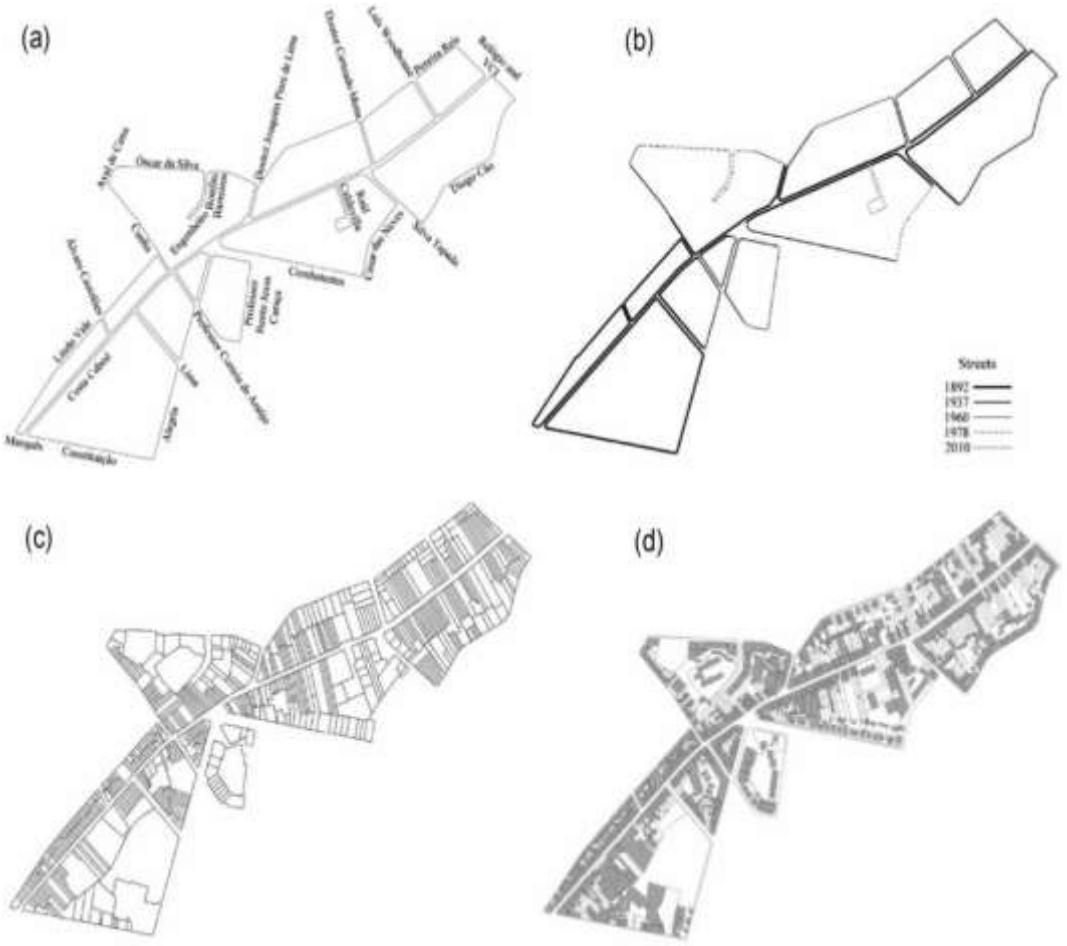
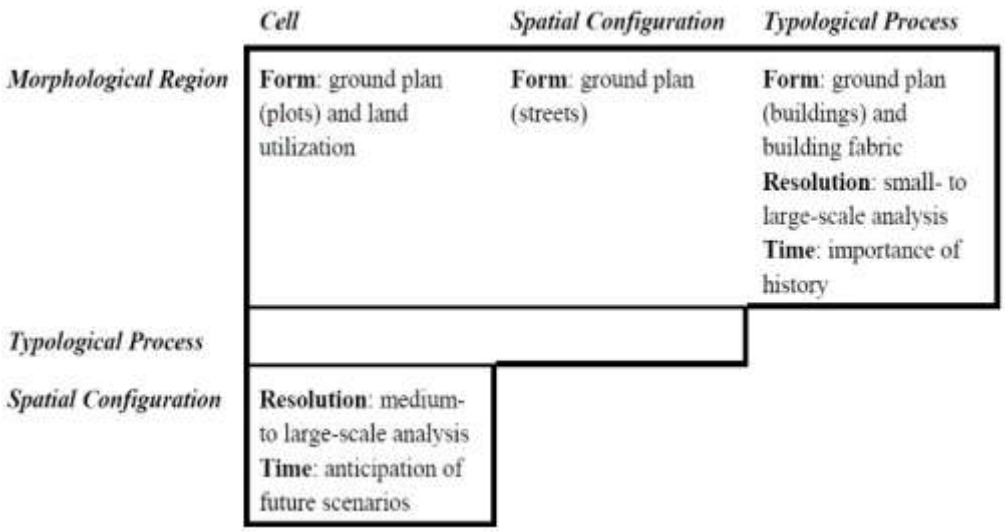


Figure 18: Rua de Costa Cabral: (a, and b) streets, (c) plots, and (d) constructions (Oliveira et al.,2015).

Table 3: The crucial points of connection among the different concepts (Oliveira et al. 2015)



Li and Zhang, (2021), developed a methodological structure for integrating the configurational and historico-geographical methods to identify their complementarities. They used Chinatown in Singapore and Ludlow in the UK as the case studies to examine their new framework. They recognized that the configuration of the streets, in particular the integration and segregation patterns, correlates with the distribution of the plan units and, thus, may influence their recognition; conversely, place-specific information about the historico-geographical process of the cities can aid to clarify the modifications in the configurational properties of dissimilar plan units. They eventually found that combining these two methods can provide a better comprehension of the historical formation and transformation of the form of the metropolises for both incrementally growing urban areas and those with rapidly altering urban landscapes. Indeed, the historico-geographical approach can classify a hierarchy of plan units that reflected the historical expansion of the urban area.

Monteiro & Pinho, (2021) argued that there are different views on understanding, explaining, and designing urban forms. Urban morphology can go beyond these sights

by comparing and developing new combined views. Their research addresses the present challenge in three parts: the first section separately applies the historico-geographical, typological process, and configurational approaches to Porto city. The second section applies the combined methodology for Morphological Analysis and Prescription (MAP) to the city of Porto. Lastly, the third section promotes a comparative analysis of findings derived from the first earlier methods. The MAP technique is a theoretical and methodological framework in urban morphological studies. This methodology draws on the incorporation of three approaches (historico-geographical, configurational, and process-typological), and three procedures within these methods (morphological regionalization, angular segment analysis, and typological process).

The MAP collects the particular contributions of each method and process, through a combined vision of the sections and entire, consists of complementary ways of approaching the elements of urban form, and different scales of analysis. The foundation that supports the combined framework of MAP is the separation of the urban tissues into morphological units (figure 19) (inferred from the theory of morphological region) supplemented by the typological process of constructions and the angular segment examination of the street networks. Table 4 elucidates the MAP methodology in six phases. Monteiro & Pinho, (2021) focused on comparing different approaches of urban forms, exploring the uses and advantages of composite insight. The pilot study of the three approaches underlined their potential and clarified the possible relationships (the common ground) that allowed to accurately combination the different methods into the MAP methodology. Subsequent comparison with MAP has shown that there are advantages in combining these approaches. They tried to offer

answers to some key questions in the field of urban morphology, about the comparison between different morphological approaches and the crossing of research paths, advancing towards the creation of an effective incorporated and combined framework for a better describing and prescribing urban form. Analysis and Prescription (MAP) to a study area in Porto offers relevant findings.

Table 4: Procedural framework of Morphological Analysis and Prescription (Monteiro & Pinho, (2021)

Phase		Approach	Method
Analysis	1 Delimitation and characterization of morphological units	historico-geographical (process-typological)	morphological regionalization (typological process)
	2 Identification of the typological process	process-typological	typological process
	3 Development of angular segment analysis	space syntax	angular segment analysis
Prescription	4 Regulation of the street system	space syntax	angular segment analysis
	5 Definition of guidelines for urban form transformation	historico-geographical process-typological	morphological regionalization typological process
	6 Contribution to the zoning map and regulation		

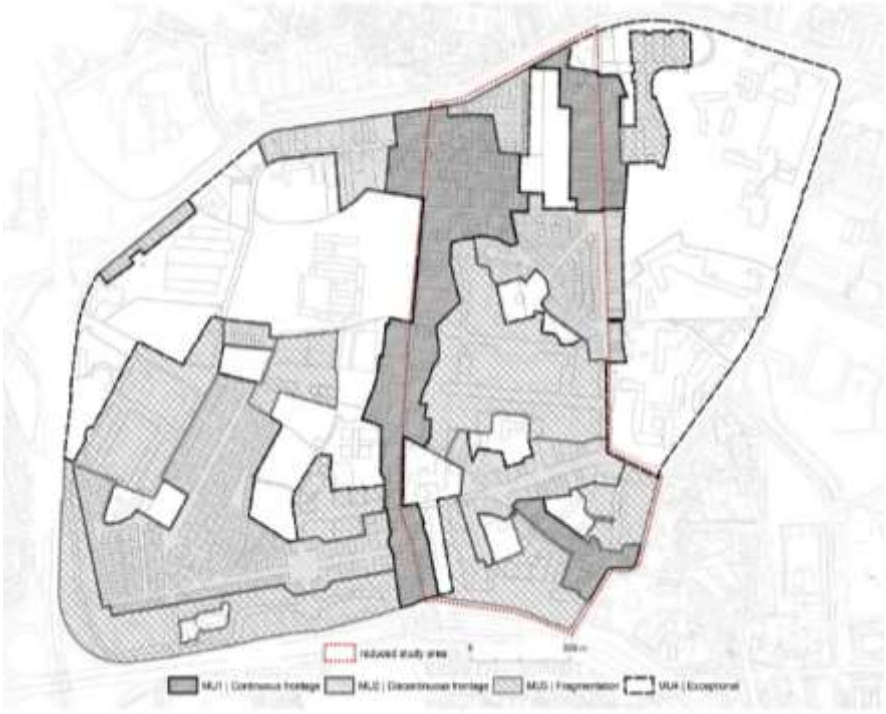


Figure 19: Morphological units' map (Monteiro & Pinho, 2021).

2.7 Chapter Summary

This chapter considered four different approaches to the study of urban form; the historico-geographical approach, the typo-morphological (or process typological) approach, the configurational approach, and the spatial analytical approach. According to Kropf (2017), the spatial analytical and historico-geographical have come out of the field of geography, and the configurational and the typo-morphological approaches have origins in the fields of architecture and urbanism. Eventually, it tried to take into account the previous attempts and those authors who have tried to combine different morphological approaches.

Table 5 summarizes previous efforts by referring to the main characteristics of each approach and comparing and combining them in separate studies. Based on the outcomes obtained from the comparison of previous research, it can be concluded that each of the methods develops a specific way of analysis and interpretation of the urban landscape, with different purposes, even if concurrent in the observed elements of urban form. The historico-geographical approach aims at understanding the structure of the urban landscape and the underlying development processes, based on the historical expressivity of the landscape and the morphogenetic priority of the different elements of urban form. The typological process of buildings tries to comprehend the progressive transformation of building types over time, based on a process in which modifications of existing forms lay the foundation for the production of new forms in subsequent periods. The configurational analysis seeks to comprehend human movement based on the street system's configuration, evaluating street accessibility using a set of syntactical measures.

Table 5: Authors who have tried to combine different morphological approaches.

Approach	What are their main characteristics? What are the common aspects that they share with other approaches?			
	Historico-geographical Approach	**Typo-morphological Approach**	**Configurational Approach**	**Spatial Analytical Approach**
Kropf (2009), (2017)	This approach to urban morphology pursues to clarify the geographical patterns, character, and structure of human settlements thru a systematic examination of their essential elements and expansion through time.	This approach seeks to inform architectural and urban proposals with an understanding of the built environment as a context for development by examining its detailed structure and the formative processes.	The configurational and typo-morphological approaches have origins in the fields of architecture and urbanism.	The spatial analytical and historico-geographical have come out of the field of geography. This approach makes use of a range of quantitative methods such as mathematical models (fractal and other non-linear forms, agent-based models, cellular automata, graph theory and network analysis).
	Combined and Compared Different Morphological Approaches			
	Undertaking a comparative critical analysis of key publications from the different approaches to urban morphology. The outcome highlights that there are at least four broad types of general aspects: • spatial relations of physical features • interrelations between humans and physical • flows • change			
Pinho and Oliveira (2009); Oliveira et al. (2015)	**Historico-geographical Approach**	**Typo-morphological Approach**	**Configurational Approach**	**Spatial Analytical Approach**
	The application of the approach of morphological region presents a number of outcomes concerned with the historico-geographical structure of the landscape. The outcomes for each street are mostly related to its shape and the plots and buildings that express it.	The typological process uses the fabric of the building as a whole to disclose the types of buildings, the main relationships between them, and how they evolve over time. Typological process and morphological region seem to have the potentest connection	The way that spatial relationships within a building or urban area, are displayed is a typical element of space syntax. The most faint association can be found among the spatial analytical and typological process, and between the spatial configuration and typological process.	They work within a grid based on primary rules explaining the state of the cell according to the shape of the neighbors and their connection to the cell itself. Land utilization and plots are two essential elements for the recognition of morphological regions at all ranks, and for the development of the cellular matrices.
	Combined and Compared Different Morphological Approaches			
	Oliviera et al. applied the concepts of all four of the main morphological approaches considered earlier to the city of Porto, and finalized that, "morphological regions" might in the future offer the most promising means to complement the different results of each approach. The principal points of communication between the four approaches are examined in threefold: elements of urban form, levels of resolution, and time.			

Approach	What are their main characteristics? What are the common aspects that they share with other approaches?			
	Historico-geographical Approach	**Typo-morphological Approach**	**Configurational Approach**	**Spatial Analytical Approach**
Griffiths et al. (2010)	The Conzenian and configurational approaches promise an enhanced analysis of the relation between street plan, plot pattern and land use in which it becomes possible to describe the relationship between the street network in which street plans are embedded.		Syntactic research of space separates from the Conzenian perspective because its main concern is not with historical morphological periods, but with the relationship between street networks, movement patterns, and land use distribution.	
	Combined and Compared Different Morphological Approaches			
	Griffiths et al. Sought to combine the syntactic methods of space with historico-geographical thinking in the study of the streets of the Greater London suburbs, and showed that the two approaches could complement each other, but the former could not solve the questions posed by the latter.			
Monteiro and Pinho (2021)	**Historico-geographical Approach**	**Typo-morphological Approach**	**Configurational Approach**	**Spatial Analytical Approach**
	Understanding and description of urban landscape based on formation process and form complexes	Typological evolution of buildings over time Clarification and design of building fabric based on evolution process	Organization of street system – map of street segments measured by integration and choice. Clarification and assessment of street system accessibility based on configuration	
	Combined and Compared Different Morphological Approaches			
	Comparison with MAP has shown that there are advantages in combining (historico- geographical, process typological and configurational approaches). MAP methodology suggests a structured examination of the different elements of urban form and offers a new insight about the associations between street network, town plan and building types.			

	Historico-geographical Approach	Typo-morphological Approach	Configurational Approach	Spatial Analytical Approach
Li and Zhang (2021)	This study proves that street configuration is interrelated with the distribution of plan units; also place-specific knowledge relating to the historico-geographical process of the city can aid to clarify the transformation in the configurational properties of different plan units.		From a configuration point of view, the characteristics of the street networks can be used in conjunction with other elements of the urban form to inform and identify the characteristic areas (e.g. morphological areas).	
	Combined and Compared Different Morphological Approaches			
	The authors provide a methodological framework for combining historico-geographical and configuration approaches in order to consider their complementarity. Findings show that the combination of these two approaches can provide a better understanding of the historical changes of the urban form for both urban districts with increasing growth and areas with rapid changing urban landscapes.			

Chapter 3

HISTORICO-GEOGRAPHICAL AND CONFIGURATIONAL STUDIES

The physical structure of cities is defined and clarified by city morphology. Taking a dynamic perception, it describes how its various factors change physical arrangement during the time and how a variety of procedures are involved in this transformation. Urban morphology can also provide understanding into prescribing new urban forms and modifying or preserving existing forms (Oliveira, 2019). The field of urban morphology has a significant contribution to our understanding of cities and has great potential for further deepening. Urban morphology is a scientific approach to understanding changes in urban form in the light of human behavior patterns and the historical development of cities. Urban morphologists examine the evolution of a city's transformation through allocating and determining its diversity of components. Over the years, various studies have been conducted on historical approaches. Such works have been carried out to examine historical development in different countries (Koc and Kubat, 2019). Adapting the theoretical framework of urban morphology and referring them to the historico-geographical structure of urban development can lead to proper planning and urban design strategies that purpose to improve the quality of life in modern urban landscapes (Karaulan and Kubat, 2018). The emphasis of this chapter is mainly focused on two dominant approaches in urban morphology, the historico-geographical and configurational approaches which are the key point of this thesis. The combined/coordinated methodology discovers the spatial structures of

urban areas that are more likely to be correlated with historical urban processes. Given the potential of these two approaches as a coordinated and combined methodology to inform morphological region or plan unit identification, selecting and applying these methods could be an emphasis for prospect historico-geographical studies. The combination and coordination of these two approaches can provide a new perspective on the transformation processes of urban form.

By methodically evaluating and associating urban structures throughout different morphological periods, knowledge about the formation, transformation, and continuities of street configuration can be used to comprehend the evolution and the interrelationship between plan units or morphological regions. On one hand, the space syntax sees street configuration as encapsulating generative rules of space and, to a large extent accounts for the spatial distribution of movements and subsequently, different land uses (Hillier and Vaughan, 2007). For instance, integrated street networks have been proved and identified to be associated with the spatial distribution of socio-economic activities.

On the other hand, the spatial-functional, historical, and geographical comprehension about the formation and transformation of plan units or morphological regions can be applied to evaluate the role that street arrangement plays in the formal evolution of a city. While presenting the origins and main developments of each of these approaches, it goes one step further debating how these two can complement each other in the following section. This section covers a broad range of theoretical frameworks that anchor the studies of built urban form. All of these discussions have a considerable influence on this research in either a direct or an indirect manner. The historico-geographical method deals with the cities through the historical and geographical

organization of the urban setting. To accomplish so, it emphasizes three basics of the urban environment, which are divided into three categories: the town plan, which includes streets, plots, and the block plans of buildings, the building fabric, and land and building utilization (Conzen, 2018; Oliveira, 2019a). This chapter covers spatial syntax, a recent configuration method for the study of urban morphology showing some conceptual connections with structural sociology analysis in the street networks. It presents the fundamental concepts, methodologies, and measures of this analytical approach focusing on the analysis of axial and segmental maps – the two most frequent spatial syntactic methods related to the study of urban morphology. The historico-geographical process shares an emphasis with space syntax; whereas space syntax generally focuses on streets, the historio-geographical approach recognizes the significance of the block plans of buildings and plots (Oliveira, 2019a).

3.1 Historico-geographical Approach

In the middle of the twentieth century, the historico-geographical method had its origins in the works of MRG Conzen (1960), a German urban geographer. Conzen was an important developer in the progress of urban morphology through his studies on British towns (1962, 1966, 1960, 1969, 1975, 1985). Urban morphologists of this approach tend to build a hierarchy of the city at different scales. The structure in the case of Alnwick is a tripartition, wherein the original town plan is divided into the street structure, plot structure, and building structure, and the socio-economic activities can be interpreted via the function of the space (Kropf, 2009). Whitehand (1977) specified that the historico-geographical characteristics of the urban form had not received sufficient attention from researchers to produce either basic review literature or textbooks. In contradiction of that background, he suggested a hypothetical outline, in which the clarification of the urban form was embedded in a broader field of the

social and economic processes (Oliveira, 2019b). The historic-geographical method has emerged in the last decades in the discussion of the physical arrangement of metropolises and the processes and factors that shape them during the time (Oliveira, 2018). The background of the historico-geographical approach was discussed in detail by Whitehand (1981).

And the ideas of M.R.G. Conzen have been examined in many early papers (Whitehand and Larkham, 1992; Whitehand, 2001a) and recent studies (Kropf, 2017; Ünlü and Baş, 2017; Karaulan & Kubat, 2018; Kubat, 2020; Kristjánsdóttir, 2019; Oliveira, 2019; 2018). Following Conzen, Whitehand paved the way to diffuse urban morphology to a larger number of researchers. The Urban Morphological Research Group (UMRG), which he established at the University of Birmingham, has been acting as a center for the historico-geographical approach in urban morphology for nearly half a century since its establishment in 1974 (Oliveira, 2019). Conzen's study of Alnwick (1969) is an important book that defines the scope and principles of the historico-geographical approach.

This was further developed by Whitehand (1987, 1992). In association with the recovery of urban morphology in the mid-20th century, the establishment of the ISUF Seminar in the mid-1990s was followed by five important studies of international cooperation. The first was a collection of articles revised by Slater (1990) in which the chief topics were covered by M.R.G. Conzen, was considered. The structure and content of other corporations (Whitehand and Larkham, 1992) followed the basic themes of the historico-geographical approach. Another study, revised by M.P. Conzen (2004) was a collection of M.R.G. Conzen's surveys that were typically not published formerly. Lately, two more studies (Larkham and Conzen, 2014; Oliveira, 2019b) have

been available as compliments to Whitehand's influence on the international study of urban form. In 1926, Conzen began lecturing at the University of Berlin's Geographical Institute. His concern was encouraged by Schlüter's method of cultural geography (Whitehand, 1981). After interrupting his career due to political developments in Germany and his immigration to Britain in 1933, M.R.G.

Conzen later criticized urban studies, which was dominated by the use of quantitative models and the destructive attitude of modern urban planning in reviving urban morphology after World War II. He developed the historico-geographical approach to link morphological and functional approaches, where the previous emphases on the identification of the urban civic as a socio-geographical group with its socio-economic function and structure in terms of their spatial suggestions, while the latter classifies the formative processes and their outcomes in the urban built environment (Conzen, 2004). The importance is upon the formation of an outline of fundamental associations. It questions the nature of associations and the methods they come together to create the urban landscape (Whitehand, 1977).

3.1.1 Town Plan

A ground plan in all its man-made characteristics can be described as the structure of an urban built-up environment (Conzen, 1969). Figure 20 shows the examination of urban environments according to their town plan. These three elements are noted in the assessment of the town plan: Street system, Plot pattern, Building pattern. Any city's town plan consists of three basic components: streets, plots, and buildings Figure 21 shows graphical analytical techniques for the separation of streets, plots, and building elements along with general structure diagrams.

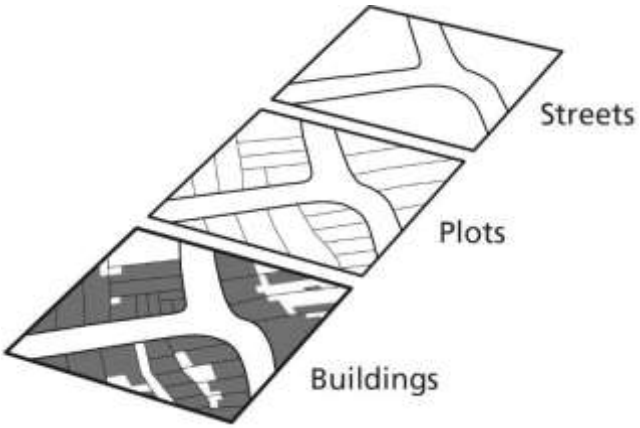


Figure 20: Morphological pattern (Kropf, 2017).

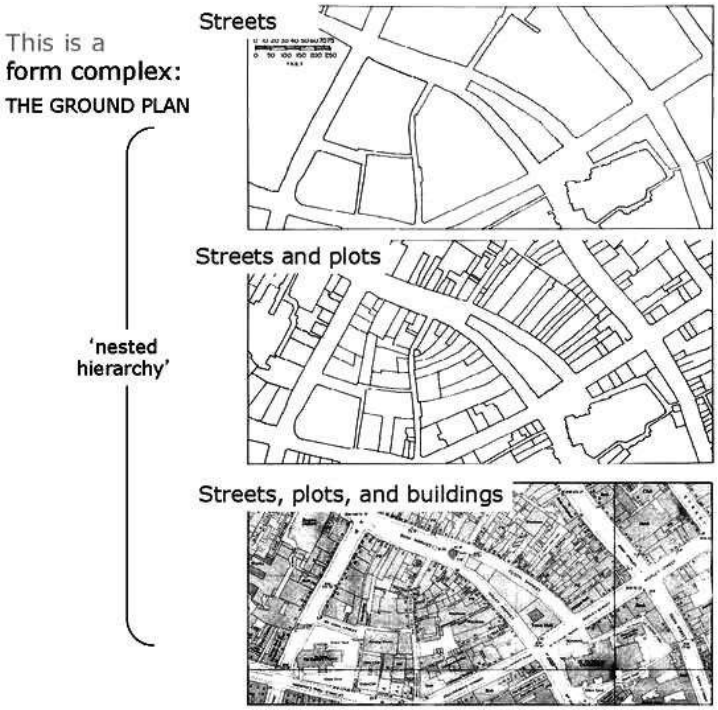


Figure 21: Spatial hierarchy of the urban basics (Conzen. 1981)

3.1.1.1 Street Pattern

Conzen (1960) identified streets as autonomous uncovered spaces that facilitate the movement of pedestrians and vehicles. As an urban division, this autonomous but interrelated scheme is being examined. Different streets have dissimilar structures, based on their usages. The street relates to the open space restricted by street and allocated for the use of any kind of surface traffic, which implies arranging adjacent

intercommunicating streets that are seen as a distinct element (Conzen, 1969). Streets form a wide-ranging system of routes interaction thru a city and provide links to entirely land parcels (Kropf, 2011). Conferring to Marshall (2006), Streets are one of the primary space organization tools in relation to buildings. Streets are functionalized within the space organizations. Types of streets are becoming significant for designers and planners to design new implementations. The critical point, therefore, is to determine the link between street hierarchies and pattern types (Marshall, 2005). A new urban model liberated forms of the streets and buildings from each other. This model could articulate buildings as solid sculpted arrangements set in urban space (Figure 22) (Marshall, 2015).

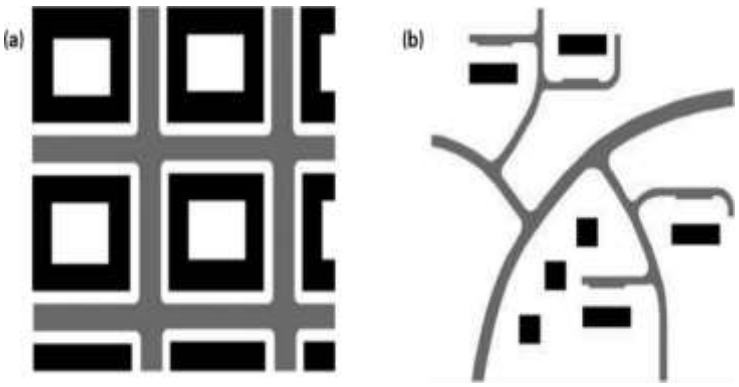


Figure 22: Traditional versus contemporary layouts. (a) Road and building fit. (b) Roads and buildings (Marshall, 2005)

3.1.1.2 Plot Pattern

M. R. G. Conzen (1969) firstly explored the expansion series of urban plots in relation to the burgages in British medieval towns. Some of his most fruitful thoughts were developed in association with the plot, which provided a very precise, micro-scale framework for examination by the standards of British human geography. One aspect to which he gave typically full attention was the connection between the block plans of buildings and plots (Whitehand, 2001). Conzen's investigations of British cities

considered the development cycle in the boundaries of individual plots. While the plots are the main units of morphological transformation through the development cycle, further morphological developments comprise plot combination and division (Conzen, 1969). A plot is a plan element or parcel of land demonstrating a land-use unit defined by borders on the ground. According to Conzen (2004), a plot pattern is the arrangement of adjacent plots in an urbanized area observed as a distinct element complex o the town plan and separated into street blocks. The line defining a street block is made up of the street lines of multiple different streets.

However, because Conzen (1969), considers both the plot series and the street block to be divisions of the plot arrangement, the plot is restricted in one or both of these sectors in strict terms. Rather than specifying a hierarchical association between the plot and the street, this just asserts the obvious fact that the plot is contained within an aggregate of plots (Kropf, 2014). Figure 23 shows the buildings confined to a single plot and plots as part of a street block that is the aggregate formed by different streets. In various schools of urban morphology (Moudon, 1997; Whitehead, 2001), plots are recognized as essential elements of urban space along with streets and buildings.

Conzen (1960) deliberated the major ambiguity of the plot, which is both a physical and a legal personality as well as a boundary for land utilization planning (Kropf, 1997). He went on to describe the plot as a fundamental organizational element of the urban form via the pattern of land division (Moudon, 1994). Conzen further presented the notion of burgage cycle: the development of built space during the time, bound by the spatial framework of the plot. The following are the distinctive properties of plot systems in urban morphology, according to Bobkova et al. (2017): First, as a basic unit of control, the plot establishes a fundamental link between

spatial and non-spatial entities (Kropf, 1997; Marcus, 2000). Second, the plot acts as a link between the built environment and the space of movement, since it connects a building to a moving network (Panerai et al., 2004). Lastly, the plot delivers the framework for the development of built form over time (Conzen, 1960; Terlouw, 1999).

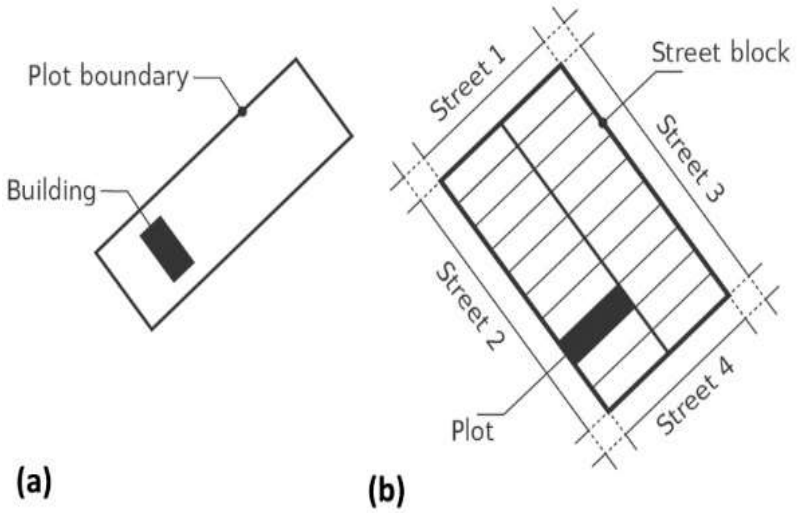


Figure 23: (a) The building contained within the plot. (b) Plots contained within the boundary created by several streets Kropf, 2014)

3.1.1.3 Building Pattern

In the conception of block plans, Conzen (1960) defines the buildings as the focal part of the town plans. In terms of their plots, they are more open to alteration than other parts of the urban blocks. Block plans or buildings are the objects defining the floor of the plot. In other words, that is, the block plan is called the space that occupied the plot. Space itself is the primary issue rather than architectural details (Conzen, 2004). The spatial relationship between components is a suitable characteristic to clarify the building pattern, as a mixture of structures (Conzen, 1969). The town plan is a structural arrangement of the built urban environment and includes three distinct sets of plan elements. The first is the streets and their arrangement in a street organization.

The second is the plots and their combination in blocks, and the third is the block-plan of constructions or their footprints. In addition, the building fabric is the three-dimensional configuration and arrangement of buildings in an urban area. It is a fundamental of three-element of building types, styles, and materials. Building and land use is the functional purpose of building and land. Within the classified nesting of three regular form complexes, the town plan delivers a morphological framework including the fabric of the building and the land use pattern, and the fabric of the building is the morphological framework for land use (Kropf, 2014).

3.1.2 Townscape

The townscape consists of the complexes of the systematic form, namely the town plan with its street scheme and linked plot pattern, the building fabric with its building types, and the pattern of building and land use with its land-use type. They are combined in the nested spatial arrangement at the level of townscape essentials, whereas the town plan is the morphological framework involving or holding the building type and land use pattern, and the plan unit is the morphological framework containing the covered, usually more essential part of land use (Conzen, 2004). Figure 24 demonstrates Barret's examination of the structure of spatial form, and the combinations of ground plan and a city landscape in the center of Birmingham. They show the primary street development formation; as Whitehand states, they are therefore the highest-ranking urban landscape units. Beyond, they represent the land utilization and building units (Whitehand, 2009).

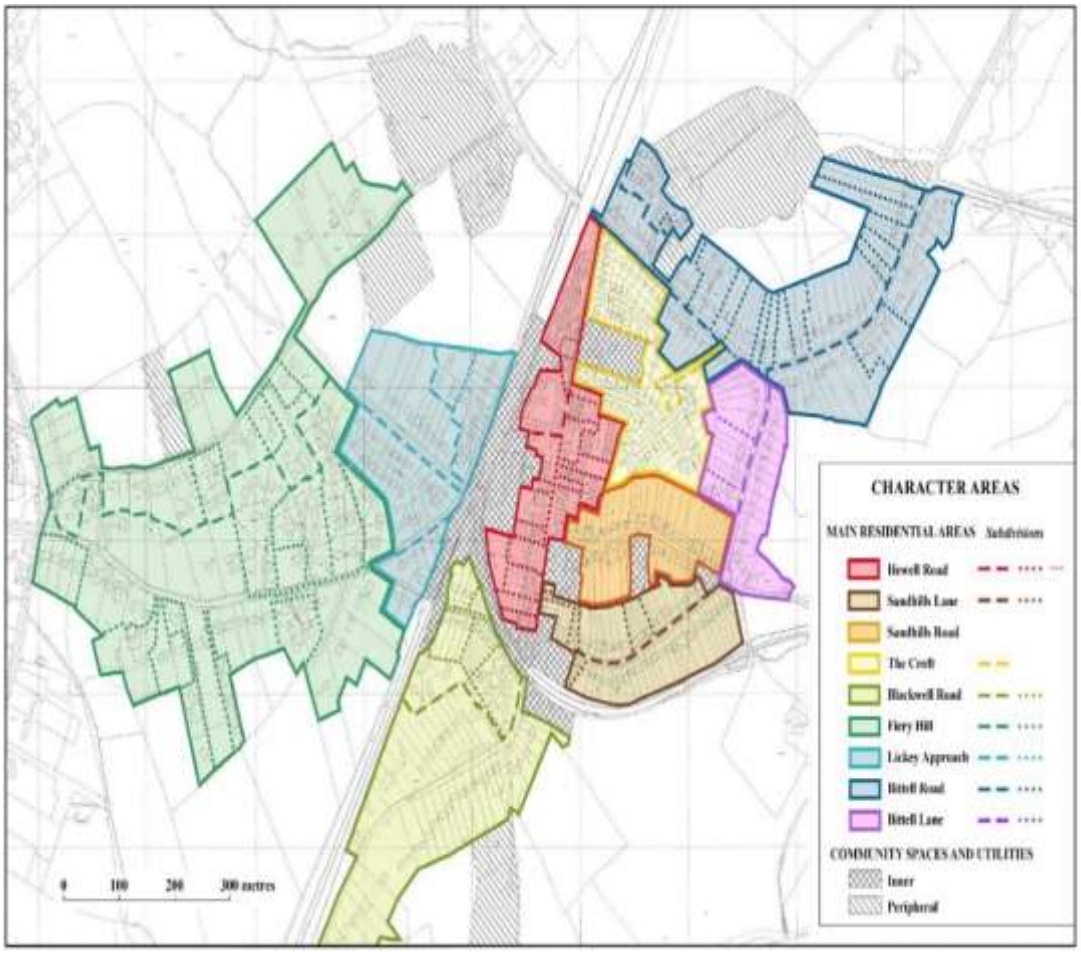


Figure 24: The features of Barnt Green area, near Birmingham, England in 2005 (Whitehand, 2009).

3.1.2.1 Land Utilization

Land use is a crucial factor in the district's growth. This factor is considered as an activity scheme generator that determines the direction and patterns of growth of the region (Kaiser et al., 1995). The use of buildings or land can be transformed based on socioeconomic factors or planning decisions. Structural functions are influenced by other land-use choices. Land use is a rich concept. Land-use systems go far beyond the basic land use classifications to include many other related features and components. These features and some of their common indicators are 1) Land as a functional space that is allocated to different uses (for example, urban, rural, residential, industrial, commercial, public); 2) land as an environment for activities (e.g., studying, working,

recreating, commuting); 3) Land as part of an environmental system (e.g., forest, floodplain, wetland, wildlife habitat); 4) land as a real estate exchange service to be bought, sold, and developed (e.g., development feasibility, ownership, and assessed value,); 5) land as openly planned, regulated space, and serviced (e.g., density, zoning, infrastructure, and future land use,); and 6) land as a visual element for social symbolism, and orientation (e.g., neighborhood, corridor, and node). Due to the main progress in the development of planning support systems (PSS), and geographic information systems (GIS), the contemporary organizer has supreme access to land use data and analytical tools (Godschalk et al., 2006).

Larkham (1996) has thoroughly analyzed the potential significance of urban morphology in conservation strategy. He points out that the historicity of the townscape that needs to be managed is made up of unrelated mixtures of the three principal morphological elements. Conzen (1975) observed that the first two of these often restrict future growth to some extent and constitute what he named the 'morphological frame'. Land use serves as the basis of the built environment. It describes the type, mix, and general location of uses within communities and eventually defines neighborhood boundaries, commercial nodes (Figure 25).

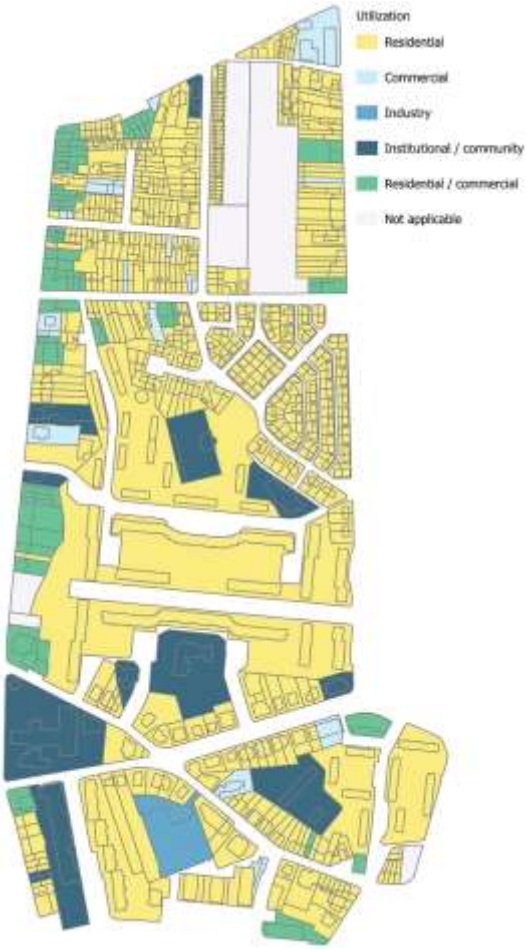


Figure 25: The building and land utilization of Amial case study, Oporto (Monteiro & Pinho, 2021)

3.1.2.2 Building Fabric

A building type can then be defined as the class of all buildings with the same type, number, and arrangement of rooms (Kropf, 2014). This theory of the plan investigation should be linked with an in-depth study of land use and building types connected to produce a full interpretation of the urban landscape. It is also essential to extend the theory to include different functional types of cities and cities within different cultural fields (Oliveira, 2018). Building type (Figure 26) can be distinguished by the type of building, age, materials, height (number of floors), and architectural style. For the character of the urban landscape, the building situation within its plot is fundamental. In most cities, the continuous alignment of various buildings by the end of the 19th

century described the street shape in a very clear way. Buildings elevation and chiefly the interaction amid their heights and the width of the road they are locating are other significant characteristics of the structures. Further momentous features of the constructions are the design of the façade, the position of the staircase, and the organization of the dwellings (Oliveira, 2018).

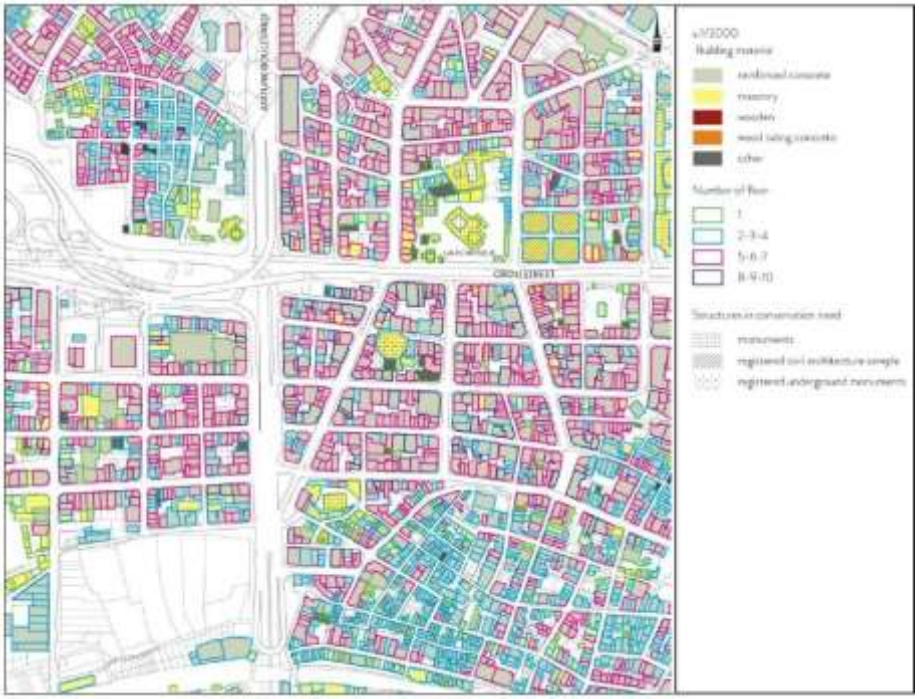


Figure 26: Building fabric analysis of Aksaray city (Küçük, 2014)

3.1.2.3 Plan Unit (Unit type)

The Urban Forms Dictionary by Larkham & Jones, (1991), identifies the plan unit as part of any town plan, that is morphologically distinguished from its roads, plots, and constructions (Conzen 1960). In 1991, the plan unit is identified by Larkham and Jones in any component of the ground plan which differs in its structures, roadways, and plots morphologically from its surroundings. The historico-geographical method has become one of the most important methods within the field of urban morphology, based on the seminal work of M. R. G. Conzen from the late 1950s onwards, and

primarily supported by Whitehand from the 1970s (Oliveira, 2019). In this approach, the concept of morphological region, and the method of morphological regionalization, is highlighted as one of the most essential cases in understanding the historico-geographical structure of the urban landscape (Oliveira and Yaygin, 2020). Following Conzen's extensive plan analyses of Alnwick (1960), Newcastle upon Tyne (1962), and Ludlow (2004), the historico-geographical techniques have been extensively used to study the origins and development of British historic towns by mapping the morphological development of the town plan across time. Conzen, in particular in his study of Ludlow, showed how the urban landscape classification method historically creates a hierarchy of morphological regions (Conzen 1968, 1975, 1988, 2004). The primary phases of the method involve generating three maps (Figure 27). Figure 27 is based on maps of Birmingham's city center presenting plan units, building form units, land utilization units and, the product of the combination of these three maps, urban landscape units or townscape (Whitehand,2009). The integration of these three maps offers a demarcation of morphological regions. In the case of Ludlow, these regions reflect a significant number of social and economic processes that have occurred over a long period—in this case, over 1000 years. These regions are a combination of the areas identified in the previous maps. These are plan-type areas or maps of plan units, building form and fabric or building type, and land utilization (containing building utilization). The historical 'grain' of the town was reflected through Conzen's delimitations of plan units, or different sections of ground-plan type. Based on plan analysis using a combination of field survey, analysis of historical ground plans, and documentary records, this map is concerned only with a two-dimensional view. There is a hierarchy of areas, indicated by the strength of the boundaries between them.

For example, the edge of the medieval town is a strong boundary (Conzen, 2004). The medieval core is a dominant feature that is reflected in a first-order boundary. The commercial core in the medieval core is a second-order frontier (Gu, 2019). The historico-geographical approach might categorize a hierarchy of plan units based on the historical evolution of the metropolitan region (Xiaoxi and Zhang, 2020). This plan unit is regarded as a unitary area because of its distinct ground plan from neighboring areas. These units can be explained in terms of the circumstances of their evolution across time (Gauthiez, 2004). Conzen's influence is essentially on the use of town plans as a basis for historical morphological research. From the geographer's point of view, he claimed on looking at plots and buildings simultaneously as an integrated object and defined the street, plot, and building as a plan unit. The map of plan-type areas, also known as plan units, depicts unitary areas circumscribed by their ground plan, which includes the site, street layout, plot pattern, and building block plans. This map is only concerned with a two-dimensional representation and is based on plan analysis utilizing a combination of field surveys, examination of historical ground plans, and documentary information. There is a hierarchy of territories, as indicated by the strength of their boundaries. The edge of a medieval town, for example, is a prominent boundary (Conzen, 2004). Thus, a morphological region is an area that has harmony in terms of its form that differentiates it from neighboring areas, according to a combination of the town plan, building fabric, and land/building utilization. While the concept of plan unit, considering only the ground plan, was first used by Conzen in Alnwick. The notion of the morphological region would be then developed in Ludlow, where Conzen reflects not only the ground plan but the three form developments (Oliveira, 2021).

Figure 27: Urban landscape units in part of central Birmingham, England in 1970 (Whitehand, 2009)

One of the most significant environmental elements in the scheme of plots in a city is that the public domain is separated from the private domain. Conzen (1969) describes the plan unit by way of any component of the ground plan that, as far as its streets, plots and buildings, is morphologically distinct from its surroundings. The town plan consists of three components of patterns of streets, patterns of plots, and patterns of buildings or block plans. Figure 27 shows the plan units that signify the classification of the urban landscape. The type of building, their plot size, street development throughout the different eras, and combinations of them are essential of plan units. In addition, the plan unit specifies urban fabric (Moudon, 1992). Conzen essentially in his study of Ladlow, creates how the urban landscape is classified, creating a pecking order of morphological regions (Conzen 1968). The original phases of the process involve creating three maps. Figure 28, shows the map of the plan units, the building arrangement (building type), and building or land utilization (containing building

utilization). The map of plan-unit or plan-type areas demonstrates unitary areas surrounded consistent with their ground plan, containing the street arrangement, plot arrangement, and building block plans. This map is deliberate with a two-dimensional sight and is based on plan analysis utilizing a combination of field survey, historical ground plan analysis, and documentary records. There is a pecking order of regions, designated by the asset of the borders among them. For instance, the authority of the medieval city is a solid border (Conzen 2004). Kropf (2011) calls the urban tissue or plan unit the main creation of morphological study, which reflects the various combinations of streets, plots, and buildings that frame an urban context.

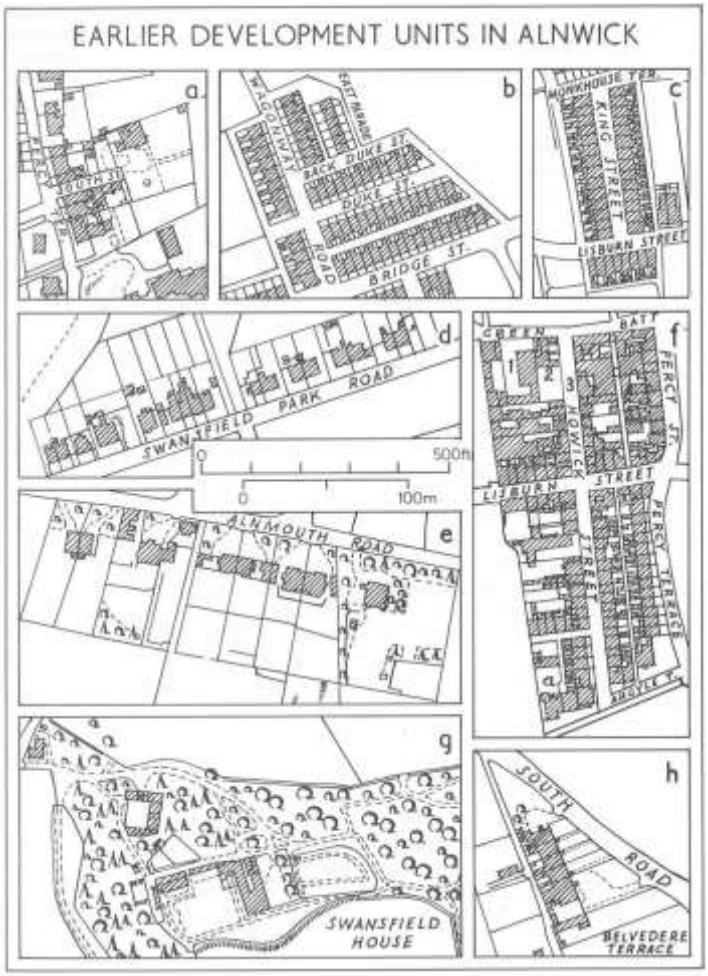


Figure 28: Examples of plan units: Alnwick, Northumberland (Conzen, 1969)

3.2 The Configurational Approach

The configurational analysis represented by the syntax technique allows the modeling of a town that connects science and intuition and it can be used in urban planning and research (Hillier 2009). The primary concept of the configurational analysis is that urban components should be analyzed within a given scale concerning their interactions with all other components of urban form. It privileges the assessment of the urban street network over the evaluation of built-up regions or the configuration of lands parcels.

The configurational analysis extends beyond geometrical relationships connecting a form element to its instant neighbors and specifies its configurational characteristics by taking into consideration the relationships developed within a specified scale of analysis with all other components (Lévy, 2005). Space syntax presupposes, that the spatial networks may be defined as dissimilar structures for analytic purposes, however, these arrangements coincide in social reality (Rashid, 2019). Hillier and Hanson (1984) distinguished that the spatial configurations of a city depend on a "naturally" spatially structured distribution of movement.

Hillier presents two important ideas in this context the analytical framework of space syntax is used to study the configuration of urban street networks, which is based on two ideas relating to movement. In comparison to a more segregated area, space syntax considers the connectivity of streets to find spaces that are easily accessible with their urban settings (Hillier, 1999). At an urban level, whether it be a vehicle or a pedestrian, space syntax suggests certain innovations. The movement caused by the layout configuration is referred to as natural movement by Hillier et al. (1993). Another

feature of space syntax is how spatial interactions within an urban area or a building are represented. An axial map is created from this representation (Hillier and Hanson 1984). There are three broad approaches to configurational analysis. The first one utilizes the main graph of a street network based on metric distances in the physical networks (Porta et al., 2006). The second technique uses topological distances based on a dual road network graph. Space Syntax axial assessment is a typical instance of a dual approach (Hillier & Hanson 1984). The third approach is based on Geometrical (Angular).

3.2.1 The Syntactic Analysis in Urban Morphology

Space Syntax is a series of techniques and theories for analyzing architectural and urban space. It is a way to investigate buildings and cities, to relate how the built environment structure affects the experiences and behavior of the people who live there. This principle has been a tool for understanding how cities are structured, function, and the social consequences of spatial configurations in the environment, and illustrates the evolution of social and economic processes of space over time. The theory of space syntax proposes that the function of form relationship in cities and buildings is generally passed by these structural characteristics of entire configurations (Hillier and Hanson 1984).

3.2.1.1 The Street Network Movement Relation

Hillier and Hanson (1984) created the distinction in The Social Logic of Space that a city's spatial configurations govern the movement distribution that is 'naturally' influenced by the spatial design. Hillier and Hanson (1984) differentiate that the spatial configuration of a city is governed by the spatial distribution of movement that is "naturally" shaped by the spatial arrangement. In this regard, Hillier suggests two main proposals. First, he argues that configuration is the main determinant of the distribution

of movement flows and their simultaneous presence in space. The organization of the street network causes movement and, as they shape the movement, they also create the distribution of land use (Hillier et al., 1993). Second, he argues that the dispersion of land use patterns stems from their dependence on movement in the urban network (Hillier, 1996). The space syntax suggests several inventions at the level of the interactions among urban movement and space, moreover vehicular or pedestrian. In 1993, Hillier and his colleagues describe the movement created through the configuration scheme as a natural movement. The space syntax theory proposed a configurational study of urban space based on the role of the grid structure as the fundamental component for both movement creation and placement of activities.

This theory, which Hillier et al (1993) has defined as "natural movement," acknowledges the key feature of locating activities aimed at taking advantage of a greater pedestrian flow and higher movement demands. In turn, the location of activities would promote the movement of attractions and so increase the primary effect of movement according to grid arrangement. Movement theories in space configuration presented a set of methodologies that measure the built forms and analyze the city through the street network.

3.2.1.2 The Axial Map and Segment Angular Analysis

The axial analysis is one of the basic techniques of space syntax. At the core of an axial analysis method lies an axial line map, a representation of the continuous structure of open spaces in urban environments. The first axial line model was introduced by Hillier and Hanson (1984, p. 17) in the early 1980s and was defined as a system of longest and fewest intersecting lines covering all open spaces. These axial lines are the consequence of a two-stage process in which the spatial system under

examination is first characterized by the plane organization of convex spaces. Convex spaces are polygonal demonstrations of incessant open spaces in which each part of the space must be observable from any other part. Space syntax effectively recognizes that there may be an important spatial presence of bonding components in a design.

The axial line is the initial technique of space syntax to embody and compute open space patterns and physical characteristics in the built environment (Kim & Penn, 2004). Space syntax calculation is based on the configuration of axial lines, where the axial lines illustrate the bounded space geometry (Figure 29). Two steps are taken to build an urban axial map. First, the entire area is separated into a private (or non-public accessible) space and publicly accessible space. Second, the smallest set of longest lines is drawn in the openly accessible space so that all the spaces of the space are enclosed and the lines of each "island" surround the non-public or private space.

These lines are recognized as axial lines. The set of axial lines is called the axial map of the urban area. Figure 30 shows two examples of an urban area plan and the corresponding axial map. Figure 31 shows three different kinds of basic maps that are used in the syntactic analysis of computational space. Creating an axial map manually likewise needs experience and training to model the longest and the least axial lines possible in a city or neighborhood (Figure 31b). Convex maps (Figure 31c) are drawn manually and this can be inefficient. Thus, a raster-based map (Figure 31d) that is applied to all public spaces turns out to be time-saving to apply associated to an axial map or a convex map (van Nes, 2018).

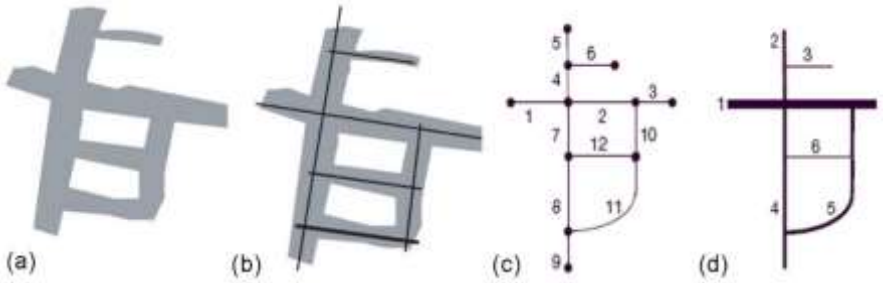


Figure 29: The structure of the space is captured in the axial system (a) Street space (b) overlapping axial lines (c) road system graph (Marshall, 2005)

There are three basic notions of space syntax: Convex space is a space in which no line passes through the environment between either of its two points. The convex map that shows the least amount of design of convex spaces and the links between them depict these spaces. It is feasible to follow axial spaces or axial lines on foot, and the axial map shows the least number of axial lines that show all the convex spaces of a structure and their relationships. An isovist map is a general space that can be viewed from a point of view and is reflected by an isovist map that shows visible areas of convex or axial lines (Klarqvist, 1993). To analyze and qualify space configurations thru using space syntax, an axial map of the open space system is essential.

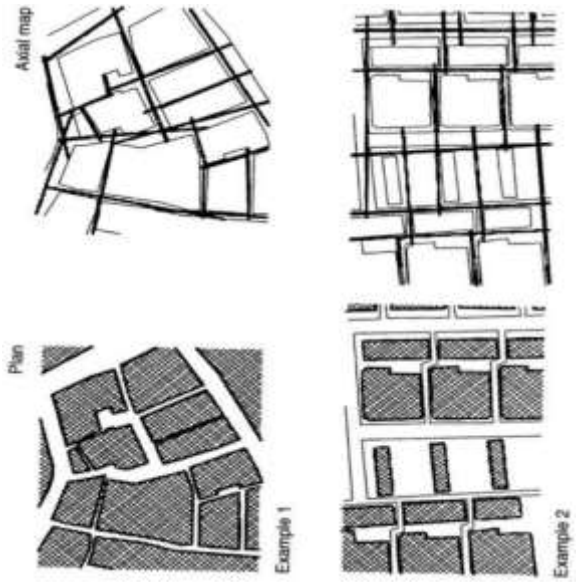


Figure 30: Construction of axial map (Timmermans, 2011)

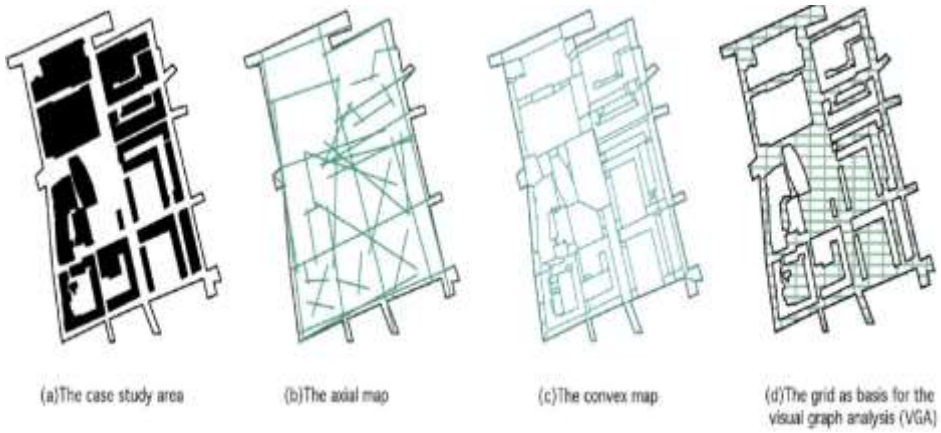


Figure 31: Three various kinds of plans that are used in space syntax examination (Yamu et al., 2021)

The axial map is made by showing the geometry of a city's street network in straight lines (Figure 32). By definition, an axial line is a least and longest line needed to link each street with all the other streets that construct a city. (Penn, 2003; Turner et al., 2005). This form of representation can be seen as an alternative to the traditional node-link maps commonly used in integrated land-use transport systems. The space syntax techniques identify the urban street network configuration structure through a computer model called the UCL Depthmap (Turner, 2008-2011), in which the segment map is analyzed. For this spatial model, segment angular analysis is used since it is a useful geometrical tool that identifies the shortest and straight angular routes through the spatial network (Hillier et al, 2009).

This sort of analysis is based on the argument that geometric distance in urban configuration is a calculation of how people move in the urban system, that is, following spatial navigation and thus similar to user’s possible movement states in urban space (Turner, 2000; Hillier and Iida, 2005). The angular assessment of the segment requires the same principle as the axial line with the distinction of axial lines being broken down into segments. The angular segment analysis addresses

discontinuities when there are minor changes in geometric configuration. With her British library hypothesis, Figure 33 demonstrates a segmented axial map with its corresponding segment. At the points where axial lines intersect, each axial line is divided into segments. Segment lines are asserted to provide a more accurate assessment of the shortest paths calculated by their least angle shift of direction (Turner et al., 2005), which helps measuring by topological dimensions, also metric and geometric distances across and across the street network. The angular selection segment measures how many fewer angular paths are within a specified range between each pair of segments. The angular distance is described as the cumulative angular variation between all neighboring segments along the route (Turner, 2007).

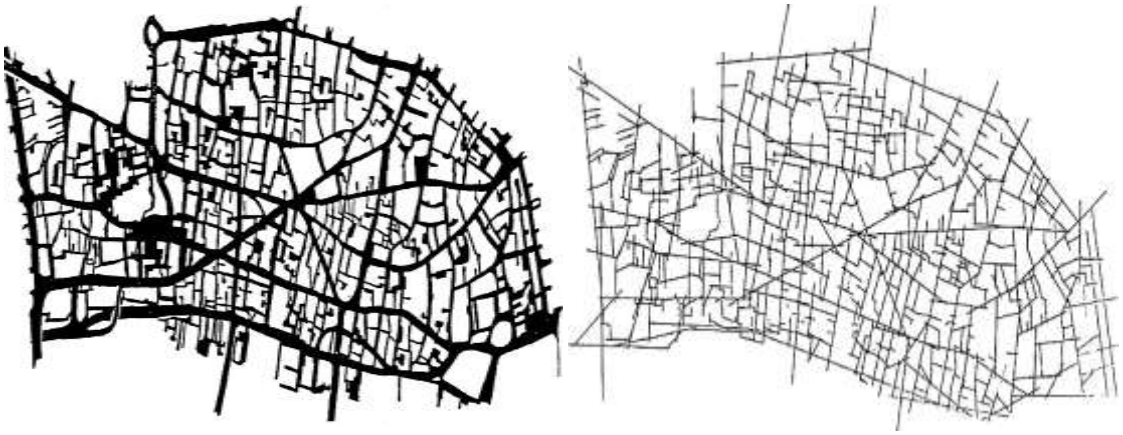


Figure 32: Left, City of London Street Network, Right, City of London Axial Map (Hillier, et al. 1993)

3.2.1.3 Defining Distance as the Network in the Street Configuration

Segment angular assessment requires the urban street network's segment map. The segment map analyses the relationship between each segment row and all other sections of the urban scheme. Individually street segment is therefore calculated depending on how available it is from all other street segments in the city.

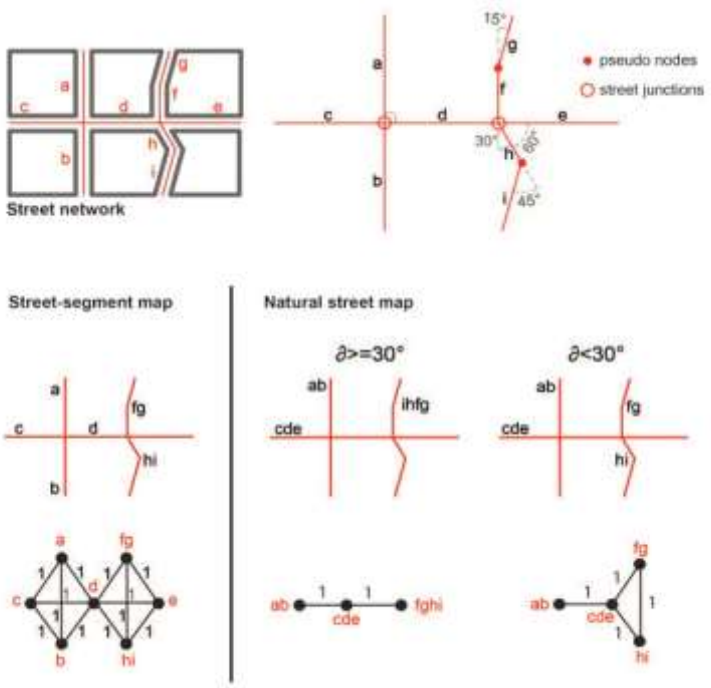


Figure 33: The notion of angular cost (Stavroulaki et al. 2017).

The assessment enables three range definitions between each section of the street and its neighbors: (i) Topological: Assigns a value between a segment and its neighboring segments for each transition of direction or turn. (ii) Metric: The distance in meters between a segment's center and a neighboring segment's center. (iii) Geometric or angular (least angle shift): assign a value of the degree of angular directional change between section and neighbor (Narváez, 2015).

These three distance concepts are used to calculate two measurements that show centrality measurements (Hillier, 1996): integration, which evokes how close a street segment has a connection to all others under each distance definition. ‘Spatial integration ' means how close you are to everything from everything in terms of space syntax, referring to movement potential types (Hillier and Iida, 2005). The second metric is Choice, which calculates the distance under each distance definition between each pair of sections on which each segment rests. Spatial choice indicates the

likelihood of pedestrians being willing to transverse one room instead of other areas, referring to the kind of potential for travel (ibid). Thus, each distance definition results in an integration and selection calculation resulting in a separate street network assessment: The metric distance definition will demonstrate the shortest integration and choice path scheme; the topological definition shows a system with the lowest map of turns and the geometrical definition shows a system with the lowest map of angles change (Hillier, 1996, 2014). The urban system describes by the street segments under the spread of accessibility, variable of maximum accessible, or 'integrated', to the minimum accessible, or 'segregated' (Hillier and Vaughan, 2007).

Therefore, motion in the street network as a likely measure of urban centrality is specified as either how close a destination is to fully other destinations, or how motion is more possible to pass across one place in relevance to all other places. Modeling the street network in Space Syntax outcomes in a depiction of the city's urban structure by calculating accessibility steps into the urban configuration. The outcome, therefore, is an urban centrality model based on the city's spatial configuration as opposed to the classical urban land model definition of distance. The model is depicted by color-coding that shows the accessibility calculations in the urban structure.

3.2.1.4 The Common Indicators of Measurement

Three concepts of distance are used to calculate two measurements that represent the criteria of centrality (Hillier, 1996):

The Integration (To-movement) is one of the key indicators in determining the centrality of a particular axial line in a system, regularly refer as the Betweenness or Centrality Closeness (Freeman, 1977). In urban researches, the high value of INT shows that more people are gathering in space, which may lead to social activities and

interactions such as marketing or retail. Between numerous syntactic criteria, integration is the most important criterion when exerting to the segment or axial maps of space syntax. In 1996, Hillier states that the integration properties of a line in a segment or an axial map are based on the shortest paths amongst the line and other network paths (the definition of "shortest" in terms of the least directional variations).

This metric considers to-movement and estimates the amount of accessibility to all other streets of the urban system, taking into account the total number of changes in direction or syntactical steps of an urban entity (Hillier and Hanson, 1984). Connectivity is closely connected to axial integration. The less the direction of a given road changes to all other streets, the greater its integration, and thus the more interactivity it becomes. In brief, the longer the urban axial line, the greater its connectivity to other lines and the greater its integration assessment and vice versa.

Global and local radii: Classical space syntax analyzes typically use a topological radius that refers to the number of changes in direction. A radius of n is applied for the "global" integration analysis, whereas a radius from 3 or 5 is commonly used for the "local" integration analysis (Hillier and Iida, 2005). The global axial integration analysis also called the citywide integration analysis, computes how each axial line in a built environment is linked to every other axial line, in terms of the entire quantity of direction modifications to all other axial lines (Hillier, 1996). In return, local axial integration analysis examines how each axial route in the given number of directions changes with the neighboring streets in a built environment. A street segment with a higher integration value requires fewer turns to reach from other streets in the network. Figure 34-a depicts a street network, whereas Figure 34-b depicts the levels of integration (darker lines are higher in integration). Space syntax measurements, like

intersection density, can be determined with simply street centerline data and specially developed open software (Turner, 2004).

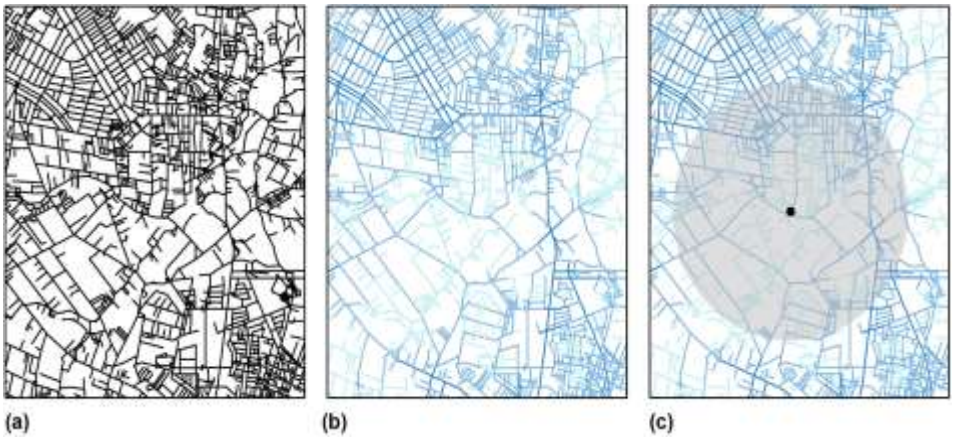


Figure 34: The procedure of computing space syntax measures: (a) base map (street centerlines); (b) space syntax measure of integration considered for each street segment, (c) area-level measures calculated by combining integration values in a buffer zone (Koohsari et al., 2019)

Global integration is an axial map analysis, which indicates the degree to which each line is closer in the network under the concept of the most direct route of least directional modification. The map is then shifted to a graph where the junctions between lines are viewed as paths between nodes and lines are represented as a node (Penn & Turner, 2002). Integration concept depends on the depth idea and not just the metric distance to determine a space concerning all other spaces in the system. The integration measure is the function value of the average quantity of axial lines. The space segments, which require the least number of turns to achieve all other streets are named the most, integrate (Jiang and Claramunt, 2002).

Local Integration is an integration version that limits route measurements from any route to the distance of the double step. This measures the space's local rank. *Intelligibility* ranges on a scale from zero to one of the data from the locally available visual data that can be inferred about a complicated relational model. The assessment

includes global integration (radius n) and local integration, connectivity, global and local intelligibility.

Global intelligibility declares the grade of the linear relationship among the global integration and connectivity is determined as the grade to which it is potential to comprehend and experience from the spaces that connect to the system. Ultimately, tools help determine the features of parts and elements and promote visual research on research design. The city network structure is depicted in (Figure 35) as a segment map and a graphical analytical explanation. The display of integration and choice measures use a color spectrum in which the most integrated streets are those that require the fewest changes of direction to touch all other streets, which are commonly depicted in red color. The most segregated – or those demanding the most turns – are represented in blue color (Figure 35a). Employing the similar color range as in the integration measure, the streets with the greatest choice values (shown in red) have the fewest amount of divided values in the whole graph (Figure 35b) (Hillier, et al 2007).

Choice (Through-movement) or axial betweenness, also known as Betweenness Centrality, is a rudimentary indicator of space syntactic analysis. The choice measures indicate how frequently a vertex is utilized as a path for connections between all dissimilar origins and destinations of the graph system. The choice value is supposed to correspond to movement flows through spaces in urban studies. As a result, it's commonly utilized to predict human movement potentials in urban areas. In the space syntax community, the axial betweenness of a segment or an axial line is calculated by producing the shortest routes between each duo of segments that each segment situated under the notion of distance (Hillier and Iida 2005).

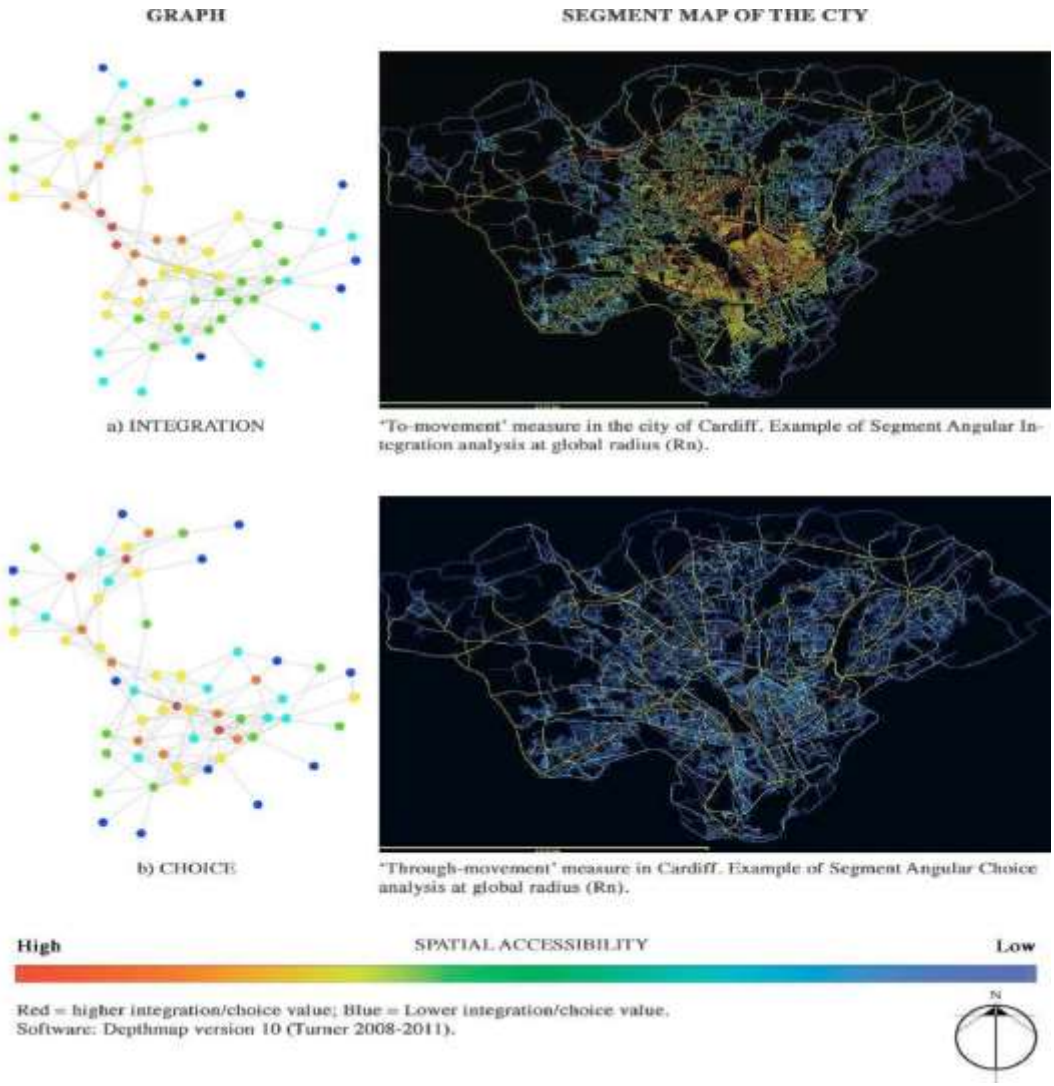


Figure 35: a) Space syntax integration computations using the angular segment analysis Global radius (Rn); b) Global radius choice (Rn) computations (Hillier and Hanson, 1984).

The choice measures the ability with the motion of a definite space, specified by the integration measure (Hillier, et al., 1987). The Space Syntax approaches recognize the configuration of city networks by the use of an open-access platform UCL Depthmap (Turner, 2008-2011). The segment angular analysis for this spatial model (Hillier et al., 2009) is employed as a beneficial geometrical tool that has determined the shortest angle paths thru the spatial network (Turner, 2000; Hillier and Iida, 2005). The angular segment analyzes use multiple measures to perform different sorts of accessibility

estimations. This thesis utilizes different kinds of measures identified as follows among its distinct versions:

Connectivity is a local measure that calculates the number of close neighbors in a given area, which is directly linked to space. Other terms used in the space syntax method theory include "connectivity," which refers to the degree to which each axial line's intersection or one-step possibilities are measured. Integration describes all other spaces with a regular depth of space. Control is the process of determining how much space controls the access of its immediate neighbors, taking into account the number of additional connections between them. The Space Syntax configuration view is based on the system representation in terms of connectivity patterns between separate spaces. The spatial analytical approach enables us to produce topological demonstrations of any spatial design locally or globally. Connectivity computes the amount of connection or one-stage facilities to each axial line (Hillier, 1996). Figure 36 illustrates three different types of axial analyses of Rotterdam The global integration study (Figure 36c) indicates the locations of the streets that are the most spatially integrated. The most integrated streets and roads in Rotterdam are found in the ring road's eastern parts. The 5 percent score of the most strongly integrated streets is represented by the red and orange axial lines. The most integrated streets locally are depicted by the local integration with a radius of 3 (Figure 36d). The numerous local shopping streets are highlighted by yellow and orange lines in this study. The connectivity map (Figure 36b) depicts the number of direct connections between each axis and its immediate neighbors. The dark blue lines have one to two connections, while yellow and red lines have up to 32 connections.

The concept of "intelligibility" is partly determined by what may be perceived and observed locally in the system (Hillier 1996). The degree of intelligibility is deliberated through the amount of linear correlation among global integration and connectivity values (Hillier and Hanson, 1984). The Intelligibility of a built-up area designates how challenging is to calculate the global network system based on the local network data of a built setting (Hillier, 2007). A built-up area is considered intelligible when a great amount of variance in global network measurement is explained by the local network measure. Intelligibility is consequently utilized as a measure of axial map complexity (Rashid, 2019).

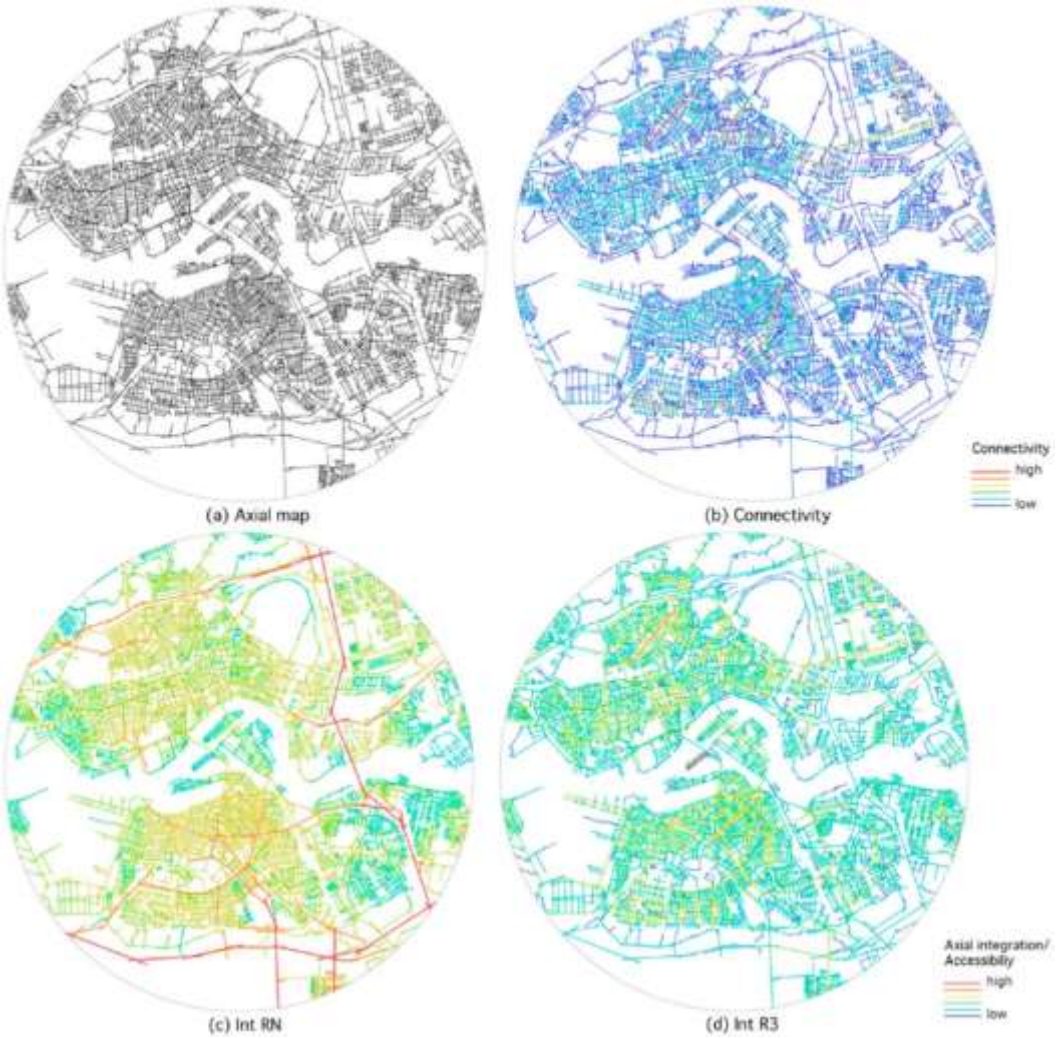


Figure 36: (a) Rotterdam axial map (b) connectivity, (c) global integration, and (d) local axial integration analysis (Yamu et al., 2021).

3.2.1.5 Spatial Accessibility Using Integration and Choice Measures

As the research on space syntax shows the measurement of road network movement possibilities takes into consideration two types of movement (to movement and through movement), which involve every human trip (Penn et al., 1998; Hillier, 1999; Hillier et al., 2009; Hillier and Iida, 2005):

Based on these two types of movement, the two kinds of accessibility measures defined by space syntax are calculated through Depthmap: Integration and Choice. The measure of choice, on the one hand, refers to how one can travel from one location to another –making a through movement trip. The morphology of blocks, plots, and paths, therefore, establishes a standard for moving through the urban system. On the other hand, the integration measure describes how readily it is possible to reach one place in relation to another.

Therefore, it is asserted that accessibility shapes the selection of destinations. People make a massive amount of small journeys and a small number of large journeys, so destinations nearer to more roots will have more ability as destinations in general. A metric radius can be implemented as a metric limit at which angular turns are calculated in segment angular analysis. The analysis is therefore useful in finding important lines that are more related with either to- or through- movements in the system. According to Turner (2001), the metric radius of a measure with the radius of n (Rn) is said to be the number of segments in the network needed to reach all other segments without any radius restriction.

3.3 Chapter Summary

The historico-geographical process of urban morphology pursues to clarify in a methodical assessment, its geographical composition, patterns, and its essential

elements as well as their growth in times (Humboldt, 2015). By focusing on Conzen's townscape as a physiological urban landscape, the characteristic of the cities can be recognized by way of the physical configuration of the spatial patterns. This produces a constant representation with a complex view of complementary components according to diverse morphological periods. The historico-geographical approach addresses the city, as its name suggests, through its historical-geographical structure. In this regard, it concentrates on three aspects of the urban background: the town plan, comprising the street, the plots and block plans of buildings; the fabric of the building, and the utilization of land and buildings. Conzen's training and early study in Berlin before he emigrated to the United Kingdom affected the perspective and content of this work.

The purpose of the Alnwick book (1960) is to comprehend how the plan of a city has gained its topographical complication, the impressions that may be used to analyze town plans, and how the evolution of a town plan contributes to the regional structure of the city. At the end of the 1970s, Whitehand started to define the historico-geographical method. While focusing on Conzen's work, Whitehand expanded its scope by explicitly emphasizing the link between urban form and socio-economic manners (Oliveira, 2019b). The historico-geographical approach of urban morphology tries to explain geographical patterns, structures, and characteristics of human communities by analyzing their constituents and development through time systematically (Kropf, 2017). While the configuration method measures street structures to determine different physiognomies.

The combination of the two approaches and comparison offers additional insight and data that enables us to comprehend the urban form. The configurational technique is

in between the two paradigms, predicting the human movement that shapes the Urban form by using "the street network," which is a relatively static feature from the past. Based on the natural movement theory, the space syntax demonstrates that the urban network configuration mostly controls the pedestrian movement patterns, and the attractors only serve as multipliers or complement for the recognized system (Hillier et al., 1993). According to Ye and van Nes (2017), while the configurational approach provides a comprehensive analysis of the street network, it is confined by a certain morphological component, ignoring the consequences of other morphological elements like land-use diversity.

By emphasizing the interplay between street network structure and land-use function, the integration of historico-geographical and configurational research throws light on a novel perspective on comprehending urban form. In order to build the framework of the thesis, this section has formed the theoretical base for a methodology that will be mentioned in chapter 4. Table 6 shows the summary of similarities and differences of historico-geographical and configurational approaches in urban morphology.

Table 6: Comparison of the similarities and differences of historico-geographical and configurational approaches

Historico-geographical Approach	Configurational Approach
Comparison of similarities and differences of historico-geographical and configurational approaches	
Similarities	**Differences**
The historico-geographical approach shares with space syntax a focus on the ground plan; while space syntax is mainly concerned with streets.	The historico-geographical and have come out of the field of geography, while the configurational approaches have origins in the fields of architecture and urbanism.
The historico-geographical acknowledges the importance of plots and the block plans of buildings.	As in the previous comparison, these two approaches seem to have different conceptions of time.
The application of the morphological region and afterward plan units (which is the main product of the historico-geographical approach) provides a number of results relating to the historico-geographical structure of the landscape. The results for each street are mainly concerned with its morphogenesis and the plots and buildings expressing it.	The theoretical underpinnings of space syntax do not intrinsically include a historical or constitutive grounding. The method of Space Syntax is used to calculate attributes of urban space and method to measure the accessibility of spatial configurations.
From the configurational point of view, structures of the street network can be used together with other built form elements to inform the recognition and identification of characteristic areas (for example morphological regions).	However, the application of spatial configuration reveals something that the morphological region does not: the 'accessibility' of each street within the urban system.

Chapter 4

FRAMEWORK FOR HISTORICO-GEOGRAPHICAL AND CONFIGURATIONAL ANALYSIS OF URBAN MORPHOLOGY

This chapter introduces the research methods of the thesis. This thesis deals with two specific methods addressed in the literature review. This section intends to accumulate a methodological structure by referencing the current literature to develop the methodology through a synthesized framework of historico-geographical and configuration methods together to achieve a better comprehension of urban form. It presents the background of techniques used in the investigations and their application to test the research questions along with the data resources used. A model of complementary space syntax techniques and historico-geographical approach based on the Conzenian method is explained to describe a spatial model to measure street accessibility in the form of an urban network. In parallel, part of the substantial analytical research also comes from an analysis of the evolution of the urban street network of Famagusta, which addresses specific periods of socio-economic development. The selected districts were evaluated according to evaluation criteria based on topological and geometrical terms. The space syntax data were sourced from the analysis of an axial and angular mapping of the commercial street system of the case study of the three-selected zone in Famagusta City. This thesis deals with two specific methods addressed in the literature review:

The study proposes a complementary method. The first method is the historico-geographical method that is mainly focused on the town plan analysis of Conzen (1960). The main theme of this thesis is the use of twofold morphological methods in urban research and planning. The first method focuses on the town plan and townscape as the two main criteria of historico- geographical approaches. The methodological framework of this research emphasizes documenting the evolutionary procedure, interpreting published manuscripts, and considering the history. These are important key issues that can help a better understanding of the historical process of urban form and street networks, especially on commercial streets. Secondly, the space syntax method was used to calculate urban space features and was shown to be an objective technique for evaluating the accessibility of configuration structure to assess the impacts of urban form and street network on accessibility and movement. Consequently, a clear analysis of the pattern is made for clarification in this research. The study therefore mainly uses quantitative data in the methodology configuration scope (space syntax measurements and survey data for examining street networks). This research has focused mainly upon how both the historico-geographical and configurational approaches in combination can aid a finer elucidation of the evolution and historical process of urban form and street networks. The use of morphological region presents a number of implications related to the historico-geographical approach of urban morphology. The consequences of each street are more related to its formation and transformation and the buildings and plots that represent it. Nevertheless, the use of spatial configuration shows what the morphological region does not indicate: street networks' accessibility. It might be expected that higher integrated streets, would conform to higher accessibility of streets.

4.1 Analytical Framework

This study adopts a spatial analytical methodology based on space syntax and historico-geographical approach, to quantitatively and qualitatively investigate the spatial organization of Famagusta city in a way to achieve a better understanding of the evolution of urban form and street formation. The mixed-method is chosen as the research methodology because the research subject is intricate and cannot be interpreted specifically through quantitative or qualitative methods. To carry out a practical investigation on the continuous history, this study picked up three particular points in the period from the 1192s onwards. Data were collected from selected areas and transferred to Arc GIS and Depthmap X.

This methodology tests the use of qualitative and quantitative procedures to describe the factors influencing the urban form and its associated socio-economic activities. Table 7 indicates the general framework and methodological outline used to develop the complementary approach based on a testing model, which consists of three primary phases: the theoretical background, the empirical study, and the research findings. The theoretical background phase investigated the fundamental literature underpinning the research on urban form from the two relevant morphological approaches. The empirical study comprised three phases: 1) the categorization of variables and data, 2) the measuring of variables, which are derived from the corresponding approach, and 3) the testing of the model to analyze the case study. An analytical model comprising methods from the historico-geographical and configurational approaches was built in ArcGIS based on the street network data acquired from the main elements of morphological characteristics. Additionally, space syntax analysis was undertaken using Depthmap X software to unravel the syntactical growth processes of Famagusta

during the historical period. To assess the selected case study in terms of the complementary approach, firstly, the main elements of the morphological characteristics were evaluated based on the historico-geographical method by documenting the evolutionary process: the townscape, town plan, land utilization, and building fabric were assessed by examining the process of urban development. The GIS tools contributed to the quantitative analysis process and data acquisition, which can support the historico-geographical approach as a complementary tool.

Secondly, space syntax methodology was used to evaluate the street network configuration and to explore the different spatial levels of syntactic values in relation to distinctive phases of city development. The method of space syntax enables the quantification of configurational spatial relationships in built environments and their relationship to utilization patterns of socio-economic activity. The selected districts were evaluated according to variable measures based on topological and geometrical terms. There are three broad methods to configurational analysis: the first is based on physical network metric distances and utilizes a primary street graph (Porta et al., 2006). The second strategy is based on topological distances from a dual road network diagram; axial analysis of space syntax is a typical example of the dual approach (Hillier & Hanson 1984). Local and global integration, choice, connectivity, and intelligibility are some of the topological procedures adopted in the axial analysis. The third approach is based on geometrical (angular) properties. This form of urban modeling has been explored in several accessibility studies using the street network as the basis of the analysis (Hillier and Iida, 2005). The segment map is usually generated from an axial map (Turner, 2004). Another essential concept in space syntax is the measure of accessibility based on a topological viewpoint.

Accessibility measurements are computed by integration, connectivity, and choice in space syntax. The measure of choice denotes how one can cross from one location to another to make a through-movement trip. The measure of integration defines how easily one location can be reached in relation to another. Therefore, by investigating the accessibility of the street networks, space syntax could facilitate the prediction of the human movement pattern. In this study, angular segment analysis was used to calculate global and local integration, connectivity, choice, and intelligibility values.

For assessing the geometrical accessibility of streets, segment angular analysis was used to identify the shortest angular paths through the spatial network. The graph statistically indicates network accessibility as a potential through radius-n movement: in other words, every segment has a value and color (from red to blue) according to how many times the angular path falls between all other segment pairs in the system: the highest values are shown by red lines, while the lowest are represented by dark blue lines. By converting the street networks into axial lines, the urban area can be quantified and each line's connectivity can be calculated in order to evaluate the topological accessibility of streets.

Local and global integration were also measured, as was intelligibility, which is defined as the degree of correlation between global integration and connectivity values in the system. In addition, this study used SPSS software for statistical analysis to calculate the correlation between different variables and the ranking of each district in each variable: between local and global integration and between global integration and connectivity. The historico-geographical analysis and syntactic data were combined into a Geographical Information System (GIS). The GIS platform offered the opportunity to integrate the street configuration and historico-geographical method to

measure three main properties of urban form: street network configuration, morphological region, and town plan analysis in different morphological periods. This incorporation into GIS has also examined the relationship between the built environment and the patterns of socio-economic activities following their spatial location by collecting street network data from different periods. The redrawing of historic maps, coupled with axial and segment analysis, enabled the assessment of the evolution of the urban layout of the city throughout different periods.

In some sections, qualitative interpretation of data was used to investigate the function of patterns of street networks in urban form. This research provides a framework for a thorough overview of form evaluation and definition of form indices in the context of studying urban scale phenomena. Redrawing historical maps, combined with axial and segmental analysis, has made a thorough research of the evolution of the city's urban design over distinct eras possible. A series of analyses are carried out in the next phase to evaluate local and global integration, which contribute to the intelligible structure of the city. The syntactic intelligible character of an urban structure is the degree to which connectivity and integration values in the system are correlated. Furthermore, the angular segment analysis technique was used to calculate the integration (locally and globally), choice, connectivity, and intelligibility values. For assessing the geometrical accessibility of streets, the segment angular analysis used is the one that identified the shortest angular paths through the spatial network.

Table 7: The general framework and methodological approach of study.

Theoretical Background

Historico-geographical approach

Morphological Period	
Morphological Region	
Town Plan	
Variables to Measure	
Town plan	Townscape
Street Pattern Plot Pattern Building Pattern Urban block components	Land Utilization Plan Unit Type Building Type Process of urban development

Space syntax method

Data Types: Metric Non–metric	Axial Length is the simplest of all morphological measures that can be derived from the axial map. Segment analysis is any analysis of a segment map.
Variables to Measure	Connectivity is a property of each line within the network of interconnected lines.
	Global Integration: The degree to which that space is integrated from a system as a whole. Local Integration: The degree to which that space is integrated from a partial system consisting of spaces.
	Choice measures movement flows through spaces.
	Intelligibility is defined as the measure of the correlation between global integration and connectivity values of the axial lines.
	Accessibility can be measured through the connectivity, integration, and intelligibility of urban layout represented by axial lines.

Empirical Study

Method	Variables to Measure	Tools	Aim of methodologies
Configurational approach represented by Space Syntax	1. Axial length 2. Segment length	UCL Depthmap X software focuses on the axial map of Famagusta throughout its historical process of development.	Relationship between space and movement based on axial and segment angular analysis. In this study, the focus is on accessibility as the potential for 'through movement'
	3. Connectivity 4. Integration (Global–Local) 5. Choice 6. Accessibility 7. Intelligibility	SPSS Statistical Analysis developed an integrated model of syntactic variables as a single statistical model to improve the understanding of space configuration through the Pearson correlation.	
Historico-geographical Method	8. Town plan Street System Plot Pattern Building Pattern 9. Townscape Land Utilization Plan Unit Building Fabric	GIS (Geographic Information System) has contributed to data acquisition for urban morphology analysis, which can facilitate the historico-geographical and space syntax approach as a complementary model.	The basic methods of this approach include observations of the physical fabric and analysis of the process of historical development based on historical maps and plans The relationship between urban form and socio-economic factors.
Complementary Method	This methodology has proposed that these two approaches complement each other by enabling the examination of the association between urban form and street network. The historico- geographical and configurational approaches in combination can be summarized in three items: – These two approaches in combination can help to better elucidate the historical process of urban form. Both approaches organize the historical patterns of urban forms as the key element to understanding how socio-economic activity is reflected in the built environment. – The historico-geographical approach focuses on the evolutionary process of urban forms. The configurational approach has often been used to evaluate the street network of cities. – Combining these two approaches making it possible to describe the developing street network through history and therefore, the socio-economic activities. It revealed that the relationship between urban form and socio-economic factors is both configurational and historical.		

4.2 Case Study

The study was conducted in the city of Famagusta, located on the east coast of the island of Cyprus in the eastern Mediterranean Sea. Famagusta is the second-largest city in Northern Cyprus. According to Haggard (1902), Famagusta is one of the most precious specimens of medieval fortification left in the world. What makes Famagusta distinctive among the world's cities are its dual characteristics of historical grace and modern development. On the one hand, it is a richly layered historic urban place of extraordinary cultural and traditional heritage. On the other hand, it is surrounded by Varosha and the port which are of great strategic and potential socio-economic value. As one of the cities in Cyprus, Famagusta's urban character and function have significant effects on urban spatial evolution, which makes the development pattern of Famagusta different from other Cypriot cities to some extent. The number of inhabitants of Famagusta city in Northern Cyprus was 69,741 in 2011 (State Planning Organization, 2013). Famagusta can be regarded to consist of four primary components from the unique physical, functional features, type, and patterns of growth:

First is the historic district of the town, surrounded by fortification walls (Walled City of Famagusta).

Secondly, the closed area constitutes a buffer zone in the neighborhood of Varosha (Maraş) which is not inhabited by the town. A broad area closed to housing since 1974 lies on the southeastern side of the Walls.

Third, the UN military site. In addition to the western and northern suburbs of the Walled City, the feature of the larger city is intensely influenced by the military lands

on the north coast of the Walled City, and the Varosha district that was evacuated in 1974.

Fourthly, the city has developed to the northwest of the walls and university campus, one of the city's main microeconomic drivers (Doratli, Hoskar, Vehbi, & Fasli, 2007; Önal et al., 1999). This study discusses the selection of cases, the historical and geographical background of the city, and the physical development of the city during its history. It means the conceptualization of historical development and the relationship between the historical development and urban form of the city of Famagusta through urban transformation is examined. The development of three particular areas is provided (Figure 37):

The first zone is the medieval town of Suriçi (Walled City) situated along the busy eastern Mediterranean shipping routes. The historic walls, dating back to the Middle Ages, surround the ancient town of Famagusta. To this day, the walls are intact, well preserved. The Lusignans built the city walls and after the Venetians captured the island from the Lusignans, they brought from Venice specialists to fortify the walls against artillery fire, especially to protect themselves from the Ottomans. The commercial streets in Walled City are lined with shops and cafés, most of them aimed at tourists. The significant organizing characteristic of the built-up area in the Walled City is the pedestrian zone alongside the main commercial streets. The pedestrian zone is scattered through the key public space, Namık Kemal Square, in front of Lala Mustafa Pasha Mosque (St. Nicholas Cathedral), and the minor square, east of the Sinan Pasha Mosque (Church of Sts. Peter and Paul) and the ruins of the Venetian Palace. In addition, the main commercial street continues to the Sea Gate and east. Second zone is Polat Paşa and Fevzi Çakmak Boulevard. The importance of this area is due to the

expansion of the city during the English period to outside of the Walled City and the development of historical boundaries toward the Maraş district that was closed during the 1974 war. The Polat Paşa Street ends in the Varosha district, which is a chief obstacle to the subsequent expansion of the whole district and the Walled City. This street is connected to Fevzi Çakmak Boulevard, on the one hand, connected to the Walled City through the Istiklal Street, on the other hand, it is connected to the modern and commercial street of Ismet Inönü Street.

The third zone is Ismet Inönü Avenue, regarded as Salamis Road, which is one of Famagusta's primary distributors and is of particular significance due to its position. The importance of this district is due to the existence of main and commercial streets and the location of the Eastern Mediterranean University campus and important centers such as the UN (United Nations). In addition, there is a concentration on this street of entertainment venues and commercial buildings.

The contemporary city of Famagusta is scattered in all three land-facing directions around the Walled City, which is freely organized around the modern and commercial streets such as Ismet Inönü Street. The establishment of Eastern Mediterranean University has transformed the direction of the growth and socio-economic center of the city toward the north, away from the historical center. The scattering of apartment, commercial, and suburban developments along main and commercial streets radiating outward from the historical center has increasingly weakened the Walled City as the center of activity of the district.

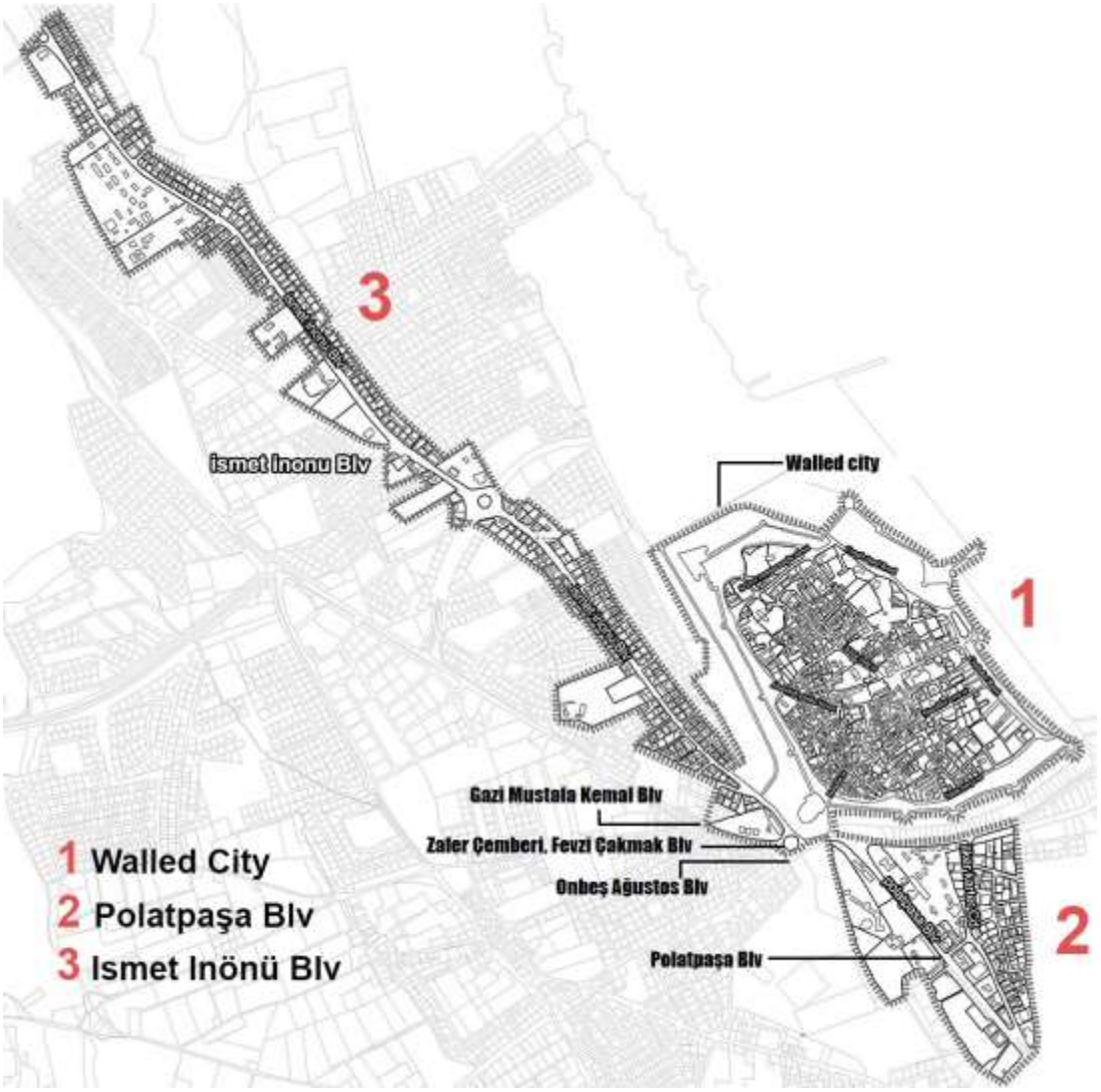


Figure 37: Three studied districts of Famagusta. By Author

4.2.1 Data Collection

This study uses a dual data collection approach. The space syntax method has been utilized to analyze factors of integration, choice, connectivity, and intelligibility as the correlation between the sets of variables. Possibility of movement, accessibility through the spatial structure of the city was analyzed using space syntax methodology. The data analysis was conducted through UCL Depthmap X Software, version 10. The program is an open-source and free platform for users. The analysis has been done on a local and global scale by considering all lines and possible connections. Firstly, the axial map was created which represents the collection of the longest possible paths in

space. This map is then transferred to the raw axial map which represents the number of the local intersection of each path with others. In the next step, segment maps were created based on the axial maps. Secondly, the outcome of Depthmap X has been statistically analyzed in SPSS software. Statistical analysis has been used to calculate the correlation between different variables, which is missing in most Space syntax-based data analysis. The approach consists of techniques that are both qualitative and quantitative. The techniques relevant to this study are a commonly used approach adopted by scientists and can lead to well-validated results. The data collection process took about seven months, with maps and historical analysis being the predominant research sources. An assessment of the urban form without maps would prove impossible. The use of maps allowed the investigator to identify phenomena mentioned in the literature and describe the features of Famagusta City's built environments including streets, plots, and patterns of building. Data related to the use of townscape was obtained by observing patterns of space use outside. A list of land use, building fabrics, periods, materials, structures, etc. were prepared. Observations were made based on the prepared list. In addition, street scenes photos were taken and recorded. Three areas were chosen in order to observe the particular features of each area. Furthermore, the street network of the city is analyzed in Depthmap using historical maps dating from the Lusignan periods to today. The intention was to compare six periods relevant years with the actual configuration of the city, considering the effects of urban street network and form on accessibility and movement. The historical analysis is done through an axial and segment angular analysis within the different historical times. Consideration of spatial accessibility in the urban street network through historical analysis address one of the questions set out in the objectives of this study, referring to whether the form and structure of an

urban core contribute to the socio-economic expansion of the city over time. Following the background of the methods to be used in this study, this section explains the main datasets taken into examination for the configurational and historico-geographical analysis. The thesis takes into account the subsequent datasets: morphological period, land uses, spatial relations, and layouts, based on movement patterns in street networks. The distribution of land and building utilization and how general or specific these might be an important part of the data for the procedure. For this reason, land and building utilization are categorized into general classes (e.g. residential, commercial, industry, green space, vacant) and according to specific types of uses, such as a military, and so on. The first body of examination concerns the historical study of the city of Famagusta. The street network of the city is analyzed in Depthmap using historical maps dating from 1192 and 2020. The historical analysis is done through the segment angular analysis within the different historical times. The intent was to compare the six relevant periods with the actual and existing configuration of the city. The data gathering and organization procedure for this thesis contains three main stages:

1. Data preparation: which first determines the required field data based on the theoretical framework of this research. Secondly, it describes the preparation of paper and digital maps for data collection in the study area.
2. Field data collection: includes direct observations according to the set times (preliminary observations were made in 2019 and continued for a week on April 8th from 9:00 a.m. to 5:00 p.m.; observations were also repeated in some places in 2020 to ensure changes in following months), activity mapping on paper maps or townscape analysis.

3. Post-Field data developing: this first involves creating a database in Autocad and ArcMap GIS (Shapefiles which often include a lot of associated data and have been used in GIS desktop applications) by importing collected data and creating required maps. Secondly, using Depthmap to create required analytical space syntax. and finally using SPSS to calculate the correlation between various factors for statistical analysis.

4.3 The Historico-Geographical Method in Urban Morphology

The Conzenian ground plan can be defined morphologically as a mixture of building type, plan unit, and land utilization trends in the physiognomy of the urban landscape. All these elements were the topic of geographical investigation. Detailed knowledge of the street pattern helps to clarify hesitancies, fill gaps in other historical information sources, and build a wider image of town history. The consequence is a model of historical plan units that were then associated with standing construction studies (including the elevation and age) and land utilization for determining urban regions.

4.3.1 Variables and Elements of Conzenian Method

The elements of the study are the variables in this research because they can change rapidly during a specific period. All of the elements and components of the historico-geographical method are related to the historico-geographical approach, cover a threefold set of plan elements (Figure 38); all of these elements have the components as explained below.

Street pattern: The arrangement of the interconnected spaces in an urban area can be called the street system when regarded independently from other components of a city plan (Conzen, 1960). In terms of morphology, streets are the most persistent component of road-based urban form from a temporal point of view. The system of plots has less

permanence than the street system and the structure of the building has less stability over time than the first two processes (Whitehand,1981).

Plots pattern: Analysis of the plot details enables the historical process to be considered. Plot patterns are usually the most distinct and the boundary between two neighboring patterns tends to stand out more obviously (Kropf, 2017).

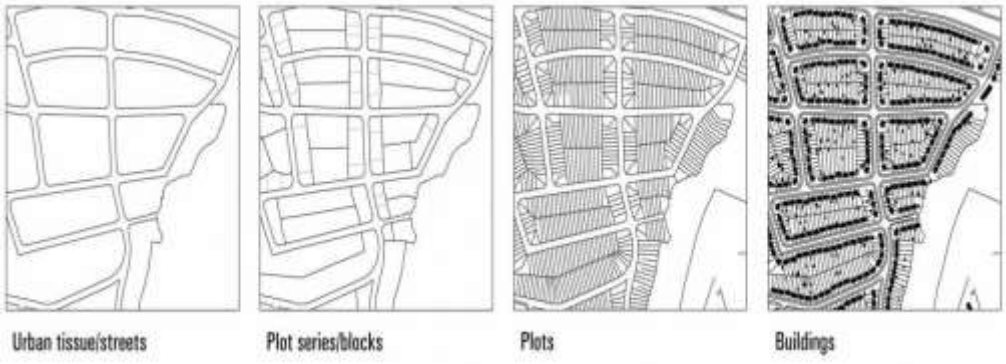


Figure 38: Different morphological patterns (Kropf, 2011)

Building pattern: A line of plots adjacent to the equal street line, each with its front, forms a sequence of plots. The block-plan design is a regional building in which a building is occupied and the lines of walls containing it are defined on the floor. This is a crucial element of the town plan loosely referred to as the building (Conzen, 1960).

Townscape: The examination of the townscape intended to assess the town development through history. The purpose of the plan unit is to determine the growth of the plot and building connections through history to the present day. However, the kinds of plan units also determine the growth of the city block. Urban land use is another element that, depending on its functional distribution, would contribute to the knowledge of urban core growth over time.

4.4 Space Syntax as a Configurational Method in Urban Morphology

Space Syntax Network Analysis delivers a method for providing morphological features to bear on the properties of a street network. Space Syntax is a set of methods for spatial pattern representation and quantification (Hillier and Hanson, 1984). Space syntax is a suite of techniques used for computing the effects of urban form and street network design on accessibility and movement. The technical background of space syntax has been described elsewhere in more detail (Hillier and Ida, 2005). Spatial structures can arise on various scales and have distinct geometric characteristics consequently. Topological and geometrical evaluation of urban forms using UCL Depthmap software enables us to comprehend the urban space configuration effects on social and economic activity (Hillier, 1996). In configurational studies, dissimilar urban morphologies should generate various distributions among their form components of the configuration indices. Configuration in terms of space syntax implies relationships that take other associations into account. For example, if we cut a street network connection, its stimulating effect goes far beyond the space in which the connection has been cut and the significance of the connection can influence the structure. This reflects the basic property of all kinds of relational systems. When we recognize them as a whole complex, changing or removing one element or relationship can have an actual system effect, which is often difficult to predict (Hillier and Hanson 1984).

4.4.1 Spatial Model of the Street Network – Space Syntax Method

In the following chapter, Space Syntax analysis considers the linear structure of a city representing the network of streets constructed as an axial map (Figure 39), to further breakdown axial lines into segment lines. As proposed by the theory, when attempting to identify semi-continuous lines in the system, axial lines appear to be less helpful.

On the other hand, a finer-grained street segment resolution is taken into consideration as the fundamental part of the street network (Kinda, 2014). The analytical unit is, therefore, the street segment between intersections. Briefly, the smallest number of longest axial lines were pulled along all the paths people could see and move through. The axes were defined using the longest possible lines of sight. In an as shallow network (in graph terms) as physically probable, sufficient axial lines were used to connect all maximum convex social spaces in the city. The axial map from the past maps will be done in a computer-aided design and drafting environment through some digital processes. To draw the digital map, the map will be scanned, rectified, and scaled. Then the street network could be digitized and the axial lines are drawn. Subsequently, the digital axial map is transmitted to two software environments of space syntax. “UCL Depthmap” of the space syntax software used in this study. This computer-based syntactic evaluation scheme is going to be used to generate the syntactic measures, graphs, and maps, which were essential for the unified quantitative methodology that this research suggests.

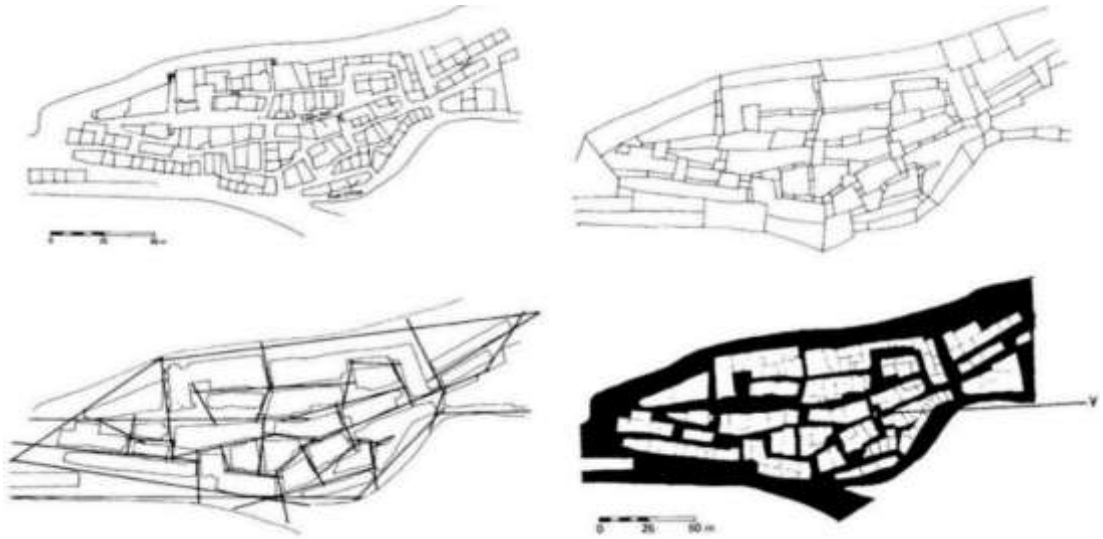


Figure 39: The modeling method for an axial map (Hillier and Hanson, 1984)

4.4.2 Measures of the Street Network (Distance)

Since the aim is to present a model to analyze urban form through two historico-geographical approaches and configurational approaches to assess the impacts of urban form and street network design on availability and movement over different periods, Depthmap takes into account the concepts of the three distance types distinguished by space syntax as part of the measurement of the distance from the city core:

1. Topological distance – calculated as the smallest number of directional turns taken to all others between segments.
2. Metric distance – calculated as the meter range from a section to all other segments.
3. Angular Distance – calculated as the shortest paths based on minimum angular divergence.

This implies that the distance is weighted as a body moves from one stage to another according to the direction changes. Turner (2000) defines the change in a direction across a path as an absolute change of direction as a body moves from point A to point B.

4.5 Tools

Depthmap X is a platform to carry out a series of spatial network examines to comprehend social procedures in the built environment. It works on several levels, from buildings to small urban settlements to major towns or states. The software aims at producing an open space map of the elements, connecting them through certain interrelationships such as overlap or inter-visibility, and then achieving graph analysis of the subsequent network. The objective of the examination is to obtain variables that may have experiential or social significance (Varoudis, 2012). The data examination

was conducted by using the UCL Depthmap X Software, version 10. It is a free and open-source platform for architects and urban researchers. The assessment was carried out on a global scale, taking into account all lines and possible connections and scale of the local area. Firstly, the axial and angular line was made which displays the set of lengthiest and shortest possible axes in space. Secondly, the results of Depthmap X software were measured in SPSS software based on the chosen case study areas. The Pearson correlation is used to compute the connection between different factors for statistical analysis. All analyzes were made for Famagusta City and three chosen zones of the historical Walled City, the commercial street Ismet Inönü, and Polatpaşa Boulevard. Moreover, drawings, illustrations, photographs, and graphs help to visually support the study. AutoCAD platform is used to draw maps, town plans, for drawings. In the configurational technique, much of this was performed ' by hand ' in the early days of the 1980s. However, it quickly became obvious that it required computation to analyze complex configurations. Ultimately, tools help determine the features of parts and elements and promote visual research on research design. Furthermore, this research used the SPSS (Pearson correlation) to calculate the correlation between various factors for statistical analysis. All the analyses were performed on the case study's three selected districts. The conduction of axial and segment lines and investigations of the urban street networks is based on street maps. Thirdly, this study calculates the correlation between different variables by SPSS for statistical analysis. The axial line file in GIS is converted from shapefile into .dxf file, in order to be introduced into the Depth Map for arranging examination of integration, choice, connectivity calculation.

4.6 Chapter Summary

Following the data collection and investigations, the obtained outcomes will be analyzed and interpreted in order to answer the main questions of this research; namely how to use two approaches in urban morphology, compare them and propose a coordinated combination method that helps to a better understanding of the urban form. To answer the questions, three selected districts of Famagusta are considered. The reason for choosing Famagusta as a case study is due to the rich and long history of this town, which has made it its present form. Famagusta's various urban features, both in terms of urban form, as well as various historical periods, opportunities, and threats such as the establishment of EMU university, the existence of a coastline, and the abandoned (uninhabited) district of Varosha, and other physical barriers have influenced the city's development direction. As one of the cities in Cyprus, Famagusta’s urban character and function have significant characteristics on urban spatial evolution, which makes the development pattern of Famagusta different from other Cypriot cities to some extent. The variables were calculated via UCL Depthmap X, and the outcome was integrated with other layers of data using ArcGIS software. The quantitative examination of this study consists of three different methods; the conduction of all axial lines in GIS within the whole city is over, the map has to be prepared for the next software which is DepthMap. Secondly, the analysis of axial and segment maps in DepthMap (version 10, UCL) software using Space syntax theory. In this study, space syntax examination of the axial map and angular to-movement (integration) and through-movement (choice) and the other variables was carried out on the segment and axial map of the city of Famagusta.

Chapter 5

APPLYING OF THE COMPLEMENTARY METHOD ON SELECTED CASE: FAMAGUSTA

This chapter purposes to present a coordinated combined framework for analyzing urban form by using historico-geographical and space syntax approaches in the case of Famagusta. The study aims to present a complementary relationship as a framework for analyzing urban form by using the concept of the historico-geographical and configurational approaches to achieve a better vision of urban form. The current section discusses the selection of case studies based on their historical hierarchy and physical growth throughout history. In addition, this section intends to define the evolution of the street pattern in the three selected zones of Famagusta through the latest six diverse historical periods. The historico-geographical approach and space syntax method was applied to the three selected regions in the city of Famagusta. These areas were selected due to their morphological diversities and long historical background. Famagusta has been an important city in terms of social, economic parameters, which have been affecting the city since the Lusignan period. With its long historical background, the changes in the morphological structure of Famagusta can lead us to understand what kind of relationships among urban development and socio-economical activities, influence urban form. In this respect, three selected regions in this city are taken as the case study area. In addition, these three regions were selected based on the most significant changes, including the formation, evolution, and development that occurred in different periods in these areas. Using

Famagusta as a case study the analysis demonstrates firstly, how the configuration of historical street network relates to the durability of socio-economic activity in the built environment over time, and secondly, how diverse plan units and ultimately morphological regionalization in combination with syntactic properties lead to a better understanding of morphological changes and evolution of the city. The overall aim of this study is to achieve a better understanding of urban form and street networks by using the historico-geographical approach and configurational approaches on urban morphology, comparing them, and proposing a coordinated combined framework.

5.1 Famagusta as a Case

Cyprus is located at the crossroads of Western and Eastern cultures and hosts many cultures (Gunnis, 1947). Famagusta (Gazimağusa) is a shoreline town on the east coast of the island near the Karpas Peninsula overlooking Famagusta Bay. The island is strategically located (Figure 40) and is the third-largest city with a population of 50,500 (SPO, 2011). Famagusta is one of the liveliest cities due to its longest coastline and the vital situation on the island. On the island (Figure 41). The most important four structural elements of Famagusta city are; the Walled City; the harbor; Eastern Mediterranean University and Varosha (closed district since 1974). Famagusta begins as a pre-urban center, most likely dating back to 1192 in its smaller original form. Famagusta is a great example due to the variance of its civilization and the evolution of urban patterns throughout the last six distinct historical periods, whereas there has been insufficient information for the previous phases so far. This feature provides an opportunity to test historico-geographical and configurational methods along with the complementary of historico-geographical and space syntax methods.

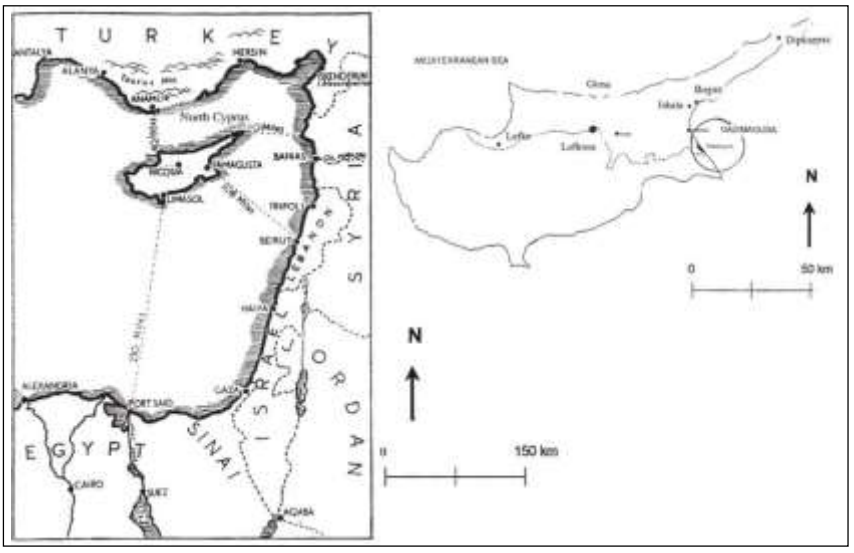


Figure 40: Location of Cyprus in the Eastern Mediterranean Sea, and location of Famagusta on the map (Önal, Dağlı, & Doratlı, 1999)

The Walled City of Famagusta, which is one of the city's four structural elements, has succeeded in preserving its strong medieval character, despite substantial changes and deterioration and decay (Perbellini, 2011). The old urban pattern and the organic urban structure of Walled City lend it a medieval character. and several public buildings remain at the intersection of streets. Concerning the organization of urban life, size, density, inhabitants, professional and industrial differentiation, the spatial distribution of urban activities, land use, and street patterns of Famagusta has developed its formal qualities throughout history in various social, cultural, economic, and administrative influences (Doratlı, et al., 2003). The variety of buildings among the Lala Mustafa Pasha Mosque (St. Nicholas Cathedral); one or two-story courtyard houses, which are denser on the south, south-west, and the core; the storing buildings from the British Colonial Era; and a substantial amount of open land in the southeast, north, and northeast (Perbellini, 2011).

Figure 41. Map of Famagusta; Walled City, Polatpaşa and Ismet Inönü Boulevard (By Author)

The important feature is the port of Famagusta, which determined the development, economy, culture, society, etc. of the city. Accordingly, the city's structure is created by the port. Two towers, one of which is the citadel (the port's primary defense structure), protected the entrance (Enlart, 1987). Famagusta has become a military base rather than a trade center for a particular era in history. Although they have been significant commercial cities in their history, in recent times they have lost their popularity, although some trade activity remains (Faraday, 1991). Famagusta can be assessed in two sections in terms of spatial features: the old city center identified as the Walled City and the contemporary developed areas outside the walls. Changing socio-economic organization of the town, around the 19th century, enhanced its growth outside the city walls.

This study considers the selection of cases, according to historico-geographical and configurational approaches of urban morphology to assess the effects of urban form andstreet network design on accessibility and movement to a better understanding of the relationship between space and movement through space syntax and conceptualization of development through historico-geographical approaches of urban morphology. To achieve these aims, the historical development of Famagusta city through urban transformation is examined. The development of three particular areas is given particular consideration as mentioned in the previous chapter.

5.2 Historical Background of Famagusta

Historically, the city of Famagusta was influenced physically, culturally, economically, and socially by diverse conquerors. While the city has survived since its foundation and has become so productive over 60 decades, it faces the division since 1974, when one of the chief cities (Maraş), in the southeastern districts became a ghost town. After 1974, the city's physical structure was completely changed and also had a substantial influence on the city's spatial structure and socio-economic and street networks. Table 8 illustrates the last six historical development stages of Famagusta from the Lusignan period until after the war in 1974. However, owing to the lack of documents of the earlier eras, this study focuses on the aftermath called the medieval period. Famagusta was an important port town with a trade-based administration and economy on important trade paths (Uluca & Akın, 2008).

5.3 Urban Developments of Famagusta During Each Period

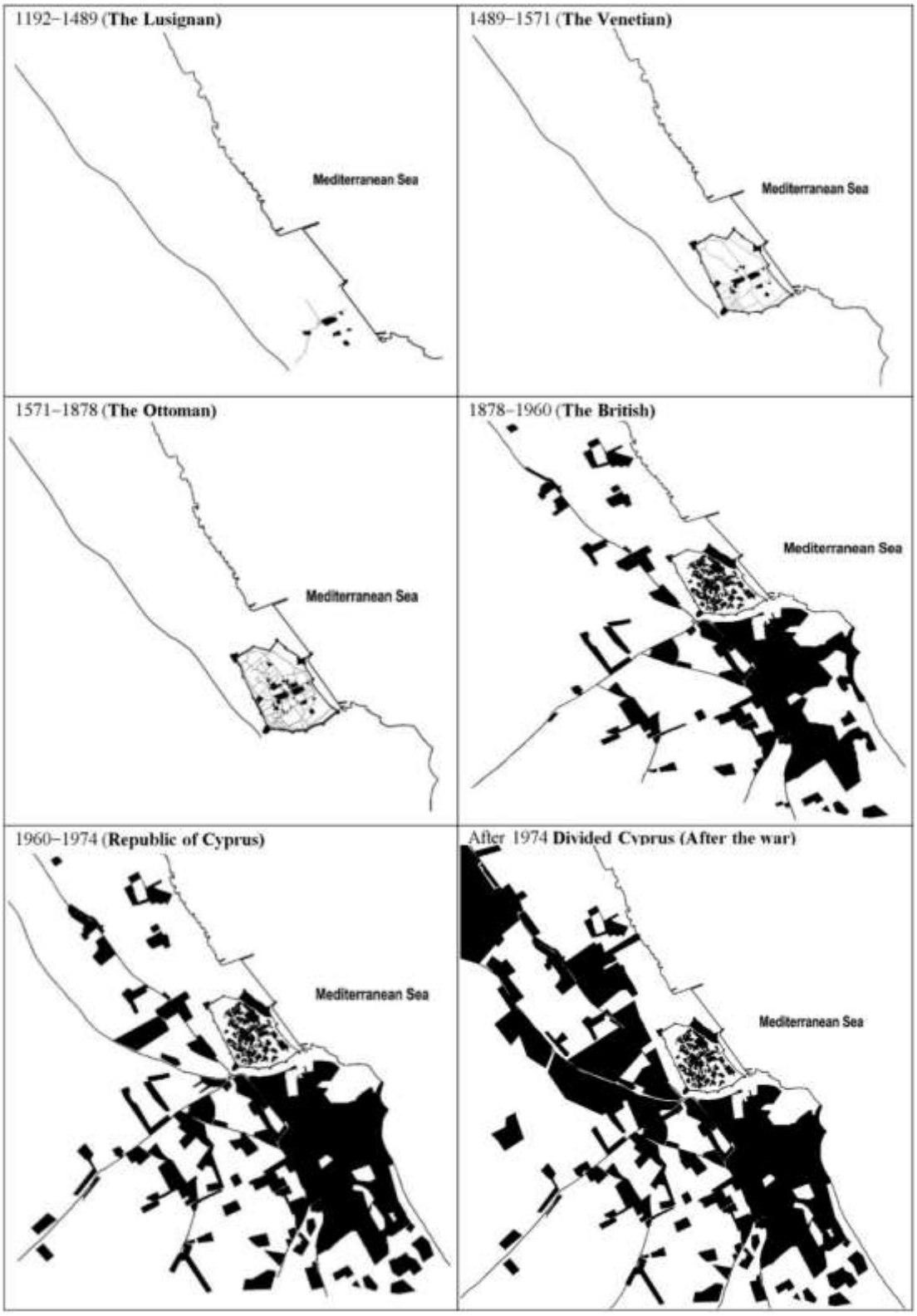
Table 8 indicates the urban development of Famagusta during the early periods; the Lusignan era; the Venetian era; the Ottoman era; the British era; the Republic of Cyprus and after the war in 1974 Physical limitations in towns refer to thresholds built-up areas and natural environments that restrict the city's development. Physically

Famagusta is a coastline city. Famagusta's natural characteristics are converted into natural constraints for spatial development during the growth of cities and cause a cut-off in city spatial configurations (Dupont, 2004). Figures 42 demonstrates the evolution form of the Walled City; the square is the central piazza of the city dominated by Lala Mustafa Pasha Mosque. The design structure of the Walled City was influenced by the arrival of different rulers. However, the design idea operates as a whole with a mixed approach of various areas pinned down by vertical mass structures at distinct line movement locations, and a central square controlling the organization of churches, main gates, and public spaces. The city includes churches, squares, public spaces, ports, and fortified walls that gave the city its architectural significance. The city expanded from the main square in an organic form, creating integrated expansion axes.

5.3.1 The Lusignan Period

The Lusignan ruled Famagusta in 1460, but their domination ended in 1489 with the island's secession to Venice and also Catherine Cornaro's abdication (Hill, 1952; Gunnis, 1947). The Lusignans' contribution to the development of Famagusta was minimal. There is no other feature to mention except a tower, an archbishop, and a place of pilgrimage (Enlart, 1987). Urbanization started with the Lusignans in the old town of Famagusta. According to Oldenburg, who visited the city during that time, Famagusta was renowned for its closeness to the shore with a nice harbor and as a fortified town (Cobham, 1969).

Table 8: Urban development of Famagusta through history (By Author)



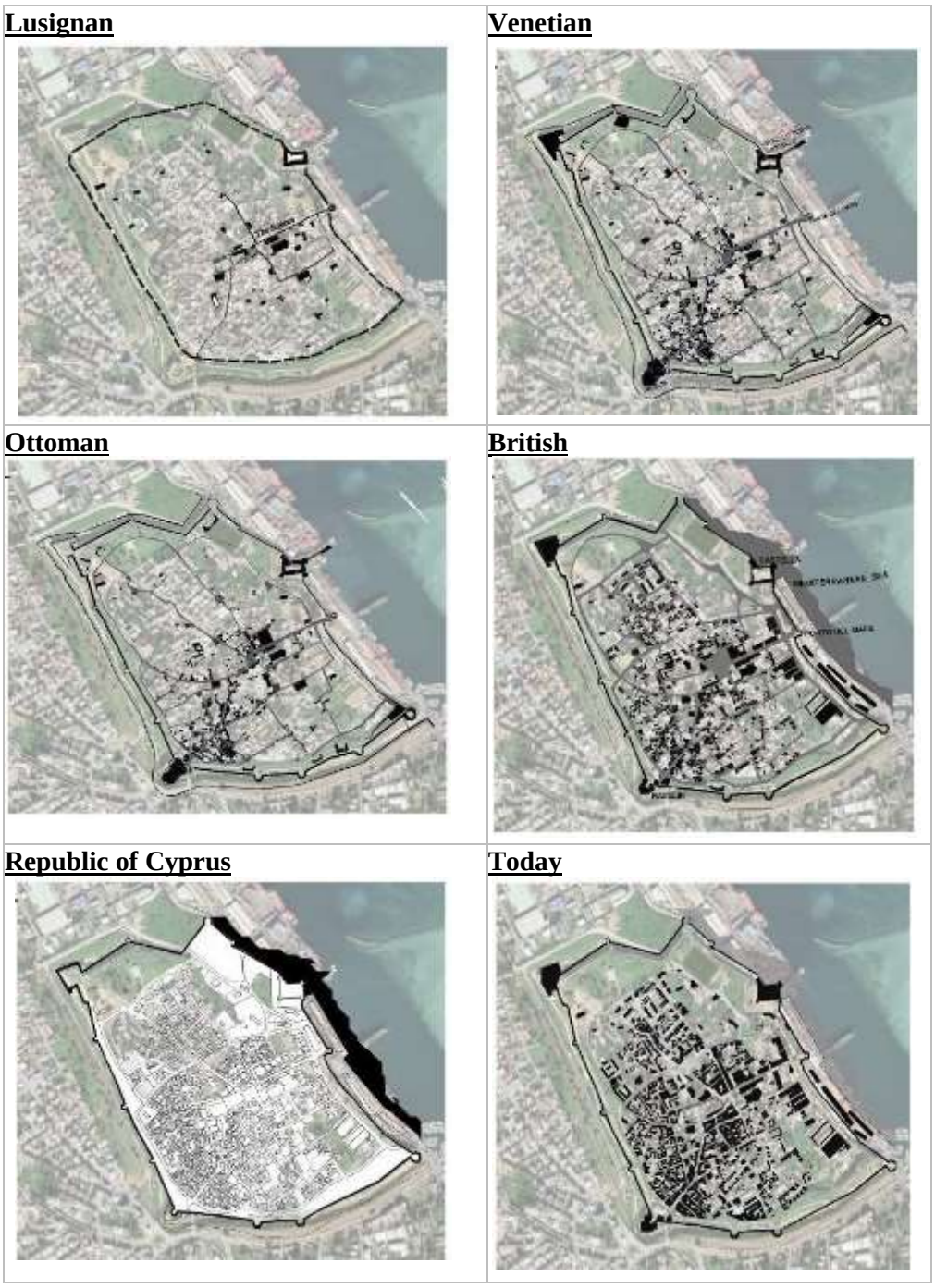


Figure 42: Urban Developments of the Walled City during the different period (By author)

With this growth, Famagusta has become a major location for Western merchants who have migrated from the war (Enlart, 1987) and a node between east and west. Moreover, the half-circular shape of Famagusta Bay offers ships the chance to anchor in safety at the harbor, which was a significant advantage during that time. Another

reason for Famagusta's increasing significance was the strict ban on trade with Mamluks dictated by the Western Pope (Makarias, 1932). The last crusader, whose territory was conquered by Mamluks in Syria and Palestine, turned Cyprus, especially Famagusta, into one of the most major trade centers in the Mediterranean region (Maier, 1968). Another significant issue in the development of the city was population growth. Migration to Famagusta brought the city cultural diversity, and the need for more land was created overcrowding.

The feudal system's effectiveness improved during those moments. The town needed greater defense against external forces with these developments (Edbury, 1999). The city was regarded as an active social activity with a dynamic trade port; more than three hundred churches were built during the Lusignan period (Luke, 1965). The cathedral with some other churches and other structures became the urban morphological components of the Lusignan period (Figure 43) (Doratlı, et al., 2003).

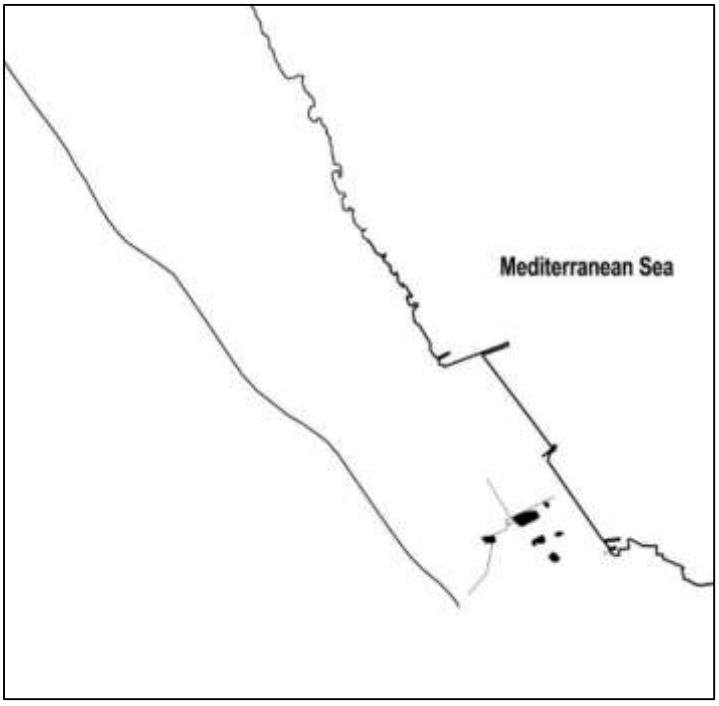


Figure 43: The Urban Morphology in the Lusignan Period

5.3.2 The Venetian Period

Famagusta became a fortified town as a military base during the Venetian period after the Lusignan era. They constructed the city wall, the citadel, fortresses, channel, gate, the land, and the sea gate. Throughout this era of urban development, the town center remains next to the Venetian Palace Square and the St. Nicholas Cathedral that is in the northwest directions (Önal et al., 1999). Famagusta was under the domination of the Venetians throughout the 16th century when they began to work to improve the city's situation. Venetians set up the contemporary military constructions to the northeastern portion of the wall where better protection was required (Langdale, 2010). People who arrived from abroad remained for a period in quarantine and were permitted to enter the town afterward. The primary square in the region was renowned for its marketing activities (Jennings, 1993), Figure 44 indicates the urban morphology in the Venetian Period. Venetians improved the city's public facilities and restored the old city. The town became wealthier and more livable than before with these changes. However, new social and economic activity was required in Famagusta.

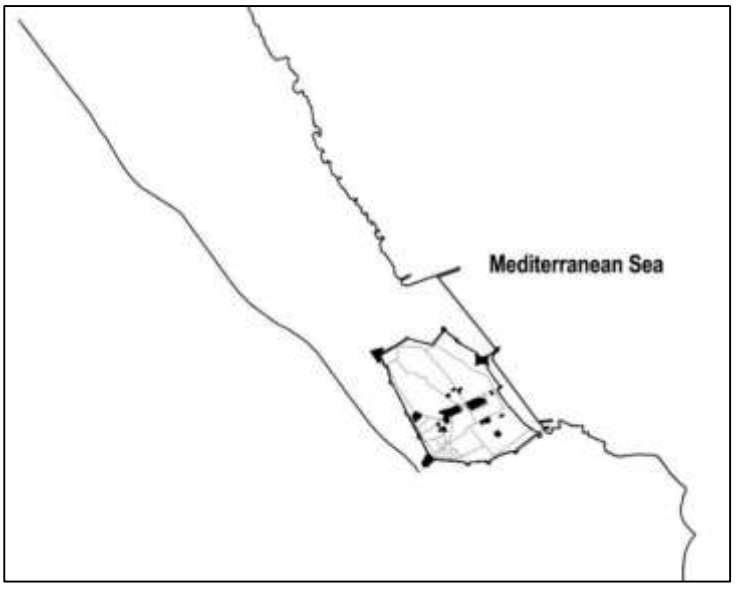


Figure 44: The Urban Morphology in the Venetian Period

During this era, Famagusta port became one of the most significant trading areas, and Famagusta attracted many traders. This enhancement has led social interaction to increase. The administration of the island appears to be extremely militaristic during the Venetian period; therefore, the physical appearance and design of the colonies were created accordingly (Gunnis, 1973). During this era, most militaristic buildings and fortifications were constructed (Önal et al., 1999).

5.3.3 The Ottoman Period

The Venetian domination period finished in 1571. There were limited citizens in the town during the Ottoman period, and the harbor was only suitable for small ships (Walsh, 2008). The accelerated growth of the town outside the walls to the south began during the Ottoman period. The Walled City, however, retained its importance as both a traditional and a residential neighborhood (Luke, 1965). There were two significant issues when the Ottomans occupied the island. First, they compelled Christians to move out of the city. Second, Larnaca's harbor became more crucial than Famagusta's harbor. As a consequence, Famagusta's prominence and the population started to decline (Maritti, 1971). In 1573, the placement of Muslims together with soldiers transformed the character of the city as a military base. Security in Famagusta has intensified in subsequent years, and the town became an exile location and an open prison. For this purpose, most buildings and urban open spaces were used for this mean (Dixon, 1879). Varosha became more crowded than Famagusta, and during this era, the region became more popular with manufacturing. During that time, a major enhancement was a change in the backbone of the road system, and Istiklal Street became the city's primary road. The streets that were close to the port started to lose their effectiveness (Figure 45). The population concentration and therefore the houses were primarily in the southern part of the Walled City, and the organic urban patterns were

being enriched by the implementation of cul-de-sacs that fit the Islamic culture and lifestyle well. In addition, a unique building formed by the so-called 'kemeraltı' house was created that permitted both pedestrian and vehicular flow. The period of the Ottomans begins in 1571 after conquering the town. The town experienced many social and physical changes during this time. At the time, many Turkish Muslims came to the city from Anatolia, forcing non-Muslims to move out of the city. The town starts its growth in the southern direction of the town along the seashore. This led to the development of Maraş zone (Önal, Dağlı, & Doratlı, 1999).

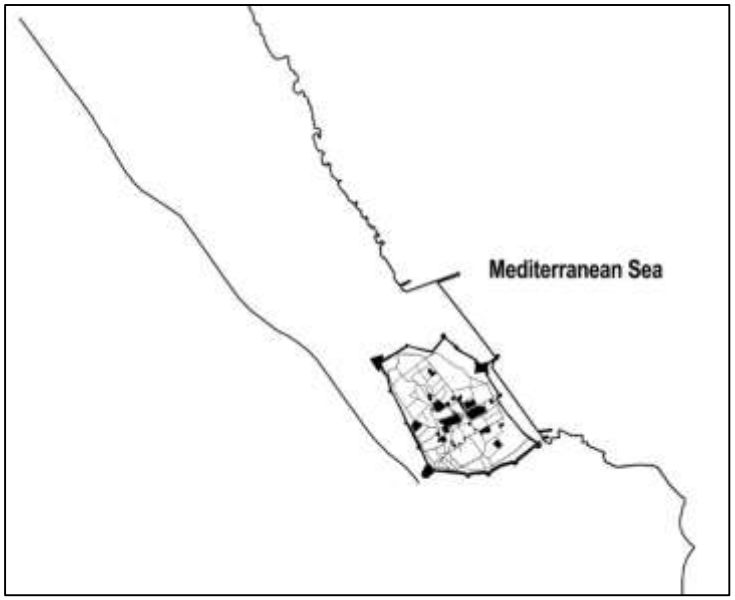


Figure 45: The Urban Morphology in the Ottoman Period

5.3.4 The British Period

The British Empire was handed over to the Cyprus administration in 1878. A large-scale process for developing the island's condition was initiated during the British era, particularly in Famagusta. The port of Famagusta had renewed significance for military and commercial reasons, making important changes to the port. During the Venetian period, the Sea Gate was built in 1910. During this period, two imperative concerns directly affected the development of the city: first, Famagusta's underutilized

port recovered its value on the island, which brought economic upgrading and population growth in the city. Within the fortifications, a few new gates were opened that offered better access to the town (Figure 46). Second, British street regulation brought major modifications to the city's road pattern. It was during this period that Polat Paşa Street developed and became important due to its construction. During this period, schools were constructed, a police station, a public library, and warehouses. In addition, the growth of the town was in the direction of the south side (Figure 47).

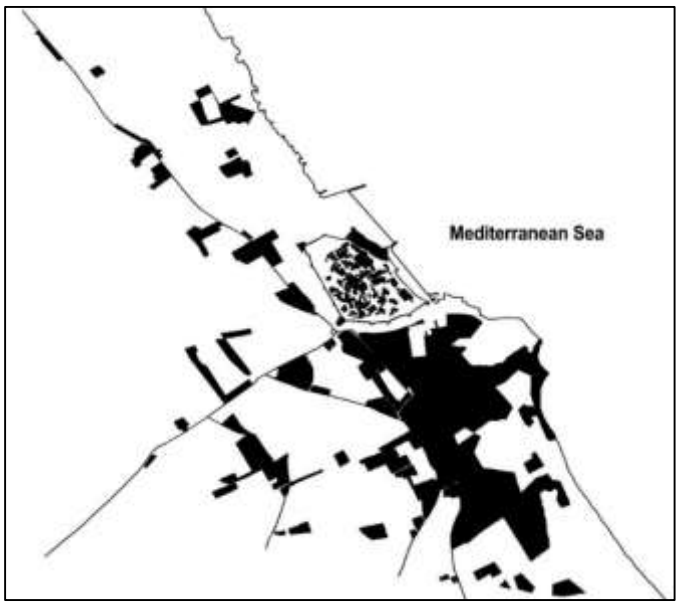


Figure 46: The Urban Morphology in the British period

5.3.5 Republic of Cyprus Period

The Cyprus Republic was based on a collaboration between Turkish and Greek Cypriots two majorities. The whole town was split into two towns between 1960-63. Turks settled in the Walled City and the Greeks settled outside the Walls (Figure 48) (Doratlı, et al., 2003). In 1963, Famagusta governance started to experience both social and administrative issues between Greeks and Turks, resulting in conflicts between the two groups. The Turks moved to the old city from their villages, which continued until 1974. A decrease in the Turkish representative's efficiency in administration issues

after 1963 resulted in an economically unbalanced situation between the two communities. Due to the congestion of the Walled City at the moment, some Turks migrated from the Walled Town to neighboring regions such as Sakarya, Baykal, and Karakol (Keshishian, 1985).

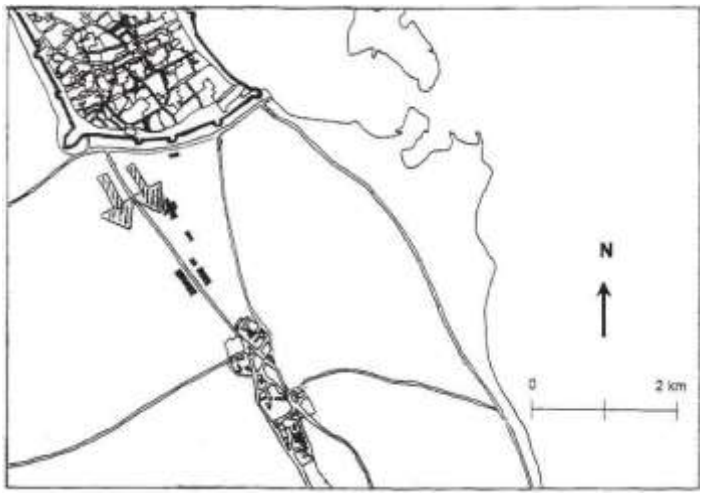


Figure 47: Development of the city to the south (Önal, Dağlı, & Doratlı, 1999)

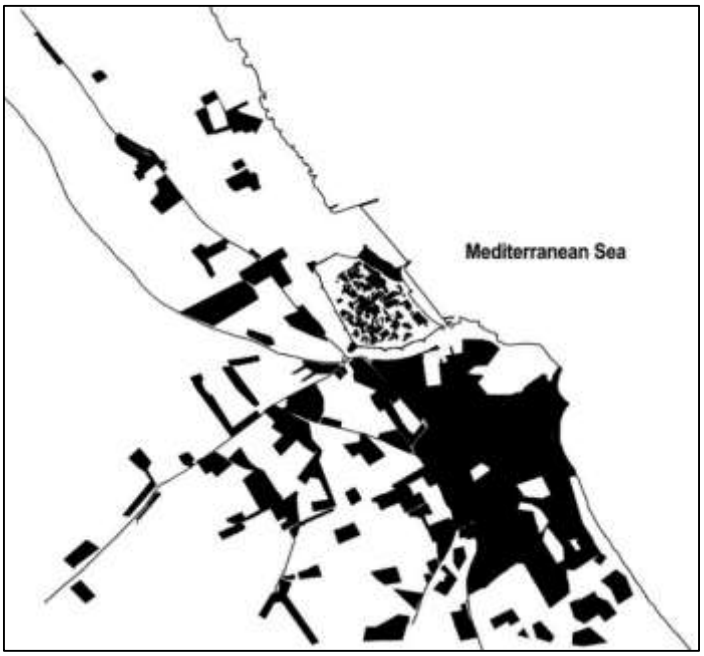


Figure 48: The Urban Morphology in the Republic of Cyprus

5.3.6 The Period After 1974

The island was divided into two sections with the conflict in 1974. The northern Turkish Republic of Cyprus was created in 1983 and the Republic of Cyprus remained on the south side (Doratlı, 2000). The southern part of Cyprus experienced political embargos after the establishment of the Turkish Republic of Northern Cyprus in 1983, and this also impacted the old city of Famagusta. There were no important changes in the town during those times because the city's structure and shape had been completed. A few urban regeneration projects have been implemented in the city's historic center in the latest years. Figure 49 shows the expansion of the city in the period after 1974 (post-war period). Varosha became a closed area and remains to this day, largely empty, buried, and patrolled by the military. This also created limitations for this study that made it impossible to enter the site. For this reason, Varosha is not in the scope of this dissertation.

Figure 49: Famagusta map after 1974 war

Political tensions that affect and damage cultural heritage remain today. The conflict and division also had an enormous impact on Famagusta since the district of Maraş/Varosha was closed to housing and the town lost most of its urbanization and development. This district was the heart of the town, and other neighborhoods were formed around it. Indeed, the extraction of this sector of the town had a serious impact on the other neighborhoods and the city's future development.

The urban growth of the city after 1974 and the Maraş evacuation left no choice except to develop an almost linear shape along the seashore in the direction of the south. The city's morphologic urban characteristics are illustrated in Figure 50. In addition to these physical features, it should be noted that the Walled City is the traditional core of the entire city, and the land use of the area with shops, houses offices, coffee shops has a mixed-use character.

Generally, division of the isle in 1974 affected many physical barriers. Abandoned closed Maraş, UN site, and military zones cut off many spatial connections among town districts and decrease availability. The collective impacts of the southern border and the university's attraction to the private sector in the northern portion of the town have significantly altered the Famagusta morphology. The city has developed towards the university site, which is presently one of the main sources of microeconomics in the city (Doratlı et al., 2007).

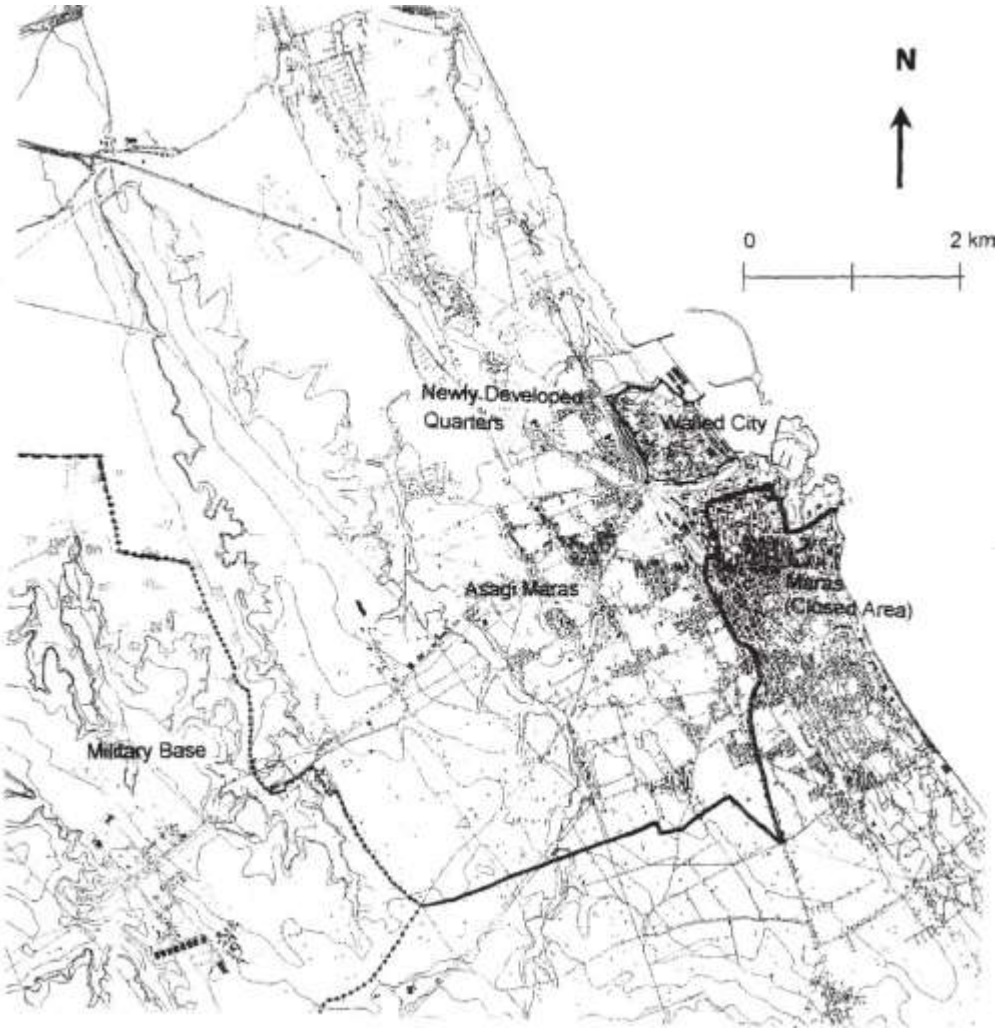


Figure 50: The Urban Morphology of Walled City today (Doratlı, et al. 2003)

5.4 Historico-Geographical Method

The procedures of historico-geographical urban morphology seek to explicate the geographical character and structure of human settlements utilizing organizing their basic characteristics and their evolution over time. The approach, which originated in the 19th century, tries to acknowledge the variety of places, such as the geographical procedure of von Humboldt and the subsequent expansion of urban geography notions and cultural landscape (Humboldt, and Knight, 2004). A thorough assessment of the sequential arrangement of city plans with the methodical differentiation of the hierarchy of complex plan elements is one of the main approach

techniques. In addition, as the name implies, this method deals with the city via the historical-geographical landscape of the city. This study evaluates the historico-geographical approach on the selected city (Famagusta) during history. Specific consideration is given to the development of three specific zones: The first zone is the Walled City (Suriçi). The second zone is Polat Paşa and Fevzi Çakmak Boulevard. The third zone is Ismet Inönü Boulevard known as Salamis Road.

5.4.1 Famagusta Town Plan

This section of the study deals with the geographical analysis of the Famagusta town plan. In this study, a recent Famagusta baseline map was obtained from the Famagusta municipality to monitor changes in street networks. The main purpose of this section is to analyze most effectively, the physical form of the case study. The town plan also contributes to the identification of the morphological regions and plan units of the Famagusta city which are the main product of the historico-geographical approach in urban form studies. One of the fundamental aspects of Conzen's theory which is town-plan analysis is divided into three basic morphological elements;

1. Streets and their structure; a street-system
2. Plots (or lots) and their integration; street-blocks
3. Buildings; block plans.

5.4.1.1 Famagusta Streets Pattern

The street blocks are the regions within the city plan unoccupied by streets and entirely or partially bounded by street lines. Each street block is a group of adjacent parcels of property or a single parcel of property. The origin of the Famagusta streets emerged in the Lusignan period around the main square. During the British period, significant changes in street morphology are evident.

5.4.1.2 Famagusta Plot Pattern

The organization of adjacent plots is obvious from the limitations of the plot and can be called the plot pattern when regarded independently from other components of the city plan. Moreover, there are two other entities, according to Conzen (1969), the street block and the series of plots. The series of plots is a row of plots each with its front-facing the same street line (Conzen, 1969). By evaluating plot width measurements in Ludlow, Slater could speculate on what the medieval surveyor had in mind when the area was designed to grow and how it was ultimately segmented (Slater, 1988). In this study, the plots form of three selected zones of Famagusta have been analyzed. Findings show that Famagusta has usually a rectangular shape, narrow and linear character (Figure 51).

5.4.1.3 Famagusta Building Pattern

The building pattern is contained within the plot pattern, which is in turn contained within the street pattern. Looking closely at these two relationships shows, however, that they are not the same. Buildings are bounded within a single plot but plots are not bounded within a single ‘street’ if the street is conceived as just the route or highway. Modern time begins with the island's autonomy. Based on two significant occurrences, this period was split into two stages. The first was the island's independence, and the second was the 1974 conflict.

In Famagusta building patterns formed, according to different periods from medieval to after 1974. The preserved Lusignan houses are mostly located on the primary square. Buildings from the Venetian period were situated close to the market square and Liman Yolu Street. In Ottoman times, Ottomans constructed just a few houses like an infill in the ancient town. The majority of popular houses belong to the British era. It can be said that they control the character of the old town. Houses were constructed particularly after the

1974 war. Figure 52 indicates the currently building patterns of the three-zone selected case study.

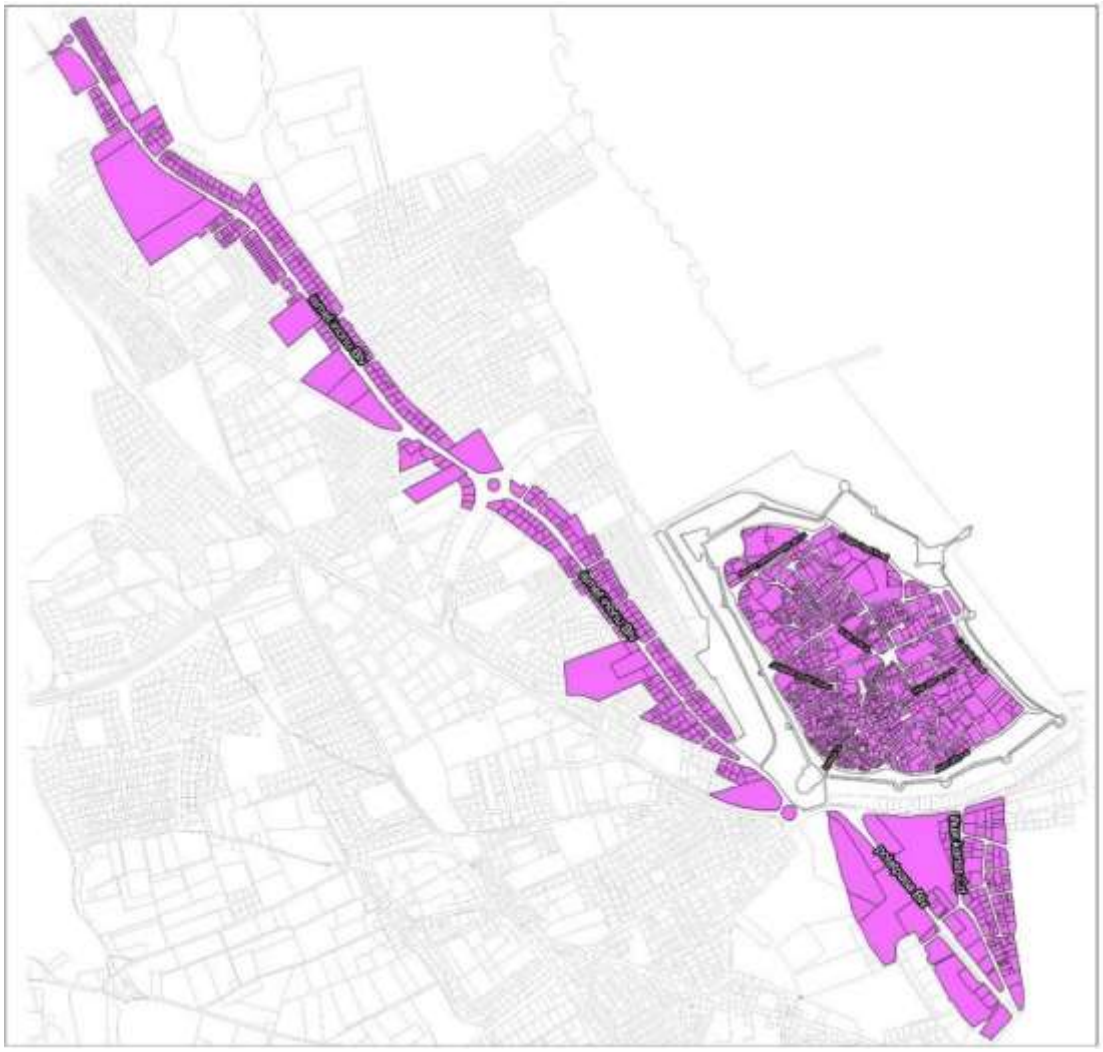


Figure 51: Plot pattern of Famagusta (three-selected zone). (By Author)

5.4.2 Famagusta Townscape

A significant theoretical element of this strategy is the division of the townscape into three main components of ground plan and city landscape by Conzen (1960). He defines city planning by way of the topographic adaptation of an urban built region in all of its man-made features. The mixture of town planning, building forms, and patterns of urban land use is physiognomy or city landscape. The topic of geographic inquiry was all these elements. The conceptualization of historical development is

another significant theoretical problem, primarily investigated by Conzen. The intersection of land use, plan unit, and building fabric provides the historical townscape formation (Baker and Slater 1992). Accurate measurement and understanding of these plan patterns state that the plan is greater, and frequently shows phases of urban development and conversion through a series of plan units (Lilley, 2000). Building types were evaluated with structure and materials according to the building period. In this portion, the Land Use, Building Types, and Plan Unit study by MRG Conzen were taken as the grounds for this research. Hence, Conzen's assessment affected all of the research on Famagusta. Functionally, a town's geographical character is determined and within some regional context, social importance is determined.

5.4.2.1 Famagusta Land and Building Utilization

In this section, the use of structures is demonstrated separately and the land use of certain fields is demonstrated regionally. The first case study area, which is Walled City, surrounds the town's defenses and exterior ring with the vacant territory. Moreover, some of the destroyed houses on large surviving plots can also be considered empty. Public facilities were situated in Walled City on the southwest side of the castle. Near the middle, there is another region that was used with the same feature. Located along the primary pedestrian were shops, commercial and businesses. In the Walled City of Famagusta, residential and commercial buildings are used in a comprehensive variety. From the point of view of land use characteristics, Famagusta has commercial activities in the historic core zones and the Ismet Inönü Boulevard commercial street, as well as religious initiatives at the edge of the central zone. In the third zone commercial axis Ismet Inönü Boulevard, commercial buildings are used considerably in this street (Figure 53).

Figure 52: Building pattern of Famagusta (three-selected zone). (By Author)

5.4.2.2 Famagusta Building Fabric

In Famagusta, the patterns of buildings were assessed in the medieval Venetian, Ottoman, British, and Republic of Cyprus, as well as after 1974, utilizing a different period in history. The majority of Lusignan buildings lie on the market square. Certain religious constructions are in the city's outskirts. (Figure 54) illustrates the building fabrics of Famagusta according to townscape analysis. It includes the material, period, and a number of floors of the different zones of the case study. In Walled City, the historic center of Venetian-era houses was situated around Liman Yolu Street and

others were distributed around the middle. Only restrained houses have been constructed like infills in the Walled City in Ottoman times. The vacant plots around the middle and a few houses near the middle were filled.

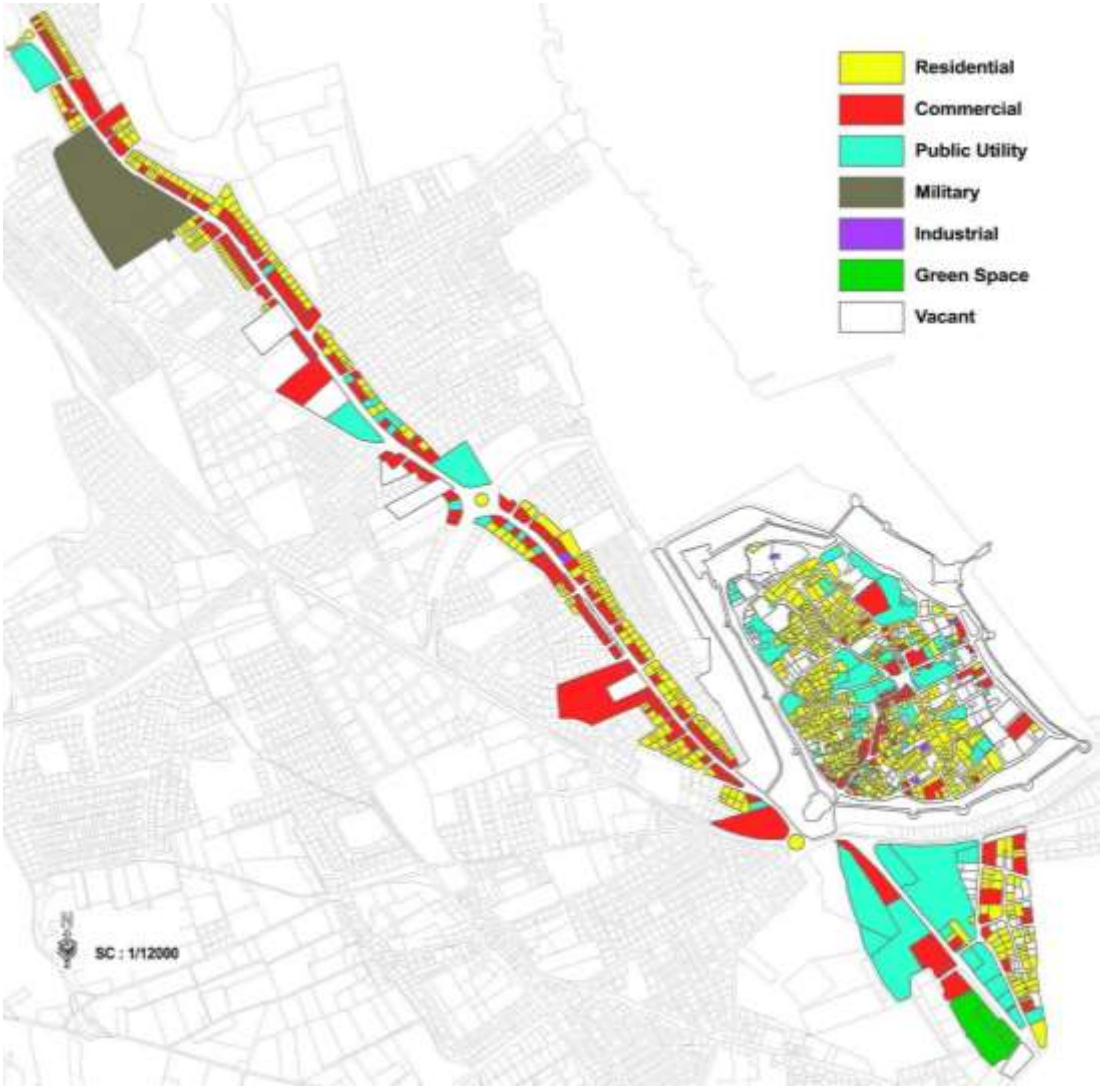


Figure 53: Land utilization of Famagusta (three selected zones). (By Author)

The majority of popular houses scattered throughout the city belonged to the British era. British buildings in Famagusta create the character of the town (Comert, 2013). In the British era and subsequent years, the city's increase in direction south (Polat Pasa Street) was accelerated. However, after the 1974 period because of many reasons such as (closed Maraş), Eastern Mediterranean University location, and natural growth of

coastal cities along the sea (Linear form) the direction of development changed towards the west of Walled City. The commercial zone of the case study that is (Ismet Inönü Boulevard) indicates the path of development after the 1974 period.

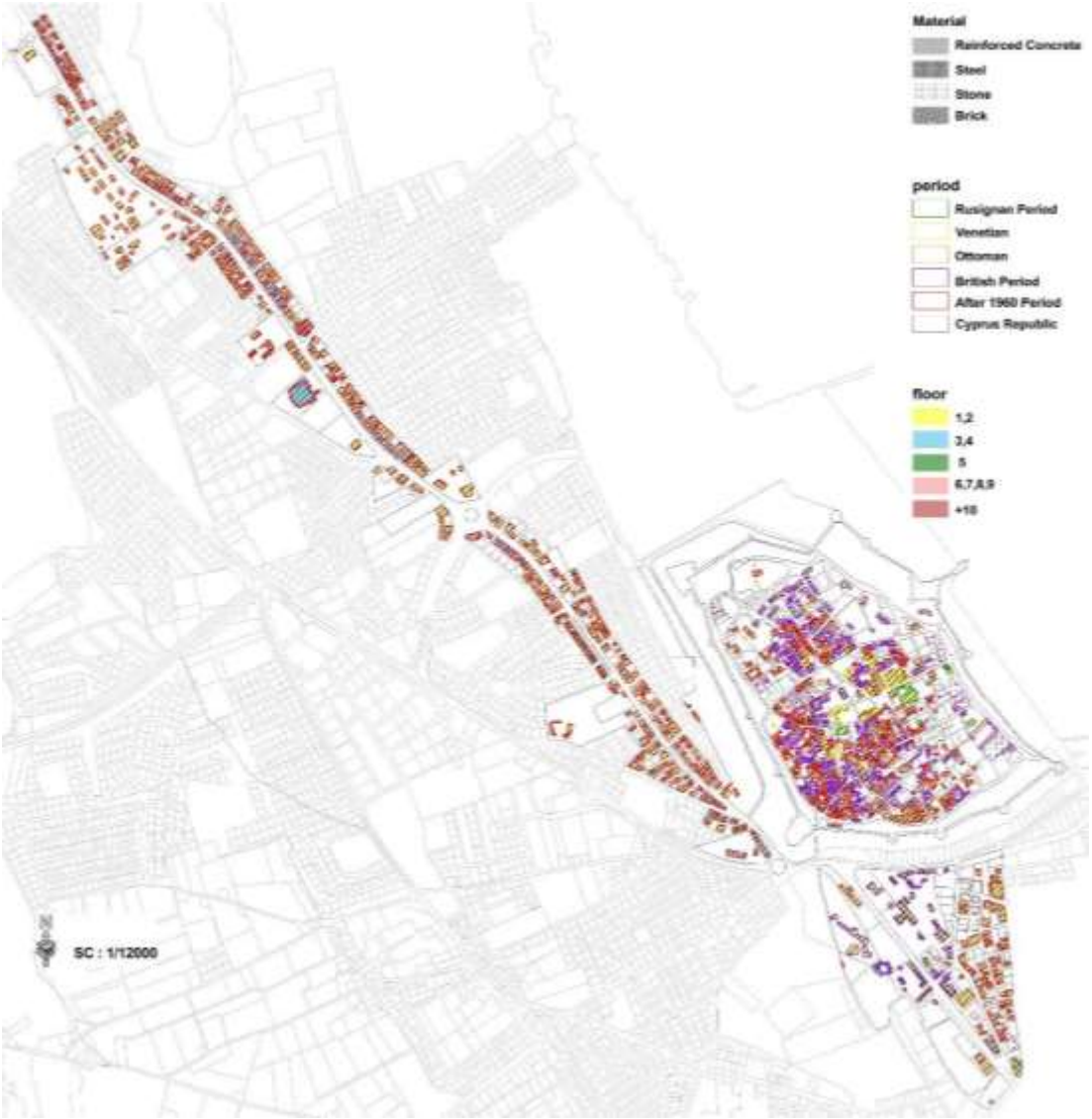


Figure 54: Building fabric of Famagusta (three selected zones) (By Author)

5.4.2.3 Famagusta Plan Unit

The identification of plan units depends on the comprehensive investigation in successive terms of street and building shapes, building block plans, and the orientation, shape, size, and grouping of plots. For instance, in Alnwick, such indication provides a foundation for identifying the layers along which genetically

substantial plan units are joined together. Nonetheless, plan units are only part of the townscape. The pattern of land and building utilization and building fabric can be studied in a unit mapped and parallel way. If these are considered in relation to each other and the plan units, morphological regions can be identified (Conzen, and Whitehand, 1981). For the components of the town plan, the street pattern, the aggregate blocks and plots, and the buildings and their block plans, this commonly applies in order. According to these physical characteristics, it tried to describe plan units that show a sense of consistency in their historical and spatial development. Figure 55 shows a number of existing and remaining buildings from different periods inside and outside of the Walled City. Figure 55 (1) shows the reverse side of the Lala Mustafa Pasha Mosque inside the Walled City (former St. Nicholas Cathedral). The cathedral was built in the Lusignan period and converted into a mosque after the Ottoman Empire captured Famagusta in 1571. Figure 55 (2) shows a view of the inside of Walled City (Namık Kemal Square), where the historical core of the city is formed. Figure 55 (3) shows the Famagusta Post Office, which is a historical building related to the British Period. Figure 55 (4) shows the Famagusta Land Registry and Cadastre Office in Polatpaşa Street, related to the British and Ottoman period, which shows the growth of the city outside the Walled City in that era. Figures 55 (5,7) show a British-era historic building in Polatpaşa Steet. Figure 55 (6) shows the end of Polatpaşa Street, which overlooks the deserted, uninhabited city of Varosha, which is surrounded by barbed wire, and entry is prohibited. Buildings and streets are empty. However, it has recently reopened for visiting. After 1974, due to the abandoned Varosha and the establishment of the EMU University, the growth of the city extended toward the north. Figures 55 (8, 9, 10) show the modern development outside of Walled City. Figure 55

(10) shows a view from the modern commercial street of İsmet İnönü Street which is located near the EMU University campus.

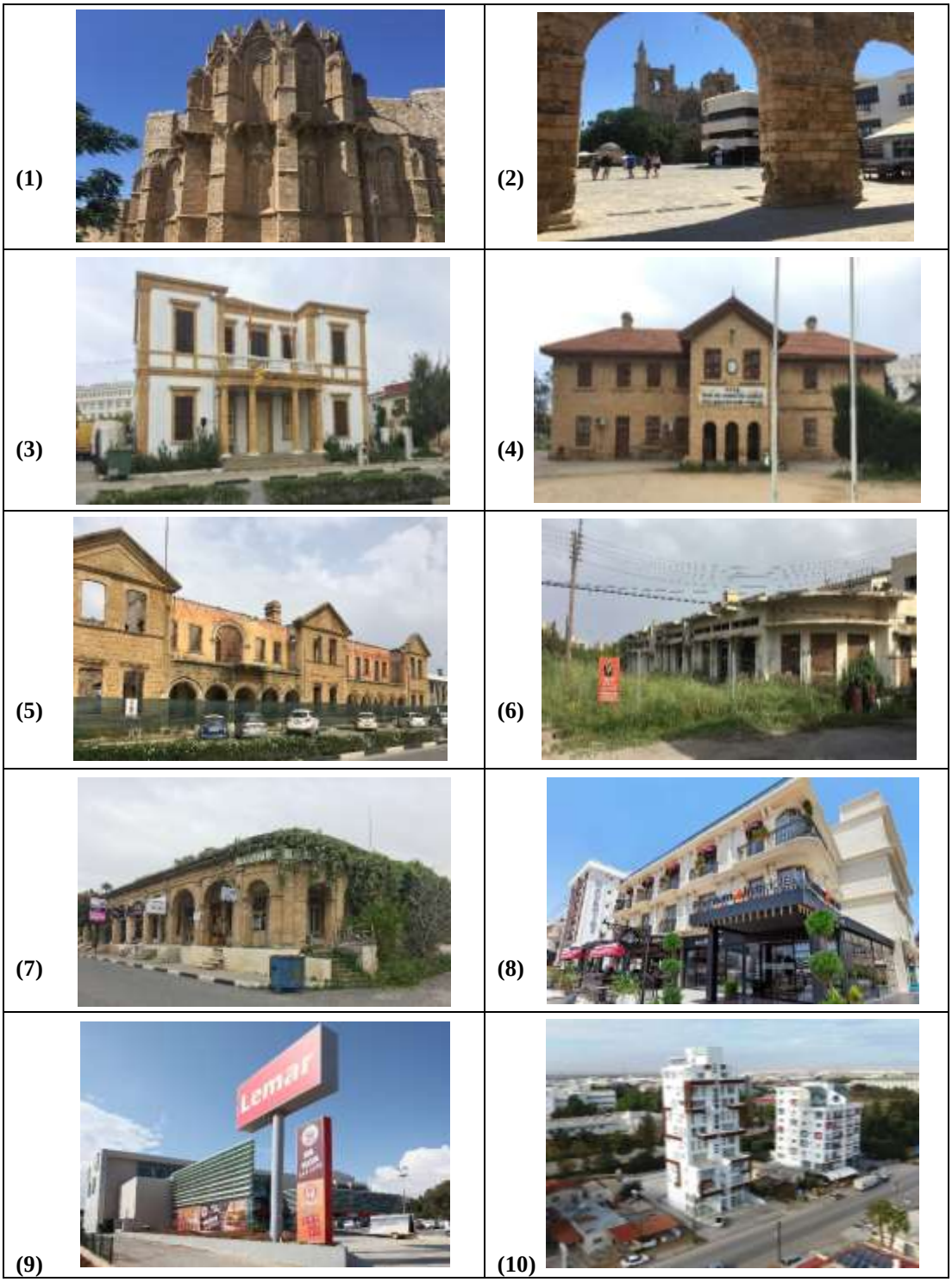


Figure 55: Current and surviving buildings in different periods of Famagusta (By Author)

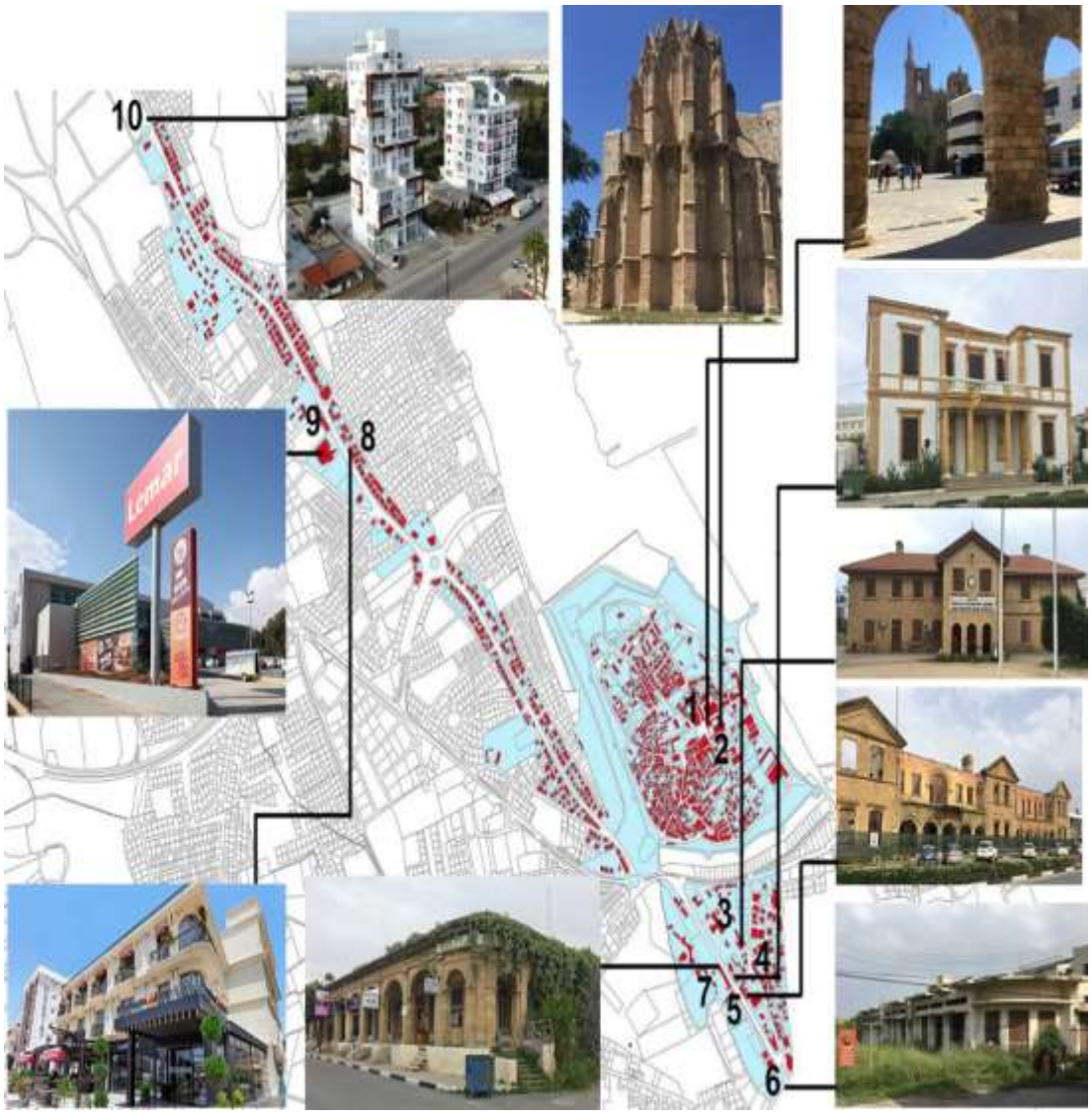


Figure 56: The position of selected buildings on the map (By Author)

Based on Conzen's principles the highest-ranking urban plan units, surrounded by first-order borders, correlate with the main plan units. Figure 56 is based on three selected areas of Famagusta's city showing plan units, building form units, land use units and, the product of the combination of these three maps, townscape units. This reproduces the main stages in the historical growth of the street plan and plot patterns of Famagusta city. The sequence of formative periods starts in the Lusignan period. By the Venetian period, most of the plots had been transformed into large plots, with public utilities. They also reflect the land-use units and main building form units. The

regions are hierarchically categorized by orders reflecting the principle of morphogenetic importance of the form developments (the town plan is the most enduring form, the building fabric is less enduring, followed by utilization). Each street has formed its plots and buildings, according to MRG Conzen, and for this purpose, street name and structure are significant components in the assessment of the plan unit. According to Conzen's Alnwick plan unit analysis, this study divided the plan unit of three selected zone of Famagusta city into seven plan units. That includes modern plot series (21st century) with small plots, modern plot series (21st century) with large plots. Traditional plot series (British period, 19-20th century) with large plots (mostly public utilities).

Traditional plot series (17-19 century or before 1960) with a large plot. Traditional plot series (17-19th century or before 1960) with a small plot, traditional plot series (20th century) with small plots, and traditional (after 1960) with mid-size. The first plan unit emerged in Famagusta with the castle, known as the pre-urban center. The medieval quarter, following the pre-urban nucleus, is located at Sinan Pasha Street, Liman Yolu Street, and Namık Kemal Street. The Namık Kemal Square is dominated by a large rectangular structure. Medieval personality plan units were noted with large irregular forms on the ecclesial structures in the separate portion of the city. An expansion of the medieval district is another development for marketing facilities on Liman Yolu Street with a small plot division.

Figure 57 shows the plan unit of three selected zones of Famagusta according to their plot series, size of their plots, and periods of their plot series. In addition, in Walled City the Canbulat Road, Cengiz topleRoad, Kışla Yolu Street, and Server Somuncuoglu

Streets have a traditional and historical character with large plots and they belong to 16th-century expansion.

On the other side, the expansion of the medieval plot in the late 17-19th centuries demonstrates small houses that surrounded the plotting cycle with residential function. In the 20th century, plot development with the new large plot was created around the ancient city's western land gate region as an expansion of the medieval period cycles.

The other formation along Altın Tabya Street and Abdullah Paşa Street is part of the 20th Century small size plan unit with various types of buildings function. During and after the British period, the urban development in the Polat Paşa area with large block and plot sizes and mainly public utilities evolved to the south in the middle of the 20th century. In this study, the plots that are related to (after 1974- 21 century) showed, as modern plot series with two types of large and small plot series and most of their utilities are commercial and residential.

They generally emerged from the large space with the division of the large blocks and early 20th-century plan units with a regular and medium plot continued on the Muzaffer Ersu within the Walled City and Ilker Cater Street behind the castle (toward the Polat Paşa Bulvarı). Fortification is a major issue that formed the boundary of the Walled City. Open spaces are categorized as empty because they have no features of the plan unit except for the defense walls and organic local loop road. The nearly unwanted urban area was also measured in this planned unit. The urban core of the Famagusta is based on the creation of the castle and the subsequent expansion of the city.

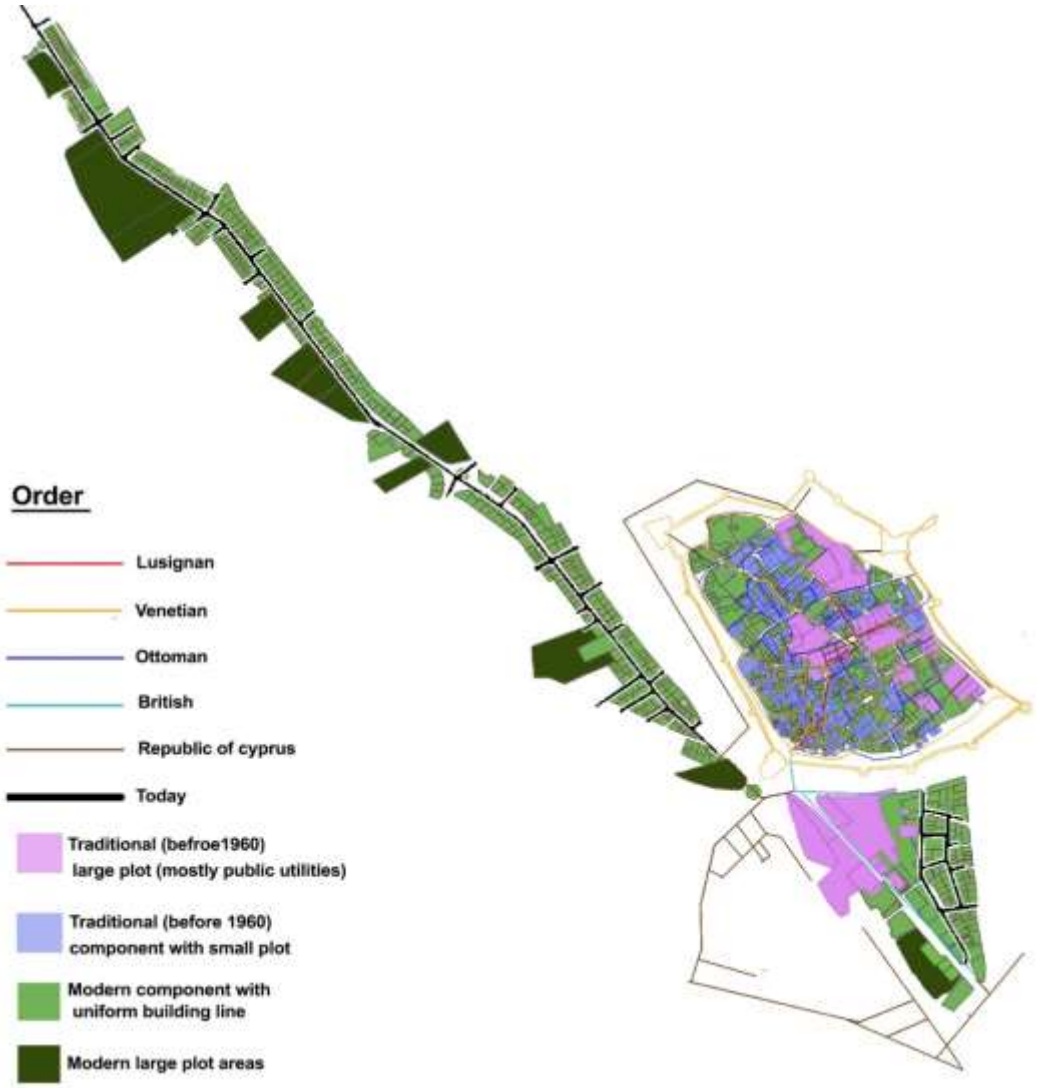


Figure 57: Plan Units of Famagusta (three selected zones)

5.5 Space Syntax Analysis for Famagusta

The streets were always the primary part of urban morphology studies, and spatial syntax was used to evaluate the road network system and urban structure through constructions and accessibility of streets (Oliveira, 2013). This approach is supported through geometrical and topological accessibility measures.

First, an axial map was created to represent the amount of each path's local junction with others. A sequence of the investigations was carried out to assess local and global integration in the following step. This method proposes the integration of space, which

depends on the average amount of road lines and shifts in direction from that space to another space system. Secondly, the segment angular assessment is used to evaluate the geometric accessibility of roads as it was discovered to be a useful geometric tool that recognized the shortest angular paths via the spatial network. All the analyses have been done for the city as a whole, according to the physical development of the city, which is extensive along the sea. Therefore, Famagusta like most coastal cities has a rectilinear configuration, to have the best sea breeze accessibility. The urban form of the Famagusta is shown in Figure 58, based on the street network pattern.

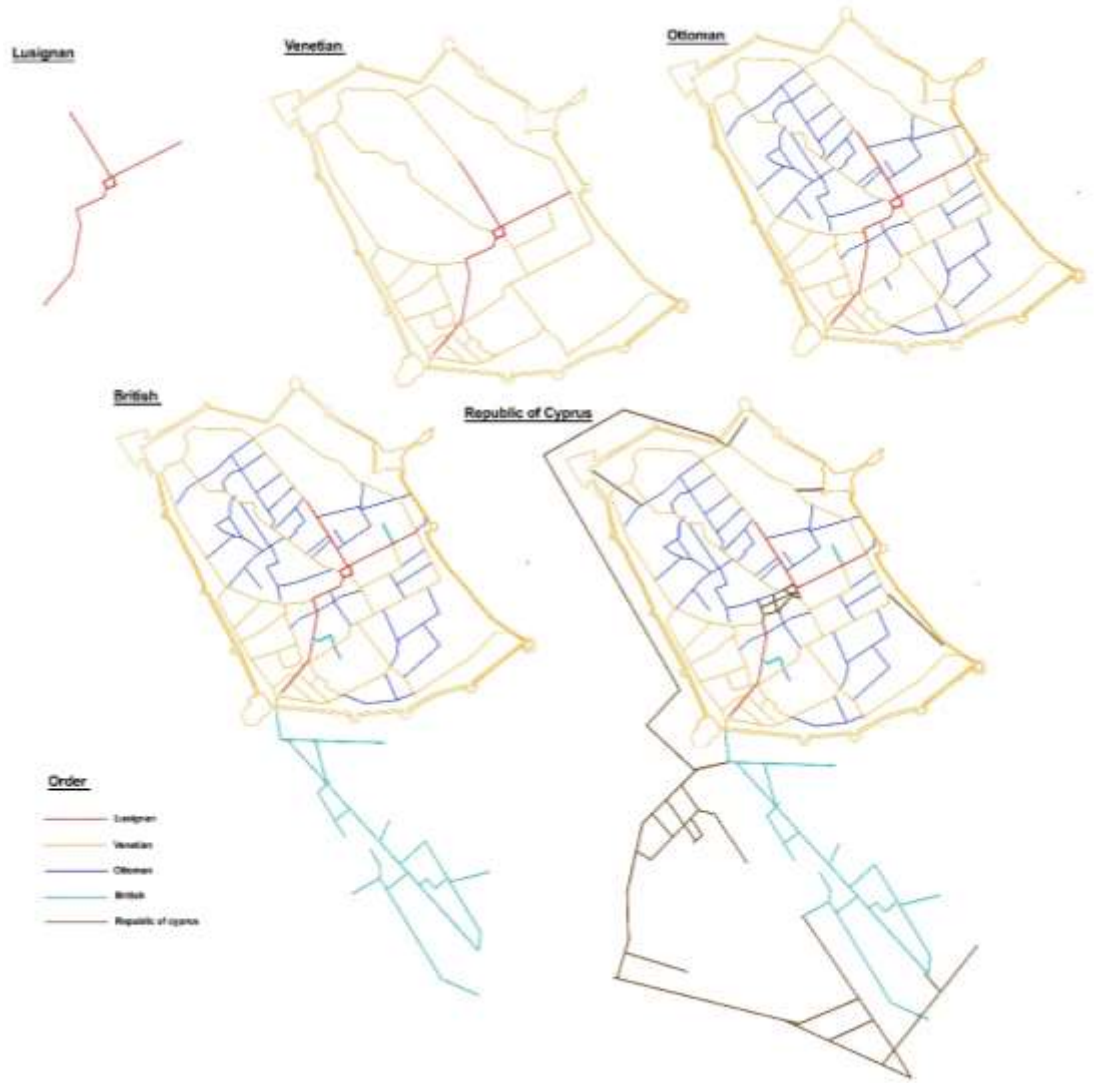


Figure 58: Street network pattern of Famagusta. By author

5.5.1 Street Network Analysis of Famagusta by Using Space Syntax

In the spatial accessibility methodology, the analysis of the urban road network was based on two different analyses: primal and dual methods. The primary is based on the supposition that two sorts of components are included in the network, where street segments are declared as edges and nodes are regarded as street junctions (Hillier, 1999). Famagusta's linear form can be more obviously defined when only the street network is drawn. In addition, in the evaluation of space syntax, this research utilizes street network patterns as the fundamental plan for spatial integration. Accessibility as the capacity for 'through movement' will be the focus of this research (Hillier and Iida, 2005). The approach is usually followed by criteria of accessibility, which are topologically and geometrically understood (Oliveira 2013). First, an axial map has been developed to evaluate the topological accessibility of roads and shows the longest routes possible in space. The segment angular map was created to evaluate the geometric accessibility of the streets, representing the shortest angular paths through the spatial network.

5.5.1.1 Global and Local Integration (Axial and Angular)

This study applied integration (also recognized as closeness centrality and to-movement), and choice (also recognized as betweenness centrality, and through-movement) as the main predictor variables. In this thesis, both axial and segment analysis technique was used. Angular segment examination is a configurational and quantitative evaluation of the accessibility patterns of a street network signified by a segment map. The street segment analysis provides a more accurate understanding of the system than the axis line. The distance between segments is computed topologically with angular alterations from one segment to another, which corresponds exactly to how people move in space (Hillier and Iida, 2005; Hillier, 2008; Serra and

Hillier, 2019). The radius of examination describes the metric distances, calculated accompanied by segments, from each segment to another. The local radius was determined to be 500 meters, while the global radius was determined to be 5000 meters. The syntactic measurement embodies every street segment through a numeric significance and by color. Warm colors imply a strong potential for movement, whereas cold colors indicate a low possibility for movement. The two main syntactical measures propose a simulation of the chief components of human movement, the integration (to-movement) and the choice (through-movement). Considering the least angular paths (shortest path) among each pair of segments, integration defines the destination possible of every segment and choice specifies the path potential of each segment. Integration can be analyzed on a local scale with limited turns and is named local integration measure while the global integration measure used the whole space system for the analysis. The more integration in space has the more intelligibility with other spaces and spatial organization of a city. This feature also indicates the amount of access to the desired space; the more integration has more accessibility to that space; often these spaces are allocated to commercial uses. By considering every other route in the system, global integration demonstrates the network's most effective routes.

It will be well accessible on the scale of the city if the line is more integrated. This study has produced a spectrum image, warm to cold (red to blue), from highest integration to lowest integration. The red paths are the most integrated and the blue routes are the most inaccessible and isolated. In the case of Famagusta Integration Maps, as it is clear in the analysis, lines with warm colors represent higher integrity and interconnectivity, therefore, higher accessibility. In addition, cool colors indicate a low degree of interconnectivity and thus lower access rates. Other significant axes that

allow the city access to diverse regions, such as Fevzi Çakmak, Bayraktar Yolu, Topçular Boulevard, and others, are included in the segment global integration map with a radius of 5,000 meters (Figure 59), in addition to the axes stated above. Unpredictably, because of the absence of networks produced by the UN site and other military centers, the most integrated street is not the Ismet Inönü Bulvarı on the city scale. The overall view of the integration map shows that the maintained military zones affect the integration of the Famagusta urban network. Different from global integration, the efficacy between all routes is not considered at once by local integration.

Figure 59 demonstrates the local integration of the Famagusta map. In the segment, local integration with a radius of 500 meters indicates the inner effectiveness of the lines in the neighborhood and the relations of dissimilar parts of the city with the whole city. The Walled City zone, which is the first zone of this study as the historical core of Famagusta, has the highest value of local integration. In addition, the Eastern Mediterranean University area, is mostly local, with a short, accessible, even short-distance structure. The local integration map demonstrates an important piece of information, as it reveals that in comparison to its local integration, the Walled City has a considerably lesser amount of global integration. Although it is readily accessible by car, pedestrian access is unavailable. It could be asserted that global integration would be more essential in a car-dependent society, but a non-vehicular structure such as Famagusta's Walled City is more expressive of local integration. Eastern Mediterranean University Site identifies a high local integration, which is unexpected.

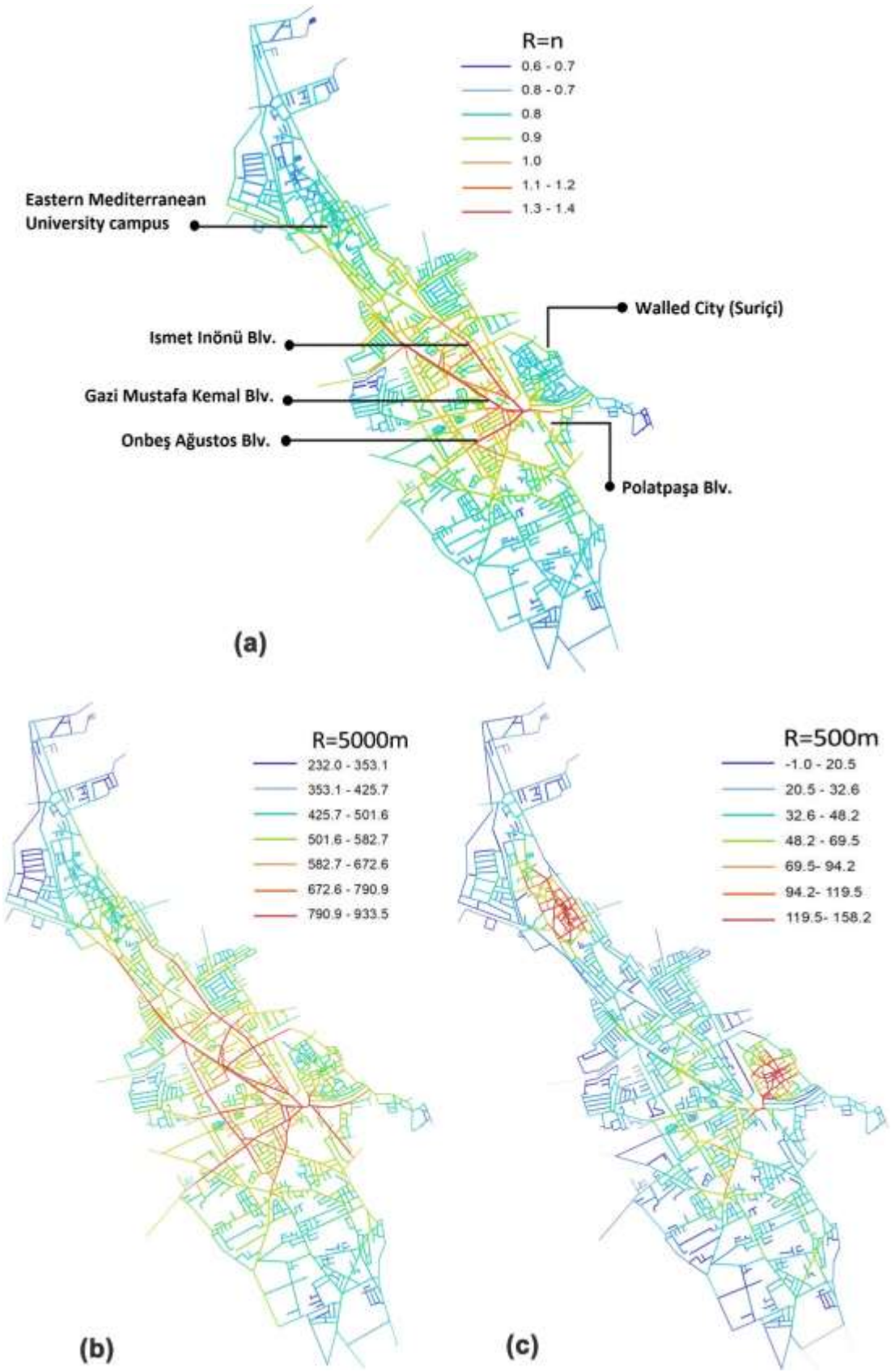


Figure 59: a) Axial integration of Famagusta; b) Angular global integration of Famagusta. c) Angular local integration of Famagusta

5.5.1.2 Choice (Axial and Angular)

In the *choice* analytic maps, (Figure 60) the main axes and between-ness are selected from the integration output, which indicates the importance of these selected axes. In the axial choice map, two main axes Ismet Inönü and Gazi Mustafa Kemal Boulevard have been selected. In the segment choice map with a radius of 5000 meters, Ismet Inönü Bulvarı axis and On Beş Ağustos Bulvarı are selected. In the segment choice map with a radius of 500 meters on a local scale based on the integration map of the same zones, hence the inner axes of the Walled City and the Eastern Mediterranean University zone are selected.

Here, by choosing the Ismet Inönü Boulevard as the commercial axis with the highest value in the output of choice as the highest accessibility and integrated axes, will discover the significance of this axis in the city, conversely, the Walled City is also chosen as the local choice. Choice measures how the shortest paths connecting all pairs of segments in the network traverse often a street segment. This measure is calculated in Depthmap automatically for any defined radius used. Intuitively, the factor of choice implies the through-movement possible of a street in a spatial system, estimating how a street segment can be a movement path or potential route that is often selected by either pedestrian (if a low metric radius is considered) or by vehicles.

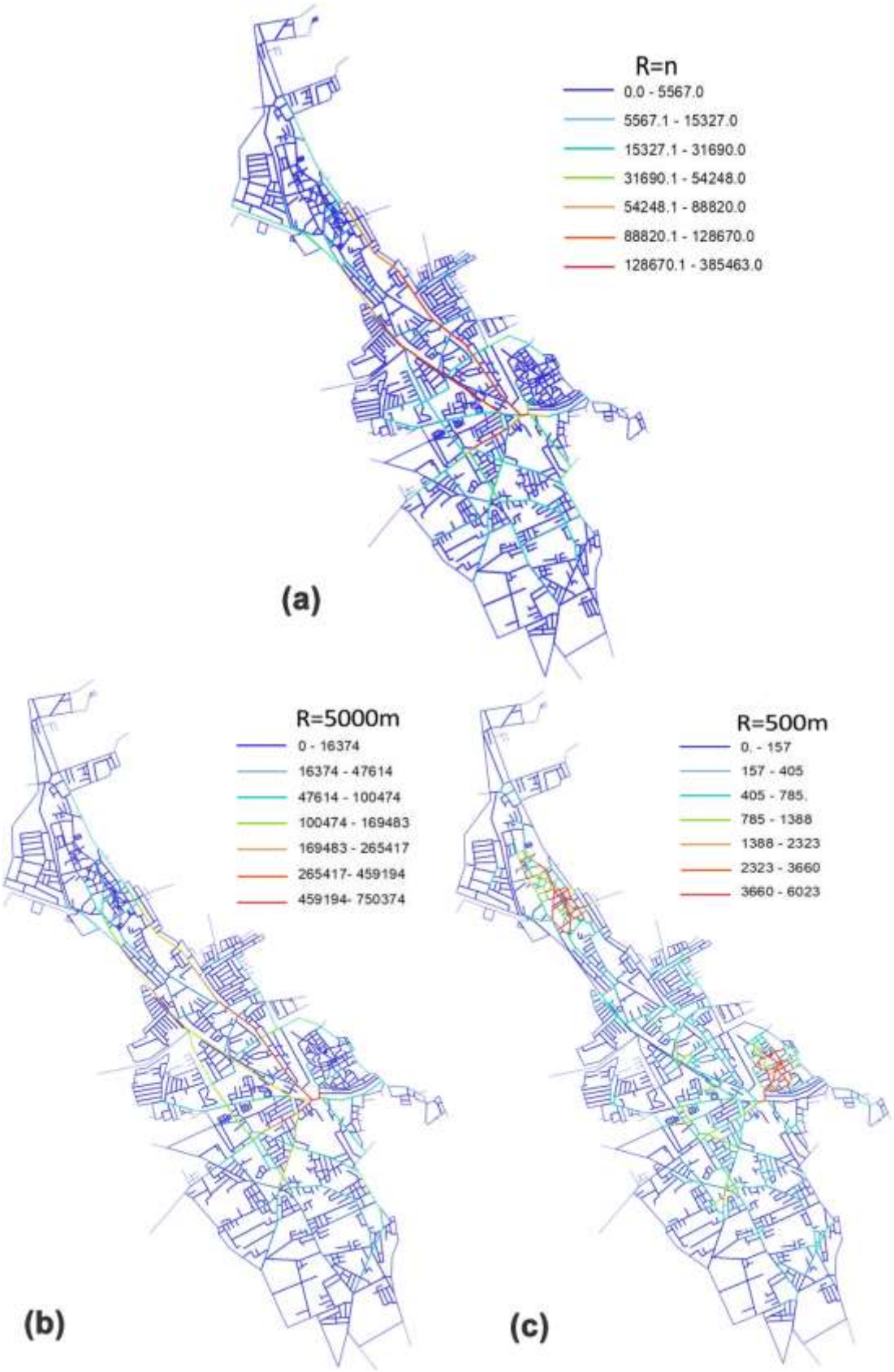


Figure 60: a) Axial choice of Famagusta; b) Angular global choice of Famagusta; c) Angular local choice of Famagusta

5.5.1.3 Connectivity (Axial and Angular)

Axial *connectivity* is one of the most obvious concepts of spatial analysis, which means spatial connection, the more connections, and the more communication with other spaces. Its functional concept is accessibility and the numerical value of the connection denotes the number of accesses leading to the desired space. In the map, the Gazi Mustafa Kemal Blv (Anit roundabout) axis has the strongest connectivity. In the segment analysis of the connectivity map, connectivity is a local criterion, because it examines the only relation between space and its immediate neighbors. (Figure 61) illustrates the axial connectivity with (R=N) and segment analysis connectivity of Famagusta.

5.5.1.4 Measuring Accessibility through Urban Spatial Network

The urban centrality metrics are both a theoretical and practical approach to understanding the urban spatial organization. The properties of these variables are based on network analysis mathematical calculations. The body of literature proposes a robust association between the way spatial grids are systematized and the way individuals use urban spaces in their lifespan. The natural movement of people across the urban grid appears to be highly dependent on the network's features (Hillier, Penn, Hanson, Grajewski, & Xu, 1993). In this study, accessibility is based on the connectivity and integration components. The axial map of the Gazi Mustafa Kemal Blv axis has the highest value of accessibility. The segment accessibility maps the Gazi Mustafa Kemal Blv, Ismet Inönü, and On Beş Ağustos Boulevard axes as the highest accessibility value and of the most value (Figure 61). In this section, we see the importance of the Ismet Inönü Boulevard axis as a commercial venture with high availability to other parts of the city and the importance of this as a socio-economic

challenge because of both commercialization and cultural-educational use and strong social interactions in this sense.

5.6 Combining Historico-Geographical and Configurational Approaches in the Three Selected Districts of Famagusta

The findings of the research are discussed with particular reference to the complementary approach for analyzing case studies by utilizing the historico-geographical and configurational approaches of urban morphology. The key findings from this section are taken forward into the result and discussions. The traditional spatial organizational pattern in Famagusta has been greatly transformed into modern development. In terms of city organization, the Walled City has developed throughout history in different phases, under different social, economic, cultural, and political conditions.

The Venetian buildings were located around the market square and Liman Yolu Street and other buildings were distributed throughout the center. The Ottomans built a small number of buildings in the old town; during the British period, development expanded outside of the city walls, including Polatpaşa Street; however, the high integration values remained within the Walled City (Luke, 1965). Development spread outside and all around the walls after 1960; housing development was particularly pronounced after the 1974 war (Cömert, 2013). Figure 62 illustrates the syntactic analysis of the evolution of Famagusta from its historical core, in accordance with the different historical periods. In addition, it combines the space syntax visualization and town plan elements in a single map by overlapping the axial maps and plot patterns.

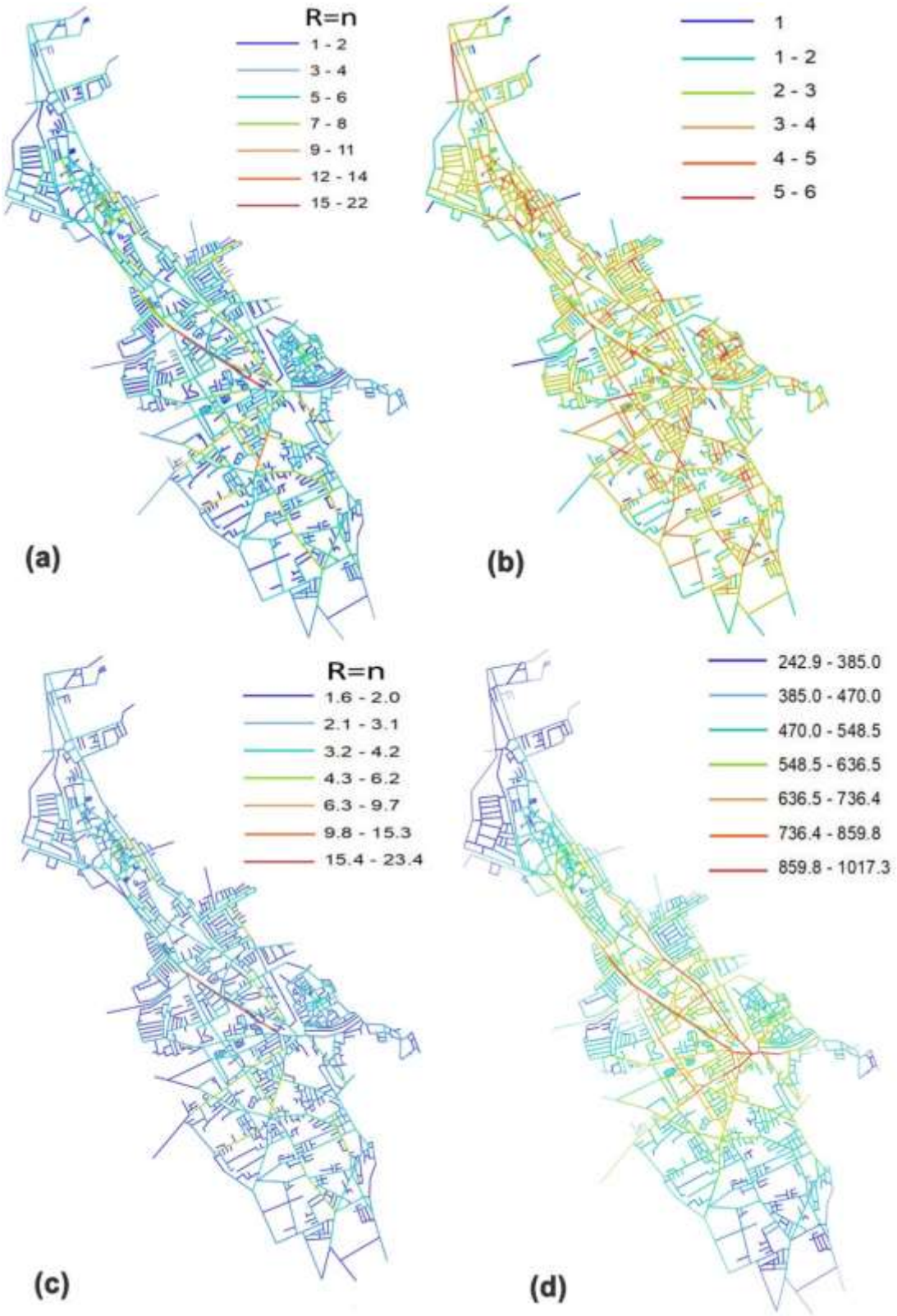


Figure 61: axial connectivity of Famagusta; b) segment analysis of connectivity; c) axial accessibility; d) right is segment analysis of accessibility based on connectivity and integration.

In the first period of the Lusignan inside of Walled City, the square and the restricted passages around the square were the only ways of access. The Venetian period brought with it the development of relatively high passages. The main passages of the area, such as Naim Efendi and Kışla Yolu Street had high-value of integration with a radius of 250, 500, 1000, and n contain (Istiklal Caddesi), (Server Somuncuoglu Sk), (Sinan Paşa Sk). In this period, the main and essential access to the Walled City has developed. The Ottoman period, fronted with complimentary access and multiple subsections and almost interconnected networks in the Walled City, and according to the space syntax analytical map, most axes have a high integration value with the radius of 250, 500, 1000, and n, and this indicates the enhancement of access and the integration of street network system in this period. The British period saw the development of outside the Walled City, and the high-integrity street networks are more in the center of the Walled City, such as; Kışla Yolu and Necip Tözün Street, and the internal and external linkage axis of the Walled City (Polatpaşa Boulevard). The period after 1960 with the relative expansion of peripheral street network system, central connectivity access with high integration, including Istiklal Road axes and Lala Mustafa Paşa Street and the connectivity axis of the Walled City to the outside of the castle such as; Polatpaşa Boulevard is still of high value. In the analytical map of the whole city, which is the newest map, the Walled City's region on the scale of global integration, as previously mentioned, has a low integration value and the linkage axes with a high value of integration are outside of the Walled City and historical texture. Combining land-use patterns with space syntax measurements makes it possible to designate the spatial features of the urban form, thus offering a new ordering system for the spatial types of urban areas. in relation to their socio-economic performance during the periods. Figure 62 illustrates the current building and land utilization of the selected districts overlaid

with the axial maps, showing the changes in the configuration of the street network within each area. The mainland uses of the historic district are public utilities, commercial, and residential. Famagusta has the most commercial activities on Ismet Inönü Street. The integration core of a city was mainly formed with the highest integrated axial lines. The integration core in the development area seemed to be intensified by local grids, attracting cafes, restaurants, and retail shops.

Figure 62: The transformation processes of Famagusta city throughout the historical eras by overlapping the axial maps and plot patterns in different historical periods.

It reflects the argument that a successful commercial street requires two parts of spatial character: the higher value in global integration and the intensification of the local grid. The urban growth of Famagusta in different periods based on the street network system is shown in Figure 63. All of the above analyses emphasize how Ismet Inönü Street is the most important street in the city as a commercial and administrative area with the highest value of choice and integration. The main institutional and commercial centers of Famagusta are located along this street.

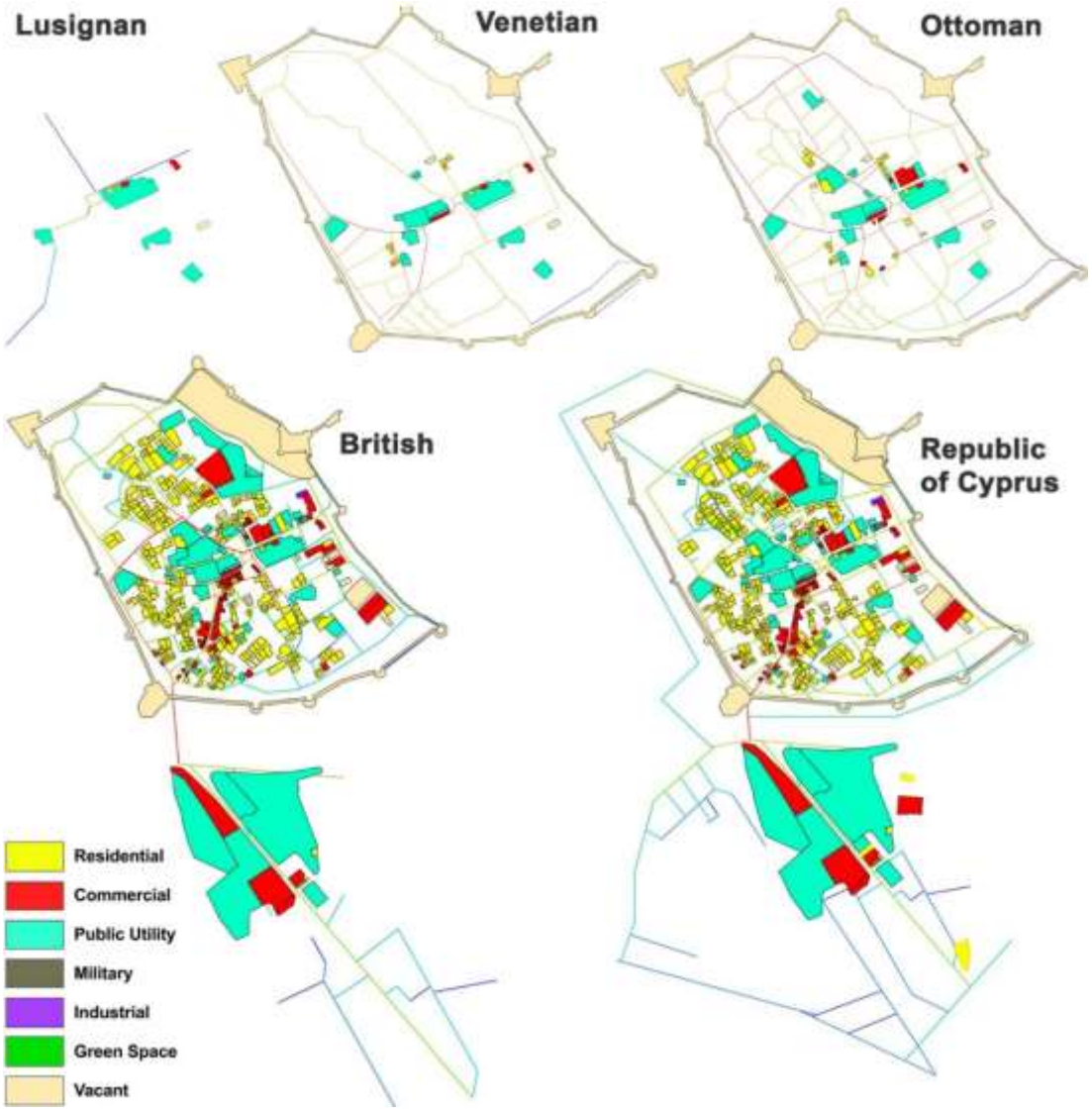


Figure 63: Combining land utilization and axial maps' global integration to show the changes in urban configuration in Famagusta from the Lusignan period to the Republic of Cyprus.

In the Lusignan period, the city developed in an organic pattern around the St. Nicholas Cathedral creating the main axis of expansion. The Venetian period saw the development of a relatively high number of passages; the streets with high integration values at the radii of 250 m, 500 m, 1000 m, and the total average integration (radius n) include Istiklal Road, Server Somuncuoglu, and Sinan Paşa Street. It was during this period that the main access to the Walled City developed and buildings were placed around the market square in the historic core of the city. During the Ottoman period, complementary accesses and multiple new streets interconnected the network within the Walled City, with most axes having a high integration value at the radii of 250 m, 500 m, 1000 m, and (radius n). During the British period, development expanded outside of the city walls and accelerated towards the south, including Polatpaşa Street; however, the high integration values remained within the Walled City. During the Republic of Cyprus period, the direction of development changed towards the west of the Walled City; the street network system further expanded, including Istiklal Road and Lala Mustafa Paşa Street, driving the connectivity axis of the Walled City to the outside.

In the contemporary city, the historic district has low global integration and high local integration. The analysis of morphological regions maps follows the study of the Conzenia tradition and historico-geographical structure of the urban landscape, in a classification of phases: the study of morphological periods and historical cartography and documents (from the earliest map of 1192 to the latest of 2020); building-by-building and plot-by-plot field survey; representing of (ground plan, building fabric, and land and building utilization– Figure 51 to 54); and then the combination of the three form complexes to achieve the definition of the different orders and hierarchy of morphological regions.

The identification of plan units depends on the comprehensive consideration in general terms of building block plans, street and building patterns, and the size, orientation, shape, and grouping of the plots. As in Alnwick, such indication offered a foundation for identifying the seams along which important genetic plan units are joined together. As is evident in this study, the pattern of land and building utilization and building fabric can be studied in a unit mapped and similar way. If these are observed in relation to each other and the plan units, morphological regions can be identified. The regions are hierarchically categorized by orders seeing the principle of morphogenetic importance of the townscape analysis. The ground plan and specially the street patterns are the most enduring form; the building fabric is less permanent.

In line with Conzen's analysis, the distinctive qualities of the urban elements forming the city plan together were investigated. This is utilized in the four morphological plan units to designate morphological homogeneity areas (Figure 64). The pre-urban core is the initial plan unit that appeared with the castle. The medieval borough, Namık Kemal, Sinan Pasha, and Liman Yolu streets appear after the pre-urban nucleus. Figure 65 illustrates the overlapping of the space syntax analysis with the building fabric into one map to describe the morphological properties of the different elements of the built environment over time.

Figure 66 represents the overlapping of the space syntax analysis (axial integration) and historico-geographical analysis in 2020. In recent years, the city has expanded to the northwest due to the division of Cyprus in 1974, military-controlled areas, the Varosha Closed Area (southeastern neighbouring region), and the establishment of the Eastern Mediterranean University in 1979. In the last 30 years since the inauguration of the Eastern Mediterranean University, Famagusta's rapid urbanization has

contributed to the transformation of urban development and significant modifications in the spatial structure of urban areas. Precisely, in the last 15 years, the growth of urban areas and the evolution of urban morphology has become an important symbol of urban development (Önal et al., 1999). The Walled City is no longer the most integrated place as it once was in local integration.

Figure 64: the overlapping of the space syntax analysis with plan unit into the one map in different periods of Famagusta

Figure 65: Overlapping of the space syntax analysis with building fabric into the one map in different periods of Famagusta

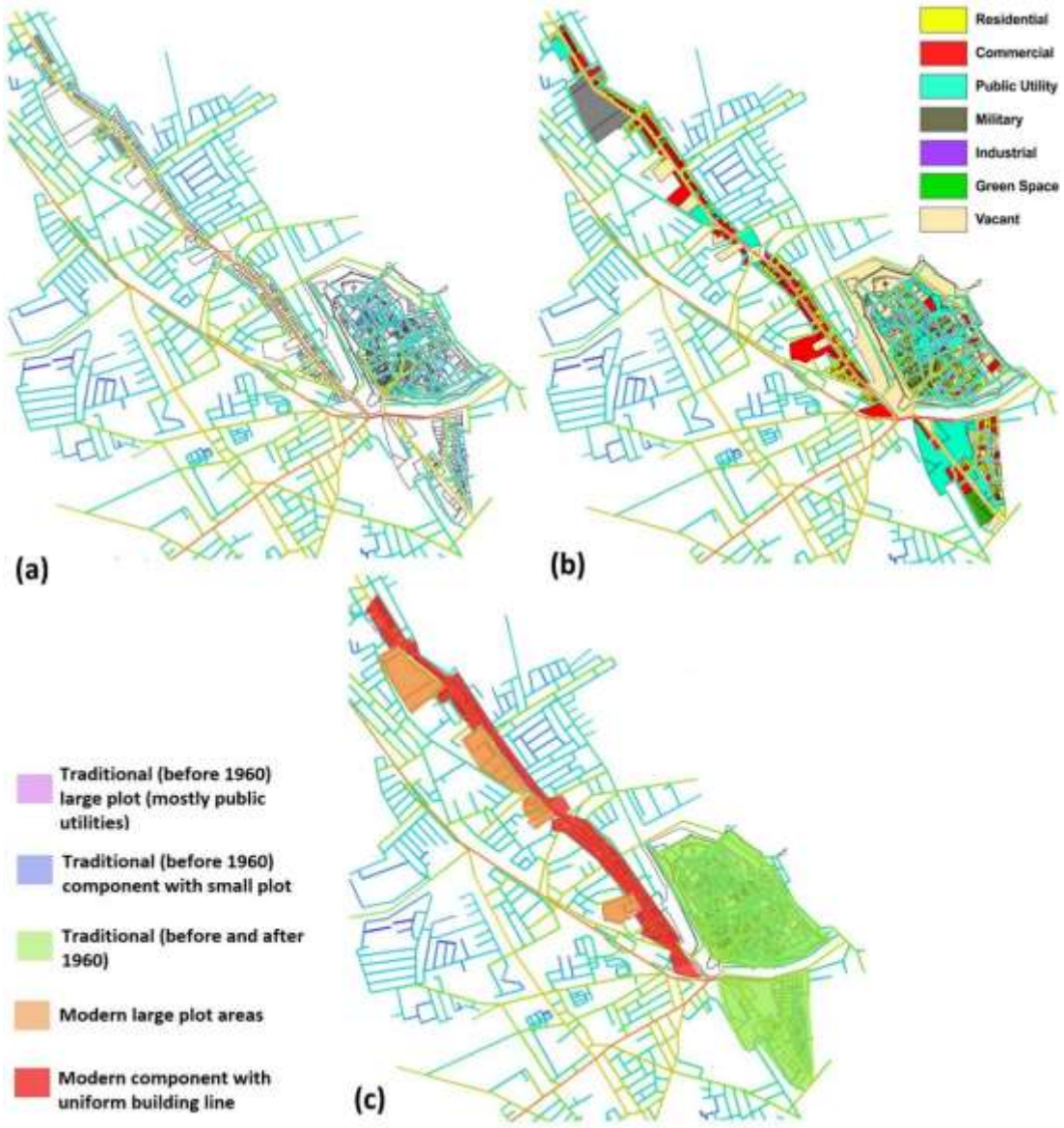


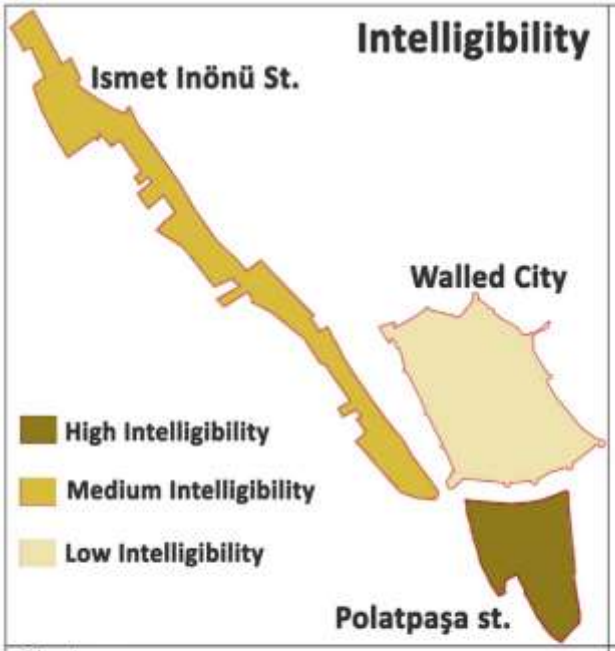
Figure 66: a) overlapping of the axial map and plot patterns in 2020; b) overlapping of the axial map and land utilization in 2020; c) overlapping of the axial maps and plan unit in 2020.

5.7 SPSS statistical analysis

Finally, the intelligibility analysis was computed by SPSS, which demonstrates that the area of Polatpaşa Street has the highest level of intelligibility compared with the two other districts. While the local and global integration of Ismet Inönü Street is higher than that of Polatpaşa Street, they are in second place in SPSS computation in the domain of connectivity, as well as global integration and local integration with the

values of 0.35 and 0.51 respectively - close to the overall average of the city which is 0.36 and 0.59. The Walled City has the lowest integration value and the lowest intelligibility. Table 9 shows the classification of the three selected districts based on different variables and eventually their intelligibility. The findings of this paper explain the spatial connections between socio-economic activities and urban form. The analysis using the historico-geographical approach, especially the land utilization, expresses the socio-economic status of the districts. Accordingly, using the configurational approach, Ismet Inönü has the highest accessibility, integration, intelligibility, and highest socio-economic status as compared to the other two districts. Polatpaşa Street and the Walled City are second and third respectively in this hierarchy. Table 9 represents the districts based on having the highest and lowest integration, accessibility, and intelligibility.

Table 9: The ranking of each zone in the different variable (By Author)

	Connectivity	Integration [Global]	Integration [Local] R3	Intelligibility	
				Global Integration/ Local Integration	Global Integration/ Connectivity
City Average	3.63	0.67	1.68	0.59	0.36
Districts					
1. Ismet Inönü (N=95)	5	1.01	2.03	0.51	0.35
2. Polatpaşa (N=33)	3	0.90	1.62	0.79	0.39
3. Walled City (N=190)	4.38	0.68	1.92	0.27	0.14

According to the table derived from this process, the range of the (Polatpaşa Boulevard) zone has the highest level of intelligibility compared to the other two zones (Walled city and Ismet Inönü Boulevard), and versus the average of the whole city, which is the main factor of the comparison of intelligibility. While the local & global integration zone of (Ismet Inönü Boulevard) has higher digits than (Polatpaşa Boulevard) zone. But this zone is in second place in the Pearson correlation study in two domains of connectivity & global integration and local & global integration with the numbers 0.35 and 0.51 close to the overall average of the city, while Walled City with the fewer digits in these two areas, has the least intelligibility. Figure 67 determines the classification of three-selected zone based on their intelligibility.

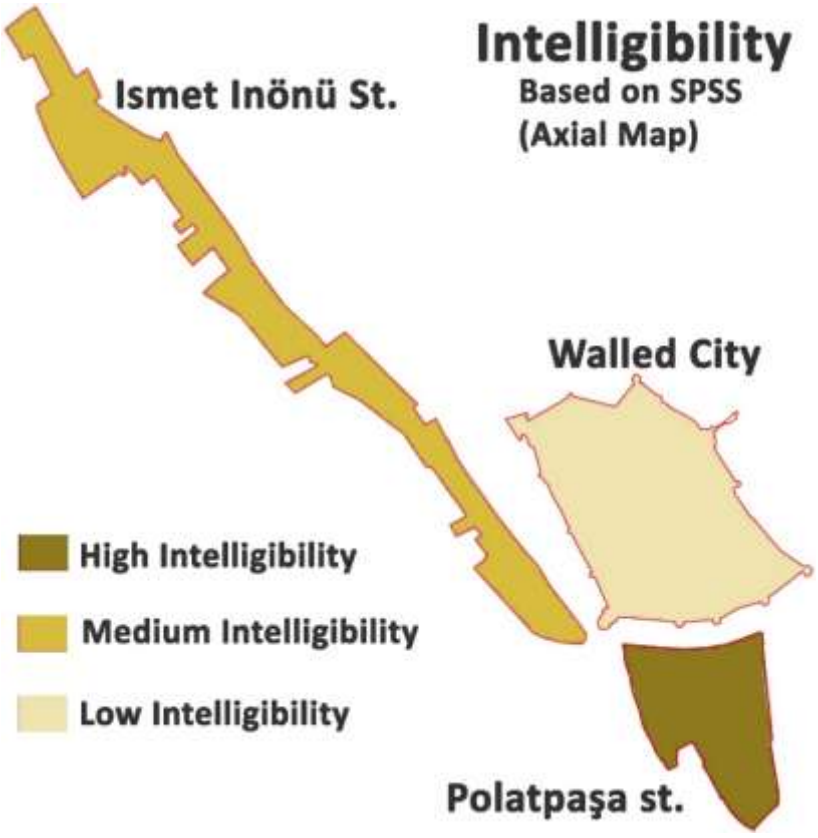


Figure 67: Classification of three-selected zone based on their intelligibility (By Author)

5.8 Chapter Summary

Famagusta has a wealthy and turbulent history that has changed the city's situation and context over every decade. The island's turbulent history remains today. According to the urban growth of the town after 1974 and the exclusion of the Maraş/Varosha area, there was no opportunity except to grow towards the north-west, almost in a linear form along the seaside; the town provides a fragmented structure with low connections among its neighborhoods. This chapter tried to carry out the analysis on the three-selected zones of Famagusta city in order to achieve the main aims of the study. The link between urban and socio-economic forms can be established by attempting to match the outcomes of space syntax analysis and historico-geographical assessment. Many barriers have affected Famagusta's urban form and its development during different periods.

It should be mentioned that the city has expanded towards the Northwest direction in almost uncontrolled and very fast due to several reasons. The first trigger of a greater concentration of urban districts is that the military and the UN camp disconnect the physical networks and do not allow the city to be integrated and to have narrower structures close to the sea. Secondly, they reduced global integration in general. Global integration will decrease because of impenetrable barriers. These barriers prevented the development of a sufficient network of streets in Famagusta and caused unnatural accessibility to decrease. The new development of the city focused on the outside due to a lack of accurate accessibility. The urban morphological character of Famagusta Walled City, which is the historical basis of the Famagusta, has an organic street network with no through road or cul-de-sacs streets. There are large open spaces around the walls of the castle that can be considered vacant. The commercial street that

was built up after 1974 as a contemporary area does not have compatibility with the Walled City district. Besides these physical characteristics, it should be emphasized that the Walled City neighborhoods constitute the city's traditional center, and the area's land use has a mix-use character while the Polatpaşa Boulevard includes public facilities and social services such as (municipality, courthouse, post office, etc). In addition, Ismet Inönü Boulevard because of its structure and juxtaposition with the main entrance of Eastern Mediterranean University has its importance.

The morphological analysis of street form indicates that each zone in the three-selected area has a unique character regarding form, length, and width. The Walled City of Famagusta has an organic street character, in the Walled City; the streets present an organic medieval form. In addition, major streets usually show irregular organization. Street network patterns of the Walled City are based on medieval features and other street formations based on those streets. However, the degree of organicity differs while Ismet Inönü Boulevard has a linear structure and form according to its development along the seashore.

These morphological characters of streets can also affect the integration such as global and local integration, connectivity, choice, and eventually its accessibility and movement. In the Walled City, town center functions consist of commercial utilization that includes the shops, offices, with or without residences. The analysis of the building fabric of the Walled City demonstrates that most of the buildings related to the medieval age are situated in the town core. In addition, Polatpaşa Boulevard developed during the British period and after that, there are some buildings with the character and structure of the British period such as yellow stone. Moreover, Commercial Street (Ismet Inönü Boulevard) that developed after 1974 does not have compatibility with

the Walled City zone, and most of the material and functions, structure, and period are different from the Walled City. Famagusta's mixed character suggests different plan units. Due to the townscape, this assessment demonstrates how the townscape was developed over time; this assessment provides an idea of how this formation would be carried out. Practically, in some regional contexts, the historico-geographic character and spatial syntax of a town are determined by socio-economic meaning. In this respect, both the Conzenian and spatial syntax identify the historical nucleus of urban form as the means of understanding the structure of socio-economic activities in the built environment. It has been found that the linking between urban form and socio-economic activity is both historical and configurational.

The method of historico-geography allows comprehending the city's evolutionary shape throughout the formative phase, in relation to six different periods in the historical background of Famagusta, which can be called Lusignan, Venetian, Ottoman, British, Republic of Cyprus, and After 1974. Famagusta's socio-economic growth is based on business activities. With these activities, it is possible to look at marketing towns. Marketing activities were performed in Famagusta through the port via other nations. The evaluation of the Conzen method intends to explain the geography and the character of towns by systematically analyzing their parts and their growth over time. He divides the townscape into three complexes including ground plan, land use pattern, and building type. The Conzenian approach does not pay sufficient attention to the configuration and classification of streets and the importance of movement and accessibility to the effects of the city's form. Hence, this study focused on a complementary method of the historico-geographic approach and the configuration approach (space Syntax), which focuses on accessibility and street

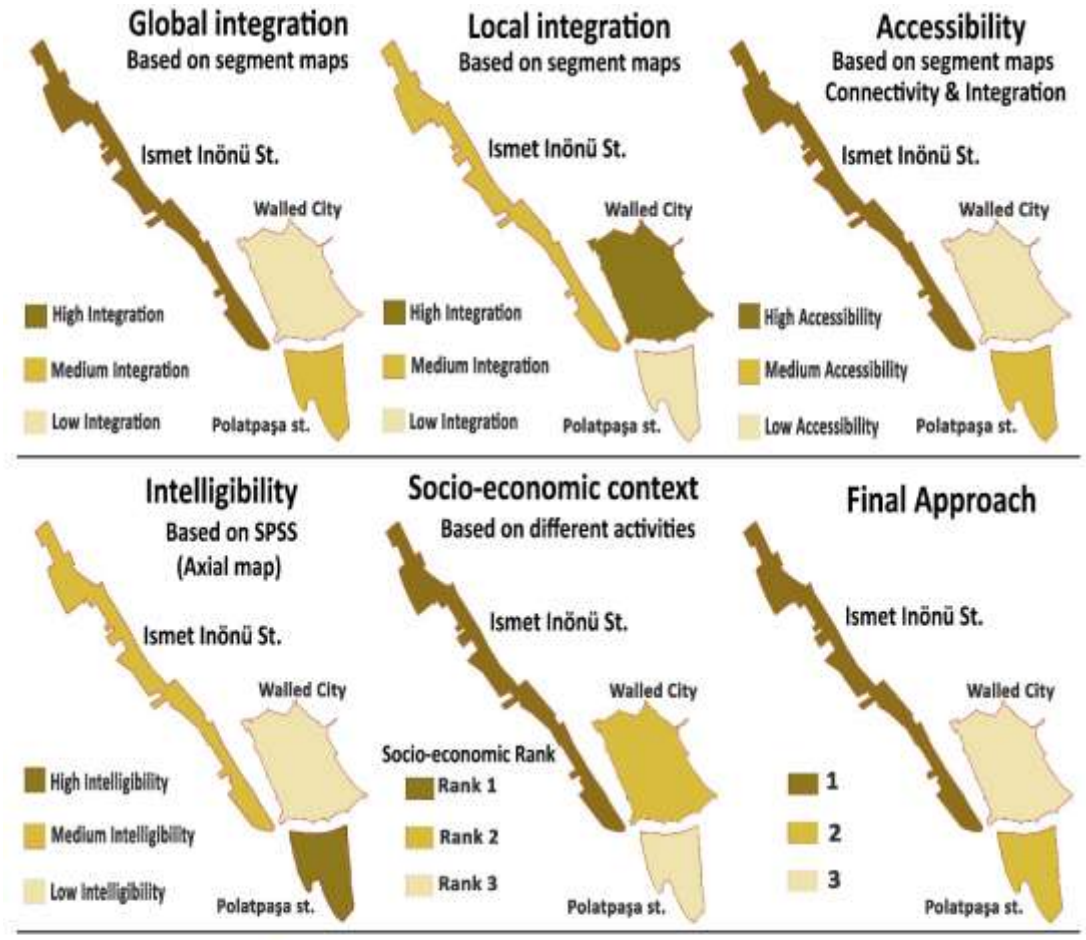
network pattern in the evolution of the urban form. In studies conducted in the case study, which includes three-selected zone; Ismet Inönü Boulevard, the Walled City, and Polatpaşa Boulevard. In the first district, an examination of the historico-geographical approach, the methods proposed by Conzen included town plan (street pattern, plot pattern, and building plan). Townscape maps were used referring to the socio-economic issue, the maps of this approach, especially the land utilization, express the social status of the zone. Thus, the Ismet Inönü Boulevard zone can be considered as the turning point for a city with its high social fabric due to the modern texture and many commercial and residential uses in this area. In addition, the Walled City zone as a historical texture with mostly residential and public uses and public utilities as the traditional, isolated and original and core zone of the city has a modest social texture.

In conjunction with the configuration approach, the output maps taken from the Depthmap software are presented in the analysis chapter. In the Output Map of the selected zones at the end of this section (Table 10), results from the Space Syntax are presented, which includes the final map of intelligibility based on Axial data, and an SPSS survey and accessibility map based on segmental maps, and global and local maps, all maps are categorized as "high, medium, low". The Polatpaşa Boulevard, with its mainly residential and administrative utility, is relatively far away and on the edge of the boundary to the closed area, (Maraş) has a modest social texture. At the end of this section, table 10 represents the neighborhoods based on having the highest and lowest, integration, accessibility, and intelligibility; for each of these variables, the map specifies a different color spectrum. For example, the neighborhood of the Walled City has low accessibility, low global integration, and low intelligibility. Ultimately, two historico-geographic and configuration (space syntax) approaches and outputs of

surveyed maps in a final approach, (Table 10) which rates Ismet Inönü Boulevard with the highest accessibility, integration, and intelligibility, and the highest social stratum compared with the other two zones. Moreover, the Polatpaşa Boulevard and Walled City zones are second and third respectively. Due to the intricate essence of cities, it is difficult to contend that the full complexity of their objects can comprise only one morphological approach. In a specific state, this might indicate that a single approach could provide a better understanding of the item, but a second approach could be better and more useful in another case. Intrinsically, it is required to improve profound information and knowledge of each of these approaches.

According to the mentioned issues and the outputs obtained from the recognition and review of the selected areas in the form of two historico-geographic and configuration (space syntax) approaches, this study derived that urban morphology with the combination of two approaches, as a complementary method will have the best knowledge of the city's form. These two approaches can be used to rank the studied areas and modify or develop the city in order to resolve the street network accessibility, and general attention to urban form and the interaction between the city's configuration and the hierarchy of streets. So we can see that the high-accessibility passages (Ismet Inönü Boulevard) have more suitable textures for more active functions and more important applications with a higher social group, while remote and far-off areas of the Polatpaşa Boulevard and Walled City with limited accessibility are mostly socially and economically lower.

Table 10: Model for analysing urban form by using historico-geographical and configurational approaches (By Author)



1. Ismet Inönü district ➤ High global integration- High intelligibility, Rank 1 (Socio-economic context) High accessibility- Medium local integration

2. Polatpaşa district ➤ High intelligibility- Medium global integration- Medium accessibility- Rank 3 (Socio-economic context)- Low local integration

3. Walled City district ➤ High local integration- Low intelligibility- Rank 2 (Socio-economic context) Low accessibility- Low global integration

Chapter 6

CONCLUSION

One of the key matters facing urban morphology nowadays is to coordinating and combining various approaches. There have been outstanding works to coordinate and combine the historico-geographical and configurational approaches to urban morphology. However, the interaction between these two approaches has yet to be comprehensively examined. Combining these two morphological approaches has the potential to shed new perceptions on the processes of urban form transformation. Nevertheless, establishing a connection between them has been difficult and time-consuming due to differences in theoretical propositions and disciplinary traditions. This thesis developed a methodological framework for combining the historico-geographical and configurational approaches, comparing them and proposing a coordinated combined methodology and eventually to achieve an enhanced comprehension of the development of the urban form, in particular, the street formation and transformation of Famagusta city.

Three districts of Famagusta City with different urban forms were studied, for example, the Walled City is a compact city, like the Renaissance port cities with fortifications. The organization of the built environment in the Walled City is formed along the main commercial streets connecting the Sea Gate and Land Gate which contains the grand public square, Namık Kemal Square, in front of Lala Mustafa Pasha Mosque (St. Nicholas Cathedral). In the Walled City, the commercial streets are lined

with shops, pubs, and cafés, many of them oriented to tourists. While the development of the city since 1947 has been extended as a linear form and has grown along the coastline. The fortifications physically segregated the Walled City from other parts of the city where there is development and activity. The analysis of the formation and development of the linear form of Famagusta has shown that its growth is generally related to physical barriers and factors such as the presence of the coastline, military lands, the restricted Varosha district, the location of the EMU University, and existence of several socio-economic centers. The compact historical center of the Walled City has been replaced by a new linear structure that is more in line with contemporary needs and socio-economic activities.

The findings show that the combination of these two approaches can offer a better understanding of the historical evolution of urban form for both urban districts with historical context and contemporary areas that are rapidly developing. In the other words, the combined/overlapping of the two methodologies delivers a broader understanding of how urban form is transformed throughout history and how socio-economic changes affected the urban form during these processes. The proposed framework shows that in general the explanatory nature of the historico-geographical approach and the prescriptive power of the configurational approach means that one can significantly extend the research scope and enrich the knowledge provided by the other. It can be argued that the coordinated combined approach paves a new path for addressing the recent challenges to urban morphology and synergizing the socio-economic activities/factors in the city. The historico-geographical approach can in particular remedy the lack of sensitivity towards historical urban processes in the configurational approach, while, in return, the configurational method can dispel the

lack of the role of space production rules in the evolution of the urban form in the historical approach. Accordingly, the historico-geographical approach shares with space syntax an emphasis on the town plan and morphological region, while the configurational approach is mostly concerned with streets, designating the movement generated by the layout configuration and space relationships. In addition, the historico-geographical recognizes the significance of plots and the block plans of buildings. This tradition aims to comprehend the structure of the urban form and the development processes, based on the morphological period of the urban landscape and the morphogenetic significance of the different elements of urban form. The morphological region dedicates the same rigor of examination to the tripartite division of urban form which are ground plan, building fabric, and land and building utilization. On the one hand, the street configuration, particularly the integration properties, is interrelated with the distribution of plan units; on the other hand, physical and place feature information relating to the historical expansion of the city can aid to clarify the changes in the configurational values of various plan units.

The spatial understanding of the plan units and the changes and continuities of morphological regions can be employed to consider the role that street configuration in the evolution of a city. Testing and using these methods could be an emphasis for the future of historico-geographical studies because of their potential to inform morphological region or plan unit recognition. Certainly, the historico-geographical approach can categorize a hierarchy of plan units that reflected the historical evolution of the urban area. Furthermore, in previous comparisons, these two methods seem to have different interpretations of time and somewhat different levels of scale. The proposed complementary method can produce an enhanced understanding of physical

and socio-economic development, and historical development of urban form upon the data from its history. Given the potential for collaboration between these two morphological research traditions, to produce a more robust framework for testing and applying, this complementary method could be a solid basis for future research and practice. By methodically comparing and examining urban form across various morphological periods and knowledge about the formation and transformation of street configuration can be applied to interpreting the interrelationship between morphological regions, configurational properties, and plan units. Furthermore, it can also offer a comprehending of how different plan units or morphological regions are spatially and socio-economically connected and consider how changes to one may have an impact on the other. Notwithstanding the understanding of the shared theoretical emphasis that the structure of the urban form incorporates and explains, its street networks as one of the built form elements and the socio-economic process is essential for both the identification of morphological regions and accessibility recognition.

This thesis mostly focused on how the historico-geographical and configurational approaches in combination can help to a better comprehending of the evolutional process of urban form, particularly commercial streets. The historico-geographical one emphasizes three elements of the urban landscape the formation, and transformation of urban form, the building fabric, and building utilization. From a configurational perspective, street network features can be used along with other form elements of urban forms to identify and define particular areas (e.g. morphological regions). This is based on the fact that the configurational approach incorporates the spatial distribution and correlation with movements on par with space syntax techniques such

as analysis of angular segments, axial integration, and consequently, the different land uses. There is potentially more insight that a coordinated combined approach can offer on the urban form. In this research, plots and building patterns provide a piece of information on the land utilization whether it is commercial, industrial, or residential throughout the transformation of urban form on one hand, and space syntax analysis provides a broad understanding of the spatial relation and integration during the urban transformation on the other. Angular segment examination produced a number of street segments maps, based on integration and choice, and connectivity, within each selected metric radius. Finally, it embodied the accessibility of the movement potential in the street system. This study, therefore, recommends that the configurational analysis complement historico-geographical analysis by promoting apprehension of the street networks based on the relationship with the evolutional process of the city. Functionally, the historico-geographical and configurational character of a city is determined by socio-economic factors.

By investigating and comparing urban form across different morphological periods, on the one hand, comprehension about the continuities and changes of street configuration can be applied to illustrating the historical development of a city and the interrelationship between urban form and socio-economic activity. In the historico-geographical approach, the urban form is seen as a hierarchy of the composition of morphological regions, defined by a distinct combination of streets, plots, and building blocks. Conversely, the configurational approach takes urban form as a hierarchical spatial structure in which streets are not considered as constituent areas but rather as a continuous network that organizes and links plots and buildings. This study recommends that the configurational analysis complement historico-geographical

analysis by promoting understanding of the street network in terms of its relationship with the evolutional process of the city.

In combination, the historico-geographical and configurational approaches ensure an enhanced analysis of the relationship between street plan, plot pattern, and land use, which enables to designate of the connection between streets networks and specific districts through the understanding of how streets of socio-economic activity are embedded within them. Based on this, it can be concluded that the relationship between urban form and socio-economic activities is both historical and configurational. In the presented case study, the high-accessibility of Ismet Inönü Street with more suitable texture for more active functions and more important applications with higher socio-economic activities stands out against the more remote areas of Polatpaşa Street and the Walled City with limited accessibility and less socio-economic activity.

The two approaches could be combined to rank the study areas and disentangle the relationship between the city's street network accessibility, its configuration, the hierarchy of streets, and town plan elements. The results obtained from this study suggest that the proposed method has the potential to provide a new perspective on the city's evolutionary trend. This complementary model can serve as a starting point for evaluating the extent to which configurational representations of contemporary built environments might equally help to illuminate historical patterns of urban transformation. It is hoped that this perspective can help as a starting point for developing a completer agenda for methodical examination of combining these two approaches in and beyond urban morphology.

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