ISTANBUL TECHNICAL UNIVERSITY ★ GRADUATE SCHOOL OF SCIENCE ENGINEERING AND TECHNOLOGY

DESIGN AND MODELLING OF URBAN DEVELOPMENT AREAS WITH REFERENCE TO HISTORICAL SETTLEMENTS: CASE OF KORÇA

Ph.D. THESIS

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<u>İSTANBUL TEKNİK ÜNİVERSİTESİ ★ FEN BİLİMLERİ ENSTİTÜSÜ</u>

TARİHİ YERLEŞME ÖGELERİ REFERANSLI ŞEHİR GELİŞME ALANLARIN TASARIMI VE MODELLENMESI: KORÇA ÖRNEĞİ

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To my family

FOREWORD

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February 2020 Egin ZEKA

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ABBREVIATIONS

ASIG **:** Autoriteti Shtetëror për Informacionin Gjeohapësinor (StateAuthority for Geospatial Information)

LAMP **:** Land Administration and Management Project

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DESIGN AND MODELLING OF URBAN DEVELOPMENT AREAS WITH REFERENCE TO HISTORICAL SETTLEMENTS: CASE OF KORCA

SUMMARY

The city is a very complex phenomena, comprised of dynamic and non-linear relationships among various components. History shows the development of different concepts of urbanism in various contexts. Some of them reach successful compositions while some others fail in terms of providing a proper interrelationship between different environments. This depends mostly on two different approaches in the process of developing cities. The first one is a bottom-up approach, which provides ground for many actors in the process of generating settlements. On the other side, there is the top-down approach, which imposes the willpower of designers, technocrats or governors. The first one is based on a complex adaptive and flexible system that gives importance to the process, while the other considers the design as an end product, based on master planning. Especially after the industrial revolution, many cities around the world developed in a top-down approach based on the modern planning principles, producing very standard, static and monotonous urban typologies, far away from rich, dynamic and complex traditional patterns. In this context, there is a broad literature and discourse that suggests that historic cities are more successful in many aspects and there are many lessons we can learn from these settlements.

The concept of this thesis is based on this approach, trying to identify the ways of learning from vernacular, self-organized settlements. It supports the idea that traditional cities are very successful on embracing a much more comprehensive and complex process, which includes many actors, is respectful to local values, and responds to the needs of the communities. This approach claims that vernacular urbanism was capable to establish a complex set of relationships, producing a coherent, good working system, and creating an ‘organized complexity’, a ‘spontaneous order’.

In this context, the main aim of this research is to emphasize the importance of bottom-up and inclusive approach in the process of building cities, by analyzing the complexity of non-planned settlements and extracting some features of their rich and dynamic patterns. Moreover, it tries to develop a method that proposes a guideline for interpreting these principles in the process of designing and building new settlements.

The thesis raises the following hypothesis:

Hypothesis 1: The spatial elements that determine the structure of historic settlements have a systematic relationship within themselves and among each-other.

Hypothesis 2: The features of spatial composition in traditional settlements can be measured and used as design parameters for possible future urban developments.

Hypothesis 3: Taking references from traditional settlements in the planning and design process of new urban areas is very significant to maintain (sustain) the urban memory of a place

The study area is located in the city of Korça and consists of an historic neighborhood near the central zone. The neighborhood is used as a unit for the above-mentioned analyses. This settlement started to develop and consolidate during the Ottoman period. It is built in a spontaneous process, as a product of many individual actions that form a complex and coherent whole. Nowadays, although gone through some transformations and adaptations, it maintains many features of the traditional urban fabric. The neighborhood is organized in an organic pattern of streets and plots. It consists mainly of low-rise courtyard houses, forming a compact urban texture. The morphological elements provide a dynamic pattern and a rich spatial experience with narrow curvilinear streets, fragmented by small plazas and surrounded by small compact housing units.

In order to elaborate further the hypotheses, the study uses a hybrid methodology which is implemented in the analyses of a historic neighborhood in the city of Korça, as the case study. This methodology includes three different types of analyses: pattern language analyses, fractal dimension analyses, and geometrical measurements of physical morphology in the study area. Firstly, the study uses some of the pattern language principles, developed by Christopher Alexander. These analyses are helpful to find out if study area possess 'the quality without a name', as defined by Alexander (1979). This quality is very fundamental to create a living, rich, dynamic, coherent, complex environment which responds to the user needs. The second analysis focuses on a procedure that implements the measurement of the fractal dimension of various morphological units in the study area. The fractal dimension concept is very useful to analyze the organic settlements and understand if there is an order and a coherence in their spatial organization. The final section of analysis deals with geometrical measurements in order to identify some physical features related with spatial organization in the neighborhood. These measurements are important not only to identify some spatial attributes of urban space but also, they are very useful to establish a set of rules that can be integrated in any possible future model for urban development.

The main results and outputs of this research can be summarized in the following statements:

- The historic neighborhood in the city of Korça is a typical example of a settlement generated through a long process of self-regulation.
- Like many other vernacular settlements, it possesses many qualities that create a sustainable, working and efficient environment.
- Through pattern analyses the study shows that the neighborhood has 'the quality without a name', as defined by Alexander, which establishes an urban habitat that is generative, living, dynamic, rich, beautiful, authentic, systematic and is close to human and nature.
- Fractal analyses in the settlement show clearly that there is a systematic relationship within and among different morphological units. Similar values of fractal dimension extracted from analyses are evidence of this systematic relationship and the strong coherence in the urban fabric.
- Some physical features of the spatial composition in the study area can be measured, although it has an organic pattern.
- These measurements cane be used as parameters in the design process of new urban zones.
- These parameters can act just as a helping tool in the complex and long process of designing and building new settlements which should include many other

actors such as: planners, architects, designers, engineers, other professionals, stakeholders, community etc.

- These parameters can be integrated in a computed model that can produce many alternatives with high complexity and systematic relationship among different parameters.
- The study proposes a guideline (framework) by explaining the steps that can be followed for building a possible computational model.
- The results of analyses and the parameters used in the guideline are contextual to the city of Korça, but the same methodology can be implemented also in other contexts that can produce different results.
- This research tries to identify firstly the way of understanding the features of vernacular settlements and then using these parameters as reference for generating new settlements. This is an important issue for being contextual and sustaining the urban memory in a city.

TARİHİ YERLEŞME ÖGELERİ REFERANSLI ŞEHİR GELİŞME ALANLARIN TASARIMI VE MODELLENMESI: KORÇA ÖRNEĞİ

ÖZET

Şehir, çeşitli bileşenler arasındaki dinamik ve doğrusal olmayan ilişkilerden oluşan çok karmaşık bir fenomendir. Tarih, farklı bağlamlarda şehircilik kavramlarının gelişimini gösterir. Bazıları başarılı kompozisyonlara ulaşırken, bazıları farklı çevreler arasında uygun bir ilişki sağlama konusunda başarısız olmuştur. Bu, çoğunlukla şehirlerin gelişmesi sürecinde iki farklı yaklaşıma bağlıdır. Birincisi, yerleşmenin gelişme sürecinde birçok aktöre zemin sağlayan, aşağıdan yukarıya giden bir yaklaşımdır. Öte yandan, tasarımcıların, teknokratların veya yöneticilerin iradesini dayatan, yukarıdan aşağıya giden bir yaklaşım var. Birincisi, sürece önem veren karmaşık, uyarlanabilir ve esnek bir sisteme dayanırken, diğeri tasarımı, master plan konseptine dayanan bir nihai ürün olarak görüyor. Özellikle sanayi devriminden sonra, dünyadaki birçok şehir, zengin, dinamik ve karmaşık geleneksel kentsel dokudan uzak, çok standart, statik ve monoton tipolojiler üreten, modern planlama ilkelerine dayanan, yukarıdan aşağıya bir yaklaşımla gelişti. Bu bağlamda, tarihi kentlerin birçok açıdan daha başarılı bulan ve bu yerleşimlerden öğrenebileceğimiz birçok şeyin olduğunu savunan geniş bir literatür ve söylem vardır.

Bu tezin ana kavramı, yerel, kendiliğinden organize olan tarihi yerleşimlerden neler öğrenebiliriz sorusunu ve yöntemlerini belirlemeye çalışan bir yaklaşıma dayanmaktadır. Geleneksel şehirlerin, birçok aktörü içeren, geniş katılımı sağlayan, yerel değerlere saygılı ve toplumun ihtiyaçlarına cevap veren, kapsamlı ve karmaşık bir süreci benimsemede çok daha başarılı olduğu fikrini desteklemektedir. Bu yaklaşım, yerel şehirciliğin, tutarlı, iyi bir çalışma sistemi üreten ve 'organize bir karmaşıklık', 'kendiliğinden bir düzen' yaratan sistematik bir ilişkler düzeni kurabildiğini iddia ediyor.

Bu bağlamda, bu araştırmanın temel amacı, tarihi yerleşimlerin karmaşıklığını analiz ederek, zengin ve dinamik modellerinin bazı özelliklerini tespit ederek, şehirlerin inşa edilme sürecinde aşağıdan yukarıya ve kapsayıcı yaklaşımın önemini vurgulamaktır. Dahası, yeni yerleşimlerin tasarlanma ve inşa edilme sürecinde bu özellikleri referans alan ve yorumlayan bir kılavuz ve yöntem geliştirmeye çalışmaktadır.

Tez, aşağıdaki hipotezleri ortaya koymaktadır:

Hipotez 1: Tarihi yerleşimlerin gelişimine yön veren mekansal ögeler hem kendi içinde ve hem de birbirleri arasında sistematik bir ilişki içindedir.
Hipotez 2: Tarihi yerleşimlerde mekansal kurgu bileşenleri ölçülebilir ve gelecekteki olası gelişmeler için tasarım kriterleri olarak değerlendirilebilir.
Hipotez 3: Gelişme alanların planlama ve tasarımında tarihi yerleşmelerden referans alınması kent belleğin sürdürülebilirliğinin sağlanması için önemli bir araçtır.

Tez, bu üç hipotezi daha da geliştirmek için, çalışma alanı olarak, Korça şehrindeki tarihi bir mahallenin analizlerinde uygulanan hibrit bir metodoloji kullanmaktadır. Bu metodoloji üç farklı analiz türü içerir: doku analizleri, fraktal boyut analizleri ve fiziksel morfolojinin geometrik ölçümleri. İlk olarak, çalışma Christopher Alexander tarafından geliştirilen doku analizleri ("pattern language") ilkelerini kullanıyor. Bu analizler, Alexander (1979) tarafından 'isimsiz nitelik' olarak tanımlanan olguya sahip olup olmadığını bulmak için yararlıdır. Bu nitelik, kullanıcı ihtiyaçlarına cevap veren, canlı, zengin, dinamik, tutarlı, çok-çeşitli bir kentsel çevre oluşturmak için çok önemlidir. İkinci analiz, çalışma alanındaki farklı morfolojik ögelerin fraktal boyutunun ölçümünü yapan bir prosedür içermektedir. Fraktal boyut kavramı, organik yerleşimleri analiz etmek ve mekansal organizasyonlarında bir düzen ve tutarlılık olup olmadığını anlamak için çok yararlıdır. Analizin son bölümü ise, çalışma alanındaki mekansal organizasyonun bazı fiziksel özelliklerini tanımlayan bir dizi geometrik ölçümle ilgilidir. Bu ölçümler sadece kentsel alanın mekansal özelliklerini tanımlamak için değil, aynı zamanda olası bir kentsel gelişime modeline entegre edilebilecek bir dizi kural oluşturmak için çok faydalıdır.

Çalışma alanı, Arnavutluk`un Korça şehrinde, merkezi bölgeye yakın tarihi bir mahallede yer almaktadır. Bu mahalle, yukarıda bahsedilen analizler için bir birim olarak kullanılmaktadır. Çalışma alanı, Osmanlı döneminde gelişmeye ve oluşmaya başlayan bir yerleşmedir. Bu yerleşme, birçok bireysel eylemin sonucunda, kendiliğinden oluşan ve tutarlı bir bütün ve çeşitlilik barındıran uzun bir süreçte inşa edilmiştir. Günümüzde, bazı dönüşümlerden geçmesine rağmen, geleneksel kentsel dokunun birçok özelliğini sürdürmektedir. Semt, organik sokakların ve yapı adaların etrafında gelişir. Kompakt bir kentsel doku oluşturan, az katlı, avlulu evlerden oluşur. Küçük meydancıklarala bağlanan ve kompakt konut birimleriyle çevirilen organik sokak dokusu, dinamik ve zengin bir mekansal deneyime olanak verir.

Bu tez dört ana bölümden oluşmaktadır. İlk bölümde araştırmanın kapsamı, amaçları ve ana hipotezleri ayrıntılı olarak irdelenmiştir. Ayrıca, bu çalışmada kullanılan yöntem ve araçlar açıklanmış ve çalışma alanının seçme kriterleri belirlenerek, araştırmanın bağlamı hakkında bilgi verilmiştir.
İkinci bölümde, bu araştırmayla ilgili konuların kuramsal arka planı irdelenmiştir. Öncelikle, ontoloji ve epistemoloji alanlarında sistem düşüncesi ve karmaşıklık kavramı incelenmiş ve bunların şehir kavramı ile olan bağlantısı anlatılmıştır. Daha sonra, literatür taraması, daha çok şehir kuramına odaklanmakta ve kentsel karmaşıklık ve ortaya çıkan şehircilik kavramlarını geliştirmektedir. Burada, kenti karmaşık bir sistem olarak gören, çok katmanlı bir ilişki sistematiği içeren ve birçok boyutu da barındıran bazı tanımlar araştırılmıştır. Takip eden bölümde, kentsel gelişim sürecinde kullanılan 'yukarıdan aşağıya' ve 'aşağıdan yukarıya' yaklaşımların farklılıkları ve üretikleri değişik kentsel tipolojiler konusu ortaya konulmuştur. Burada ele alınan teori, yerel yerleşimlerin, planlanan şehirlerin geometrik düzenlerine göre çok daha karmaşık, sürdürülebilir ve daha iyi çalıştığını göstermektedir. 'Organize olmuş karmaşıklık', 'kendiliğinden düzen', eklemlenen süreç, dinamizm ve uyumluluk gibi kavramlar, kendiliğinden oluşan şehirlerin ilkelerini ve niteliklerini açıklar. Literatürde tartışılan bir diğer konu, Christopher Alexander'ın geliştirdiği kuramdır. Özellikle, 'doku dili' olarak isimlendirilen kavram üzerinde odaklanmıştır. Bu bağlamda tez, detaylı bir şekilde, bu kavramın felsefesini, teorik arka planını, metodolojisini ve uygulamasını irdelemiştir. Literatür derlemesinin son kısmı ise fraktal geometri teorisi ve uygulaması ile ilgilidir. Fraktal geometrinin temel

kavramlarını açıkladıktan sonra, araştırma daha çok, kutu sayma yöntemine ve önceki çeşitli benzer çalışmalara odaklanmaktadır. Tüm bu teorik kavramlar bu tezin konusuyla güçlü bir şekilde bağlantı kurarak, belirlenen metodolojide yaralı olmuştur.

Tezin üçüncü bölümünde, seçilen çalışma alanında yapılan analizler ve sonuçlar yer almaktadır. İlk olarak, çalışma alanının bulunduğu yer olan Korça şehrinin coğrafi ve tarihi bağlamı hakkında bazı genel bilgiler verilmiş ve seçilen çalışma alanın özellikleri anlatılmıştır. Ardından, çalışma, seçilen mahallede üç ana analiz yapmaktadır. İlk olarak, Alexander'in 'doku dili' kavramında belirlediği ilkeler çalışma alanında analiz edilmiştir. Analizlerde, yirmi bir kriter irdelenmiştir ve çıkan sonuçlara göre, bu tarihi mahallede, farklı düzeylerde olsa da, bu ilkeler önemli bir oranda mevcuttur.
İkinci analiz, farklı ölçeklerde çeşitli morfolojik bileşenlerin fraktal boyutunu hesaplamak için kutu sayma yönteminin uygulanmasını içerir. Fraktal boyut, sokak, bina ve meydan dokusu için hesaplanmıştır. Son analiz ise, bu tarihi yerleşmenin mekansal kurgusunun özelliklerini tespit etmek için bir dizi ölçüm içerir. Bu analizin temel amacı, çalışma alanındaki kentsel dokunun fiziksel özelliklerini anlamaya çalışmaktır. Birçok ölçüm, sokakların, yapı adaların, parsellerin ve binaların mekansal kurgusunun prensiplerini belirlemeye amaçlamıştır. Bu analizlerle sağlanan birçok veri, ileride olası bir kentsel tasarım modeline entegre edilebilecek şekilde bir kılavuz oluşturmak üzere kullanılmıştır.
Tezin son bölümünde, araştırmanın başında tanımlanan hipotezlerin geniş bir analizi ve değerlendirmesi ele alınmaktadır. Bu bölümün önemli bir kısmı, organik kentsel morfolojinin ölçülmesi ve ilkelerinin olası herhangi bir kentsel tasarım modeli için bir kılavuz oluşturmak için kullanılması konusu irdelenmiştir. Bu bağlamda, çalışma tarihi mahallenin özelliklerinden referans alan bir dizi adım ve ilkeyi içeren bir kılavuz geliştirmektedir. Bu kılavuz, yeni kentsel gelişmelerde tasarım sürecinde kullanılabilecek olası bir sayısal model için adımları tanımlamayı amaçlamaktadır.

Bu araştırmanın ana sonuçları bu şekilde özetlenebilir:

- Korça kentindeki tarihi mahalle, uzun bir öz-denetim süreci sonucunda ortaya çıkan çözümün tipik bir örneğidir.
- Diğer pek çok yerel yerleşim gibi, sürdürülebilir, çalışan ve verimli bir çevre yaratan birçok niteliğe sahiptir.
- Doku analizleri, Alexander'ın tanımladığı gibi, çalışma alanı, yaşayan, dinamik, zengin, güzel, otantik, sistematik ve insana ve doğaya yakın bir kentsel yaşam alanı oluşturan 'isimsiz kaliteye' sahip olduğunu göstermektedir.
- Yerleşmedeki fraktal analizler, farklı morfolojik birimlerin kendi içinde ve birbiri arasında sistematik bir ilişki içinde olduğunu açıkça göstermektedir. Analizlerden çıkarılan fraktal boyutun benzer değerleri, bu sistematik ilişkinin ve kentsel dokudaki güçlü tutarlılığın kanıtıdır.
- Çalışma alanı, organik bir dokuya sahip olmsına rağmen, mekansal kurgusunun bazı fiziksel özellikleri ölçülebilir.
- Bu ölçümler yeni kentsel alanların tasarım sürecinde parametre olarak kullanılabilir.
- Bu parametreleri kullanarak, arasında yüksek karmaşıklığa ve sistematik ilişkiye sahip, birçok alternatif üretebilen, bilgisayar bazlı bir modele entegre edilebilir. Çalışma, olası bir bilgasayar modeli oluşturmak için izlenebilecek adımları belirleyerek bir kılavuz (çerçeve) önermektedir.

- Ancak, bu model sadece bir yardımcı araç olarak ele alınması gerekir. Çok karmaşık olan tasarım ve inşa sürecinde tek başına bu modelin kullanılması anlamlı değildir. Çok kapsamlı ve geniş katılmlı bir tasarım sürecinde entegre edilmesi durumunda katkı sağlayabilir.
- Yapılan annalizlerin sonuçları ve kılavuzda kullanılan parametreler Korça şehrine bağlamsaldır, ancak aynı metodoloji farklı bağlamlarda da uygulanabilir.
- Bu araştırma, tarihi yerleşimlerin özelliklerini tespit etme ve yeni gelişme alanları oluşturken onlardan referans alma yöntemlerini belirlemeye çalışmaktadır. Bu konu, bir şehirdeki kentsel belleğin sürdürülmesi için çok önemlidir.

1. INTRODUCTION

The city is a very complex phenomena, comprised of dynamic and non-linear relationships among various components. History shows the development of different concepts of urbanism in various contexts. Some of them reach successful compositions while some others fail in terms of providing a proper interrelationship between different environments (natural, socio-economic and manmade environment). This depends mostly on two different approaches in the process of developing cities. The first is the bottom-up approach, which provides ground for many actors in the process of generating settlements. On the other side, there is the top-down approach, which imposes the willpower of designers, technocrats or governors. While the first approach highlights a complex adaptive and flexible system that gives importance to the process, the other approach considers the design as an end product, based on master planning. Especially after the industrial revolution, many cities around the word developed according to the top-down approach of the modern planning principles, producing very standard, static and monotonous urban typologies, far away from rich, dynamic and complex traditional patterns.

In recent years, scholars have focused on finding new ways of dealing with cities by learning from the complex systems in nature and vernacular settlements. Researches in complex sciences and developments in quantitative and computational disciplines have provided many opportunities in analyzing and evaluating the complexity of relationships in different systems. The design disciplines of architecture and urbanism have taken advantages of these developments in terms of searching for new approaches in design processes. Terms like emergent urbanism, generative design, complex adaptive or self-regulating systems are getting an increasing interest in academic discourse, searching for a non-conventional approach in theory of urbanism. These new approaches take a critical position against the rigid top-down modernism planning philosophy and suggest a generative, bottom-up decision-making processes that can create a better working system in the urban environment.

In this context, the main aim of this research is to emphasize the importance of bottom-up and inclusive approach in the process of building cities, by analyzing the complexity of non-planned settlements and extracting some features of their rich and dynamic patterns. Moreover, it tries to develop a method that proposes a guideline for interpreting these features in the process of designing and building new settlements.

1.1 The Aim of the Research

This research tries to identify the development processes and the spatial qualities of self-generated settlements by focusing on the case of a historic neighborhood in the city of Korça, Albania. The main purpose is to understand and clarify the complex system of this settlement by analyzing the generative processes that shape this complexity. Another fundamental aim is to develop a guideline for a possible model that take references from the traditional city and integrates them in the complex process of designing and building new urban zones. The case of Korça is appropriate for this research because this settlement has been developed in a long generative process that takes in consideration many factors (natural and socio-economic). This settlement, developed in a bottom-up approach, is a product of a long process of individual acts and adaptations based on user needs, creating a ‘spontaneous order’ and an ‘organized complexity’

In this context, the thesis addresses some important hypotheses such as:

1. The spatial components that determine the structure of historic settlements have a systematic relationship within themselves and among each-other.
2. The features of spatial composition in traditional historic settlements can be measured and used as design parameters for possible future urban developments.
3. Taking references from traditional settlements in the planning and design process of new urban areas is very significant to maintain (sustain) the urban memory of a place.

1.2 Methodology

This thesis uses a hybrid methodology combining both qualitative and quantitative approaches (Table 1.) to reach three main objectives of the research. The first step consists of a combined methodology in order to analyze the complexity and the generative character of the study area. This procedure comprises two different methods, the pattern language analyses and fractal dimension measurement. The second step deals with measuring the attributes of morphological components by using some mathematical tools. The final step focuses on developing a guideline that uses some of the measured parameters in the previous stage and defines the steps for a framework of a possible computational model. The unit of analyses is the historic neighborhood in the city of Korça which has a distinctive organic urban fabric.

Table 1.1 : The main steps of the research methodology.

Steps	Methodology	Qualitative	Quantitative
Step 1	Pattern analysis	+	
	Fractal analyses		+
Step 2	Mathematical measurements		+
Step 3	Guideline	+	+

Firstly, to analyze the complexity of the settlement in the study area two different procedures are applied: pattern language analyses, developed by Christopher Alexander, and fractal dimension analyses. The first one has a qualitative character based on subjective analyses to a particular urban fabric, and the second one is a quantitative approach that identifies some attributes of the analyzed unit. Alexander`s pattern language is a large set of principles focusing on the socio-spatial environment and its generative and complex features from the regional scale to construction details (Alexander, Ishikawa, & Silverstein, 1977). This study focuses to around fifty of these principles that are the ones related mostly with the neighborhood and building scale (Table 1.2). Among them, twenty-one principles are explained in detail with text and diagrams in the thesis. The data for this type of analysis consist of existing maps and photos taken during site observations. This data is processed to produce diagrams that represent each particular pattern in the study area.

Table 1.2 : Pattern language principles analyzed in the study area (Alexander, Ishikawa, & Silverstein, 1977).

no	Principles	no	Principles
1	Identifiable neighborhood	27	Family of entrances
2	4 story limit	28	South facing outdoor
3	Sacred sites	29	Main entrance
4	Access to water	30	Half-hidden garden
5	Life cycle	31	Entrance transition
6	Activity nodes	32	Hierarchy of open space
7	Promenade	33	Courtyards which live
8	Shopping street	34	Roof garden
9	Household mix	35	Private terrace on the street
10	Degrees of publicness	36	Outdoor room
11	House cluster	37	Street windows
12	Row houses	38	Opening to the street
13	Looped local roads	39	Balcony
14	T-junctions	40	Connection to the earth
15	Green Street	41	Fruit trees
16	Network of Paths and cars	42	Tree places
17	Children in the street	43	Garden growing wild
18	Quiet back	44	Garden seat
19	Small public squares	45	Vegetable garden
20	Public outdoor room	46	Good materials
21	Individually owned shops	47	Gradual stiffening
22	Street café	48	Front door bench
23	Corner grocery	49	Raised flowers
24	Travellers` inn	50	Climbing plants
25	Building complex	51	Paving with crack between stones
26	Pedestrian street	52	Ornament

Another method that analyzes the order and coherence of the urban morphology, applied in this research, is the fractal dimension analysis. This methodology, developed by Mandelbrot and used later by many researchers in different disciplines, analyzes the relationships and similarities of a morphology in different scales (Mandelbrot, 1983). This study uses the box counting method to calculate the fractal dimension of various morphological units in the study area. The morphological units such as: the streets, the open spaces and buildings are analyzed in neighborhood scale, district scale and block scale (Figure 1.1). A grid of four different box dimensions, particularly 20x20m, 10x10m, and 5x5m and in some smaller scales 2.5m x 2.5m, is implemented in each scale to calculate and compare the fractal dimension for each of them. The fractal dimension is calculated by using the following formula:

$$Db = \frac{[\log(N(SII)) - \log(N(SI))]}{[\log(1/SII) - \log(1/SI)]} \tag{1.1}$$

Db: Shows the fractal dimension's value.

N (SI): The number of boxes where the shape is located in the first step (I).
N (SII): The number of boxes where the shape is located in second step (II).
N (SIII): The number of boxes where the shape is located in third step (III).
1/SI: The number of boxes in x axis in the first step.
1/SII: The number of boxes in x axis in the second step.
1/SIII: The number of boxes in x axis in the third step.

The box counting procedure is made by using AutoCAD and ArcGIS software. Firstly, the morphological units are divided in layers and converted into polyline and polygon shapes in AutoCAD and later are imported in ArcGIS to make the box counting procedure. After that, the extracted values are calculated with the formula to obtain the fractal dimension for each scale.

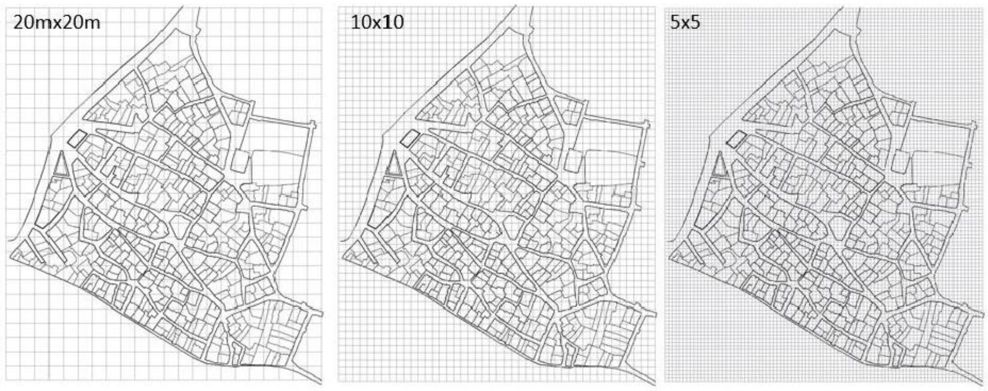

Figure 1.1 : The box counting method.

The second part of analysis in this thesis deals with measuring the spatial features of the urban morphology in the study area. This procedure includes many geometrical calculations related with attributes that show distances, proportions, dimensions, angles, sizes and other properties of different morphological units in the studied neighborhood. In order to identify which components to measure, the study uses the morphological units defined by Conzen (as mentioned in Moudon, 1997) as basic elements of urban form; the street, the parcels and the buildings. It adds also another morphological unit which is a derivate of above-mentioned components formed by a cluster of parcels surrounded by streets, the block (Figure 1.2). The measurements consist of identifying physical attributes of each morphological unit and are used to understand different spatial relationships among various components (Zeka & Yüzer, 2019). As shown in the Table 1.3, there are around 25 measurements criteria grouped in five main categories, starting from the larger neighborhood and going until building scale. Each measurement defines at least one of the following attributes: the quantity, the area, the distance, the proportions, the dimensions, the orientation and the angle. This mechanical procedure that gathers an important amount of data does not have just a descriptive character but also is fundamental to understand the common patterns of spatial composition. This is done through data analyses that extracts the most and less common frequencies of a particular pattern. The extracted percentages and frequencies for each calculation provide a good synthesis of information regarding physical form of the settlement.

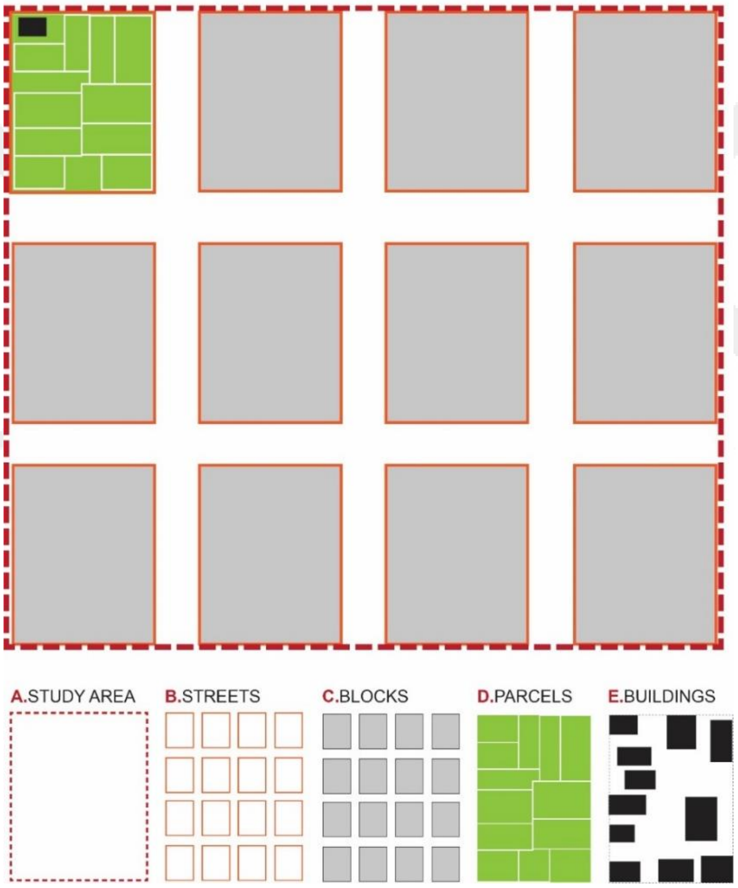

Figure 1.2 : Diagram showing the morphological units (Zeka & Yüzer, 2019).

The procedure of measurements is conducted through several steps. Firstly, the vectoral maps are processed using AutoCAD and ArcGIS for data categorization and analyses. Later the measurements and their results are processed in Excel to structure the information and understand the frequencies for different values (Zeka & Yüzer, 2019).

Table 1.3 : The detailed structure of main morphological units, criteria and measurement parameters used in this methodology (Zeka & Yüzer, 2019).

		Number value	**Area**	**Distances**	**Proportions**	**Dimensions**	**Orientation**	**Angle**
	Criteria							
A	**Study area/District**							
1	Total area		x					
2	Total Number of Streets	x						
3	Total Area of Streets		x					
4	Total Length of Streets			x				
5	Total Number of Blocks	x						
6	Total Number of Parcels	x						
7	Total Number of buildings	x						
8	Plot Coverage Ratio (PCR)[1]	x			x			
B	**Streets**							
1	Orientation of streets						x	x
2	Angular position							
3	Length between intersections			x				
4	Street width			x				
5	Proportions: street width/building height				x			
6	Directional changes angle							x
C	**Blocks**							
1	Area of blocks		x					
2	No. of parcels/Block	x						
3	No. of buildings/Block	x						
4	Plot coverage area /Block	x			x			
D	**Parcels/plots**							
1	Area		x					
2	Dimensions					x		
3	Street orientation						x	
4	Proportions				x			
E	**Buildings**							
1	Location on parcel						x	
2	Orientation						x	
3	Setbacks			x				

The final objective of the research is to develop a guideline which defines the parameters and the steps that can be followed to prepare a possible computational model for the designing of new settlements. These parameters are extracted from analyses in the study area. The frame is focused on parameters such as: block area, number of parcels, dimension of parcels, plot coverage ratio, location of building in the parcel and their orientation. It aims to develop a conceptual scenario as a guide for

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[1] Plot Coverage Ratio (PCR)= Area of building footprints/total area of the study zone

the steps for a possible computed model that can be developed in the future. The scenario is built in two different approaches by using the same parameters. The first alternative is developed through an inductive process, starting from smaller units and going into larger urban fabric. The second one is based in a deductive process, defining firstly the parameters of spatial composition in larger scale and later, step-by-step detailing the structure for smaller units. Both approaches can be useful to any process of building a model.

2. CITY AS A COMPLEX PHENOMENA

2.1 The Ontological Approach

The philosophical studies of ontology and epistemology can be very useful to have a better understanding of the complexity of the city. Ontology is defined as a philosophical branch that study the nature of existence or being (Encyclopedia Britannica Online, nd). Epistemology is explained as the discipline that investigates the origin, nature, methods, and limit of human knowledge. In this line, since the city is an artifact and a product of human knowledge, it is important to elaborate its relationship with these concepts (Figure 2.1).

Figure 2.1 : Relationship of the city with ontology and epistemology.

The work of Nicolai Hartmann (1954) who tries to establish the concept of new ontology is very helpful to clarify and understand the basis of the problem. Hartmann (1954) identifies four main levels of existence: organic, inorganic, psychic, and spiritual. The world or the cosmos works within a system that consist of different elements of these levels that are interrelated with each other. These categories and their inter-categorical relationships work according to four main laws: validity; hierarchical order; dependence; and coherence. According to Hartmann (1954), human being possesses all the four levels of existence. Another fundamental aspect that should be taken into consideration is the system of values. System of values consist of principles or essences of an ideal being (Hartmann, 1954). Hartmann (1954) makes a long list of values by categorizing them in two main groups: aesthetic; and ethical values and pointing out the fundamental moral values. The modernism fails to give a suitable response to the challenges of existence and values. The narrowness view toward system of values and specifically, the indifference to moral and aesthetic values deplete the life of man and restrict his right to have a fully human life (Hartmann, 1954). On the other hand, a sustainable world is the one that produces architecture or a city that establishes a proper inter-relationship between the above-mentioned aspects (levels of existence, laws and system of values). Within this eco-system, knowledge takes the role to understand these entities and establish a proper relationship. The argument here is that, emergent urbanism or generative design - due to its inclusive character - is an appropriate model of developing settlements, since it is based on a wide knowledge and process. On the opposite, the top-down planning is based on the knowledge and intuition of a specific group (governors, experts etc.)

2.2 Urban Complexity and Emergent Urbanism

The city is a very complex phenomenon developed in a multidimensional system of relationships. Natural and physical features are very important factors in urbanization process, but human activity remains the main force shaping the character of the city. Social and economic structure; culture and traditions; political systems; and technological developments comprise the main human activities that form the city. The configuration of the urban space is a product of changes and interrelationships of the above-mentioned human activities. The formation of a good city is strongly bounded to the balance in the interrelationship among different actors. Distortion of such relationships leads to many problems in cities.

The cities are systems that develop in non-linear mode that are open and influenced by the actions of many other open systems (Portugali, 2000). The complex behavior of humans is of course a crucial factor in this issue. It is not possible to analyze, understand, and predict the human behavior in similar ways as we do for the physical environment (Wilson, 2000). The complex nature of human behavior directly influences the process of city generation process and all these flexible systems have a close and continuous interaction in different levels among each other (Beirao, 2012).

Cities develop in an organic way as a result of many different actions and decisions, and within this complicated process the attempt to plan and organize the city seems to have small impact on their configuration (Batty, 2005). In complex non-linear systems like cities, prediction is a notion almost impossible to be achieved, due to other dynamics that are part of the system, but which cannot be designed or predicted (Portugali, 2000). The complex behaviors during the development process of cities, makes it difficult to envision the result. It appears that the output can be different from the planned or predicted one (Beirao, 2012).

2.3 Top-Down Versus Bottom-Up Processes

Although, it is clear that the complexity of the city does not allow a total control of its development process, a top-down approach that claims to predict and plan the city with all its components and impose a particular detailed layout, has been developed in the past, and is still dominant in the majority of contexts. This top- down concept of city building is commonly related with modernist planning philosophy or authoritarian regimes in the past. On the other hand, the critics to this concept suggest a bottom-up approach or combination of both that provides ground for a more flexible and complex process and emphasizes the importance of participation of many actors in city building process (Figure 2.2).

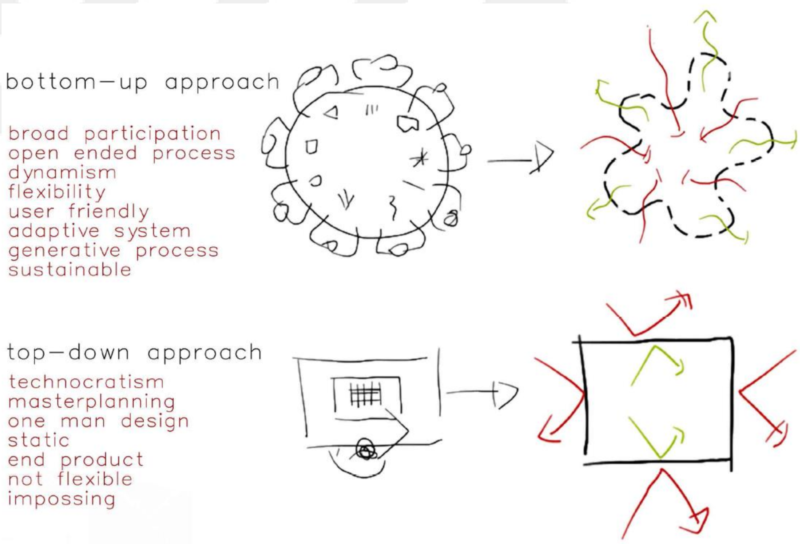


Figure 2.2 : Bottom-up vs top-down approach.

An overview of city history confirms the implementation of both concepts at different levels in different contexts. The more centralized and totalitarian systems have produced more geometric and schematic layouts that consider the city as a static product. On the other hand, cities developed in more flexible and open systems have managed to bring a varied and complex urban space that reflects the dynamism of life. This aspect of bottom up processes is one of the main issues in the contemporary urban planning discourse. The main critique is built against the philosophy of modern planning because it considers the city as a mechanical product. Le Corbusier (1927) would call the city a “a machine for living”. Unfortunately, this way of thinking has produced a lot of problems in cities, especially during the 20th century. Nowadays, there is an increasing discussion on the new approaches of urbanism. Batty (2005) explains that the concept that considers the city a physical system has been changed to a new approach that focuses more on a biological and organic system which evolves from the bottom up.

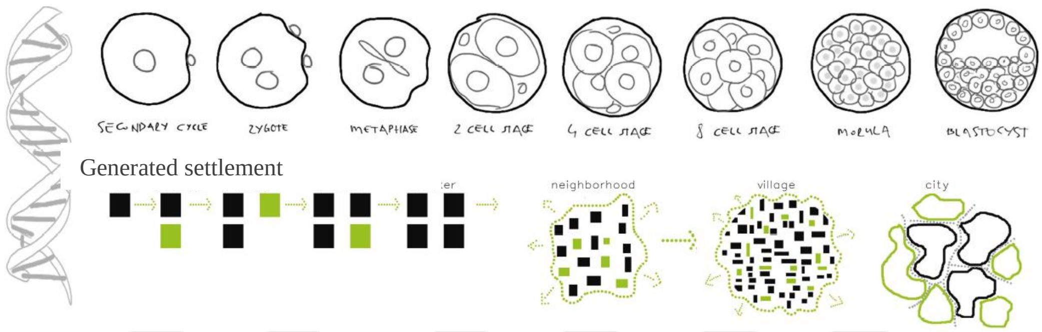


Figure 2.3 : DNA (left), embryo cell development (above) and a self-organized settlement schema.

There are many scholars that identify the problems of conventional planning philosophy and call for new approaches regarding the city functioning. For instance, Ascher (2001) proposes new generative processes in urban planning that are totally different from the static urban configurations developed in the modern master planning concept (as mentioned in Beirao, 2012). It is evident that the classical concept of ‘fixed layout’ and formal top-down approach is not able to deal with the changing dynamics and needs of urban systems (Beirao, 2012).

Different researchers highlight the need of new ways for developing more flexible, adaptable, incremental and participatory processes that are able to build a sustainable urban environment (Ascher, 2001; Correa, 2000; Friedman, 1997). Correa (2000) gives examples of cities in developing countries where dynamism, flexibility and step-by-step principles are crucial forces of city development operation. The issue of integration of top-down and bottom up process is discussed by Friedman (1997) who suggests that planning should deal just with a general vision and frame in the large-scale strategies while at lower scales of urban space it should provide ground for flexible solutions. Contemporary urbanism has to consider concerns about ability to change and reflect, open to interpretation of aesthetic issues, stimulate participation, and focus more on tools that alternate solutions rather than giving formal layouts (Ascher, 2001).

However, despite an increasing awareness on the deficiency of conventional planning concepts, it continues to be the dominant methodology used in planning processes. In many situations, the formal and static layout that consider the city as an ‘isolated’ entity rather than a complex, integrated system, is still in action (Portugali, 2009). The actual methods are still not able to provide flexible alternatives but are under the strong influence of the top- down principles, based on parameters of functionalism, intuition, and artistic formalism (Beirao, 2012).

2.4 Generative Process and Emergent Urbanism

The theories and methods that try to develop new approaches of urbanism which emphasize the complex nature of the city use many different terms to explain their concepts. Among the most used ones, which this research also uses, are the terms ‘generative design’ and ‘emergent urbanism’. The phenomena related to emergent urbanism has the capacity to produce successful models to achieve ‘quality’ in the organization of urban space (Kauffman, 1995; Holland, 1998; Mitleton-Kelly, 2003; Hensel, 2004).

The theory of emergent urbanism or generative urban design is focused on understanding the complexity of urban configuration. It proposes a new approach which gives priority to a step by step and an inclusive (user participation) urban development process. Generative urban design concept is connected strongly with the theory of complexity and has strong relations with the sciences of biology, mathematics and physics (Alexander, 2002a, 2002b; Salingaros, 2006c). This theory takes a critical position to the imposing and static approaches of modern urban planning (Alexander, 2002b, 2005). One of the main features of generative developed structures is that they are flexible, adaptive to the current conditions, and are developed in an incremental process (Alexander 2002b). According to Alexander (2005), the 20th century- except of few rare examples - lacks the dimension of generative design developments.

Mainly, the scholars find the traditional settlements and vernacular architecture successful in terms of producing generative processes (Alexander, 2005; Habraken & Teicher, 2000; Hakim, 2003, 2007a, 2007b, 2008, 2010). These kinds of structures are also considered coherent with sustainable design principles. As Du Plessis (2000) points out, sustainability means; temporality, participation, intuition and repetitive processes and systems. In this line, Turner (as mentioned in Harris, 2003) explains that the best solutions for houses are structures that are flexible to new changes depending on user needs. In this context, he looks to them as continuing processes and not as end products (Harris, 2003). Moreover, as mentioned by Bhatt (2010) and Kohn (2002) two important scholars such as Rapoport (1969, 1982) and Rudofsky (1964) discussed that the ‘intuitive and unconscious process’ played an important role in the quality of traditional settlements.

Many studies can be related to emergent urbanism or generative development processes. It can be said that generative urban design theory has its roots in complex sciences which deal with non-linear, unpredictable, and flexible systems. It is difficult to define a distinct time for the beginning of this theory. However, the research in this sphere can be classified in three main domains that are related to each other: urbanism and architecture; computational sciences and the school of economics and sociology leaded by Hayek (Helie, 2009). “By conceptualizing the city and urbanism as a system that generates morphology, instead of pure morphology, a systems analysis approach is applied that demystifies modernism, the organic traditional city, and the sustainable future city” (Helie, 2009, p. 75) .The main question here is: how can human artifact behave in similar way to the natural processes? In this context, Hayek`s theory of spontaneous order brings some clarifications. According to him, spontaneous order is developed with multiple variables or units that act individually in an adaptive way to their environment to form a complex and continuous pattern (Hayek, 1973). The configuration is a process of this individual units that works spontaneously to form an order (Hayek, 1973).

One of the pioneers reacting to the quality of the city formed on reductive and pragmatic planning principles, is Camillo Sitte. In the ends of 19th century, Sitte (1965) talks about sterility of technical planning which lack the richness and quality of space in old organic medieval cities. According to him, planning should frame some general principles but developments in small scale should be left to individual initiatives (Sitte, 1965). This idea was supported by Kevin Lynch (1981) who argues that it would be foolish to set performance standards. However, there are some general criteria to be followed. A good settlement is also an open one, accessible, decentralized, diverse, adaptable and tolerant to experiment (Lynch, 1981).

Actually, the attempts to legitimize spontaneous order and complexity in urbanism can be seen also in the work of Jane Jacobs. In her book ‘Death and Life of Great American

Cities' she explains that urban planning is an engagement of complexity that should deal with multiple variables (Jacobs, 1961). Jacobs express very explicitly her revolt to modern urban planning products and suggests for a more spontaneous city development approach (Mehaffy, 2008). According to her, the elements of an organic city work in coherence and are able to establish an appropriate interrelationship with each other (Helie, 2009).

The work of Jacobs was followed by important developments in the field of molecular biology (discovery of DNA) and computer technologies. These developments introduced a new era to the field of complexity science by providing new tools that can do multi-dimensional analysis to understand complex patterns (Helie, 2009).

As mentioned above, these approaches are very related with the developments in other fields of science that deal with complexity. The earlier appearance of the term 'emergence' can be found in the discourse of ' Systems Theory' in 1950s, but a broader discussion and elaboration of this term by more scholars was after the physicist Peter Anderson (1972) raised this issue in his article 'More is Different', where he discusses the concept that the properties of the system can be different from the ones of the units it is constructed. The well-known phrase, 'the whole is more than the sum of its parts', which is the core concept of 'Emergence', can help not just to understand and analyze how complex systems work, but also to build and produce complex behavior in man-made systems. The idea of 'Emergence' and 'Complex Theory' is that, the system is a result of simple action interacting with each other to form a different entity, and it is not important to know all the characteristics of the sub-units to understand the attributes overall system (S-Salah, 2014). Any 'complex system' encompasses dynamics for 'coherence' and 'wholeness'; also, it contains features for variations and authenticity as well as spontaneous interruptions (Holland, 1996)

In this context, the research of Edward Lorenz - who is considered as the pioneer of chaos theory and the concept of `butterfly effect` - is also a crucial work that should be noted. Chaos theory deals with complexity in nature and analyzes different patterns that express natural processes (Gleick, 1987). Lorenz uses computational models to analyze the unpredictability of aperiodic natural phenomena (Gleick, 1987). Another important work that deserves attention is the study of Benoit Mandelbrot who developed fractal geometry as tool for dealing with irregular forms of nature. The computation technologies provided ground to him for exploring repetitive geometries that generates variable patterns, seemed in a lot of processes in living organisms

(Mandelbrot, 1983). These developments attracted many scientists to study complex systems. In this line, a group of researchers formed the Santa Fe Institute where they did studies in organisms, computational systems and social sciences. This research leaded to the formation of the theory of complex sciences that triggered the establishment of other research centers dealing with complexity including urban complexity (Helie, 2009).

According to Helie (2009), the culmination of the research in complex sciences happened with the works of two scholars dealing with the discipline of complexity. The first one was the book 'New Kind of Science' written by computer scientist and mathematician Stephen Wolfram (2002). The second one is the seminal work 'The Nature of Order' by the architect Christopher Alexander (2002a, 2002b, 2004, 2005). Wolfram (2002) developed simple computer programs - called cellular automata - that are basic units with complex behavior. He claims that these simple computer programs are able synthetize multiple variables and generate complex patterns as those found in nature (Wolfram, 2002). Alexander (2004), one of the leading scholars in the field of generative urban design, elaborates the theory of generating forms for both artifacts and natural environment.

Most of the literature shows Alexander has dedicated his whole research to elaborate the complexity of nature and human products and to establish a methodology for a generative approach in the built environment. "Alexander`s intention is to notice that more attention should be paid to natural systems and traditional knowledge in terms of learning from them and developing more sustainable human artifacts" (Mehaffy, 2008, p. 73). Alexander`s theory is a based on an important critique against the way architecture and urban planning is developed during the modern era. According to him, modern architecture and planning have failed to respond to the psychological and social needs of users. On the contrary to that, he believes that the traditional settlements where successful in this aspect because they contained a shared knowledge that built healthy processes (Bhatt, 2010; Dawes & Ostwald, 2017).

His work was developed in an atmosphere and influence of a raising discourse against modernism by some other important scholars. It is worthy to mention here Rodofsky's 'Architecture without Architects' (1964), and Amos Rapoport's significant books, 'House Form and Culture' (1969) and 'The Meaning of the Built Environment' (1982). Both scholars stress the importance of spontaneity and intuition in the process of traditional settlements' development (Bhatt, 2010). During this period, two publications of Venturi, 'Complexity and Contradiction in Architecture' (1966) and 'Learning from Las Vegas' (1972) had a considerable impact on the critique of modernism. Other important works contributing to this discourse were those of Jane Jacobs and Kevin Lynch. Jacobs, in her book Death and Life of Great American Cities (1961), criticizes the modern urban planning and emphasizes the qualities of traditional cities by claiming that they possess an 'organized complexity' and are developed in a 'spontaneous order'. While, Lynch`s work focuses on the perception of users in understanding and defining different components of the cities. Finally, the critical regionalism of Frampton, where he highlights the significance of the context in traditional knowledge- a dimension neglected by modernism- was a significant work supporting the discussion (Kohn, 2002; Bhatt, 2010).

In this medium, Alexander developed a broad work that focuses in the concept of generative processes in planning and design. His work can be structured in five important phases where he published his most important researches that elaborate the theory of generative processes in natural and man-made systems. 'Notes on the Synthesis of Form' (Alexander, 1964), 'A City is Not a Tree' (Alexander, 1965), 'A Pattern Language' (Alexander, 1977), 'A New Theory of Urban Design' (Alexander,1987), and 'The Nature of Order' (2002a, 2002b, 2004) are the core publications encompassing the broad work and theory of Alexander (Mehaffy, 2008; Dawes & Ostwald, 2017).

Alexander`s theory started to take shape in his doctoral thesis at Harvard which was published as book named 'Notes on the Synthesis of Form' (1964). This study basis its concept in the belief that the traditional knowledge produced more beautiful buildings and spaces than the modern world. According to him, the main reason for that is the use of totally different approaches in building cities (Alexander, 1964). The process in traditional societies is based on a common, shared knowledge where many actors are involved in building a flexible and adaptive system which provides a well-working built environment. On the opposite to that, the modern planning is structured in a top-down process, separating the designers and users, and dictating very formal layouts that are not able to create a harmony between different forces (Alexander, 1964). As a solution to that, Alexander developed some mathematical rules that could help to solve some complex relationship and establish an equilibrium of forces in the design process (Dawes & Ostwald, 2017). Although in practice this was difficult to be achieved, this methodology helped him to understand the generic nature of different forces in built environment, that can be combined in different ways and create unending variations of compositions (Broadbent, 1980; Grabow, 1983). Later, Alexander would call these generic structures as ‘patterns’ of design (Clavan, 1979; Grabow, 1983; Kohn W. , 2002; Veloso, 2014).

Another important publication where Alexander continued to elaborate his theory, is ‘A City is not a Tree’ (1965). In this article he raises an important discussion regarding the way we should read the city. The main concept is that the city does not have a very clear and distinct hierarchy, as it might be in a case of a tree, but more than that, it is a complex system where the relationships of subsystems overlap in different levels in a non-linear way. Alexander does not refuse the hierarchy at all, but he suggests a different order where the system, its subsystems and the units are organized in a lattice structure, which he calls ‘semi-lattice’. This observation was important not just in the field of architecture and urbanism, but also in other disciplines that use deduction and abstraction as method to create a pure hierarchy in different systems (Batty, 2015).

Alexander`s third seminal work consists of a trilogy of books where he developed the theory of ‘patterns’, one of his most known concepts and a significant critique of modernism in late 1970s. The Oregon Experiment (Alexander et al., 1975), A Pattern Language (Alexander et al., 1977) and The Timeless Way of Building (Alexander, 1979) are three crucial publications contributing to one concept, the generative ‘patterns’ in natural and man-made systems, particularly the cities. This theory is very important because it provides ground for a shift in the methodology of architectural design and urban planning which is based on an objective approach, rejecting the current subjective and intuitive processes (Grabow, 1983; Gelernter, 2000). In addition, the concept of generative patterns has also been a significant research assisting in the advancement of object-oriented software in the field of computer programming (Dawes & Ostwald, 2017).

In the late 1980s Alexander published ‘A New Theory of Urban Design’ (1987), another serious work which tries to settle a ‘new theory’ by elaborating the organic processes of city growth. The approach of this ‘generative’ theory does not deal too much with the details of the end-product characterizing the conventional design methods but highlights more the gradual process in which a form can be generated as result of different actions. It challenged the design concept that is based on formal approach and suggested a totally different process where design is developed step-by-step, in a nonlinear form, considering many contextual forces (Mehaffy, 2008). The role of the designer in this process is not to define the final composition but instead of that he acts as a coordinator of the transitional steps that will create it. In this aspect, the ‘new theory’ framed a different working approach to deal with the complexity of the urban environment, which was not possible with conventional methods based on experts` intuition and knowledge (Mehaffy, 2006).

In the beginning of 21st century, Alexander launched his seminal work, ‘The Nature of Order’ (2002a, 2002b, 2004, 2005), a broad volume of four books where he reaches to an important point of his continuous research by giving a lot of attention to generative design theory. This work is a result of long exploration of design traditions through the history in different parts of the world and it focuses in two main concepts: ‘living structures’ and ‘wholeness’. According to Alexander (2002b, p.204), “A living process is any adaptive process which generates living structure, step by step, through structure-preserving transformations”. By a detailed elaboration, he tries to define many principles that can generate living structures and wholeness in urban environment (Table 2.1). The success of urban design depends on the level of the presence of these principles (Alexander, 2002a, 2002b, 2004, 2005).

Table 2.1 : Alexander’s fifteen properties of living structure / wholeness (2002b).

1	Levels of scale	9	Contrast
2	Strong centers	10	Gradients
3	Boundaries	11	Roughness
4	Alternating repetition	12	Echoes
5	Positive space	13	The void
6	Good shape	14	Simplicity and inner calm
7	Local symmetries	15	Non-separateness
8	Deep interlock and ambiguity		

Nikos Salingaros is another distinctive scholar who walks in Alexander`s path, dealing with urban complexity and generative processes. He is a mathematician who has huge work trying to rationalize and explain the living structures presented by Alexander (Salingaros et al., 2006b). Salingaros (1998) suggests a new approach in urban design, that takes its basis from mathematical processes coming from interrelated principles in complexity theory, `pattern recognition and artificial intelligence`. According to him, the urban tissue is composed of three main elements: ‘nodes, connections and hierarchy’ (Salingaros, 1998, p. 55). As presented in Table 2.2, he proposes eight principles for geometric order in the urban web that include principles related with inner organization of each unit and their relationships with other components in different scales (Salingaros, 2000).

Table 2.2 : Salingaros' eight rules of geometric coherence for urban form (2000).

1	Couplings	Strongly coupled elements at the same scale form a module. There should be no unconnected elements inside a module.
2	Diversity	Similar elements do not couple. A critical diversity of different elements is needed because some will catalyze couplings between others.
3	Boundaries	Different modules couple via their boundary elements. Connections form between modules, and not between their internal elements.
4	Forces	Interactions are naturally strongest at the smallest scale, and weakest at the largest scale. Reversing them generates pathologies.
5	Organization	Long-range forces create the large scale from well-defined structure at the smaller scales. Alignment does not establish, but can destroy, short-range couplings.
6	Hierarchy	A system's components assemble progressively from small to large. This process generates linked units defined at many distinct scales.
7	Interdependence	Elements and modules at different scales do not depend on each other in a symmetric manner: a higher scale requires all lower scales, but not vice versa.
8	Decomposition	A coherent system cannot be completely decomposed into constituent parts. There exist many inequivalent decompositions based on different types of units

An important work of Salingaros is 'A Theory of Architecture' where he tries to establish a methodology for measuring the 'degree of life in buildings'. The process of measuring this quality is based on criteria such as: 'architectural temperature' and 'architectural harmony' (Salingaros, 2006a). Each of them is calculated through the consideration of some other sub-criteria related with architectural features of buildings (Table 2.3).

$$L = T\,H;\; C = T(10-H),\; 0 \leq C < 100 \qquad (2.1)$$

Where:
L = Degree of Life
T = Architectural temperature
H = Architectural harmony
T = T1 + T2 + T3 + T4 + T5
H = H1 + H2 + H3 + H4 + H5
C = Architectural Complexity

Table 2.3 : Principles defining the 'temperature' and 'harmony' (Salingaros, A Theory of Architecture, 2006a)

Temperature	Harmony
T1 = intensity of perceivable detail	H1 = reflectional symmetries on all scales
T2 = density of differentiations	H2 = translational and rotational symmetries on all scales
T3 = curvature of lines and forms	H3 = degree to which distinct forms have similar shapes
T4 = intensity of color hue	H4 = degree to which forms are connected geometrically to one another
T5 = contrast among color hues	H5 = degree to which colors harmonize

The reflections of generative processes and emergent urbanism in Islamic and Mediterranean cities are elaborated in the studies of Besim S. Hakim (2003, 2007a, 2007b, 2008, 2010). He defines urbanism as a process and not as product, considering it as a more effective methodology for understanding cities. Like his colleagues studying generative processes, Hakim considers the urban composition principles of traditional cities as a sustainable approach. According to him, the process of decision-making in built environment is based on community`s values in traditional cities. Specifically, in Islamic societies the development of urban environment is based on Islamic religion principles and local traditions. In accordance to these rules, the decision-making is established in two levels: central government and neighborhood scale. While the first one deals with decisions related with location of main public facilities and infrastructure, the second one is based on local decisions (neighborhood decision) related with processes of city growth mainly in residential areas (Hakim, 2003, 2007a, 2007b, 2008, 2010).

Table 2.4 : Hakim's principles of generative settlements (Hakim, 2008).

1	Meta-principles comprised of ethical/legal norms that is derived from the history and value system of the society for which such a program is proposed.
2	Private and public rights are fairly and equitably exercised.
3	Private and public responsibilities are properly allocated and implemented.
4	Control and Management
5	Rules and codes.

According to Hakim (2008), there are many lessons that can be taken from the Mediterranean and Islamic cities, regarding their process of development, organization and management. In explaining the principles of this settlements, which can be used

also in generating new neighborhoods and cities, Hakim (2008) uses some essential terms of ‘emergent form’ such as: ‘complex adaptive system’, ‘self-regulation’, ‘negative feedback’, ‘generative program vs descriptive program’, ‘non-linearity, ‘agents and aggregate agents’. Moreover, he speaks about the importance of using ‘proscriptive’ rules rather than ‘prescriptive’ ones, in the process of building dynamic and well working cities (Hakim, 2008).
The principles of these traditional settlements are suitable to be implemented also in the organization of contemporary and future cites (Hakim, 2008). Here, it is important that the following principles should be taken in consideration to reach a successful output. The design of inhabited zones and their future development should provide ground for a ‘complex adaptive system’ fitting to the conditions of time and place. In addition, this system should be able to apply ‘self-regulation’ rules and make sequential ‘feedbacks’ in order to return in a status of restructuring the balances between different units (Hakim, 2008). Another important issue is that the system must work in a ‘generative program’, which activates a participatory bottom-up process, rather than a ‘descriptive program’, which is based on a top-down approach that neglects the local circumstances and results in a standard predicted outcome (Hakim, 2008). Furthermore, the process should maintain a ‘non-linear’ quality which is difficult to be predicted and contains overlapped relationships creating unexpected, surprising and unique compositions (Hakim, 2008). Finally, the system must create an environment where small scale ‘agents’ behave in a kind of semi-independent way to form various entities of aggregation, which have different attributes from their sub-units (Hakim, 2008). If the system can provide such qualities, the urban environment will have a dynamic nature; fit to local conditions; produce unique spaces; and have a strong identity (Hakim, 2008).

2.5 A Pattern Language

The ‘pattern language’ theory is among the most known and influential works of Christopher Alexander, mainly in the field of architecture and urbanism but also in other disciplines such as complex sciences and software engineering (Lea 1994; Saunders 2002; Mehaffy 2008; Silva & Paraizo 2008). It is a seminal work consisting of a broad theoretical background and detailed explanation of principles regarding the organization of built environment.

The pattern language theory was elaborated firstly in ‘The Timeless Way of Building’ in the theoretical dimension and in ‘A Pattern Language’ in the practical aspect. Alexander considers this works as two parts of one thing, one of them deals with the origin of the concept and guidelines for the use of the language the other one explains the patterns in detail and how they generate different components of a city in different levels, from town to the design of a room (Alexander, Ishikawa, & Silverstein, 1977). Later, works related to this theory were published in ‘Houses Generated by Patterns’, ‘A Pattern Language Which Generates Multi-Service Centers’, and ‘The Oregon Experiment’ (Alexander, 2002b). Since its first publication the theory has grabbed a lot of attention from different researchers because of the unconventional methodology that it proposes in the process of shaping our habitat.

Salingaros would call ‘A Pattern Language” one of the great books of the 20th century. He supports this idea by claiming that Alexander was concerning about the architecture that makes people feel good in psychological and sociological aspects; connects them with their environment; and works well. Based on that, he developed some tools called ‘patterns’, which can be found in most of traditional settlements and societies. According to Salingaros (1998b), though these patterns represented some universal qualities, that could be implemented in different contexts and disciplines, it was not embraced by scholars and designers for a long time, losing the opportunity of benefiting from it.

Alexander`s approach is based on close observations of biological processes in nature, and he thinks there are many things that we can learn from this complex but harmonious systems. He calls them ‘technology of life’. This environment is not closed within itself, but it consists of many overlapped interrelationships that form a living ecosystem. The system continuously evolves in a stepwise process adapting to different circumstances, providing solutions for reoccurring new challenges and balancing variable conditions of the system in overall (Alexander, Ishikawa, & Silverstein, 1977; Mehaffy, 2016). The process of form generating in organism called ‘morphogenesis’ is can be very inspirational for building similar systems of artificial design (Mehaffy, 2016). The generated form is not just a geometrical composition and collection of some sub-units, but is a complex system built through many transformations in an unfolding progression (Mehaffy, 2016). In many cases this process does not follow a symmetrical subdivision but generates dynamic and organic compositions that still has an order (Mehaffy, 2016).

Alexander (2002b) identified that this process is developed step by step where the new situation uses the former by transforming it to a more complex and articulated one. The development of embryo is a typical case of this process, starting with a cell as unit and going through changes that forms other wholes with a different order (Alexander, 2002b; Mehaffy, 2016). This procedure continues in other following phases by adapting to new conditions, arranging new balances and resulting in a fantastic system of complex order (Alexander, 2002b; Mehaffy, 2016). Alexander (2002b) considers this process as the ground for developing similar methodologies in the field of design. His focus is not on creating fancy impressing architecture but is more on building living structures that are developed in an adaptive inclusive process (Alexander, 2002b; Alexander, Ishikawa, & Silverstein, 1977; Mehaffy, 2016).

The theory of ‘pattern language’ speaks for an essential quality which cannot be named but is the basic principle of life and spirit and is present in all levels of manmade and natural structures (Alexander, 1979, p. 19). In the first book, Alexander presents the theoretical part of the ‘patterns’, by highlighting that the ‘quality without a name’ is the essence of the beauty in traditional buildings and urban spaces. He explains that, the larger urban system is composed of many well-integrated smaller actions that are guided by the system of values and shared knowledge of traditional communities. Although, the ‘quality’ is not defined strictly, it is explained through some terms such as: ‘‘beauty’, ‘alive’, ‘whole’, ‘comfortable’, ‘free’, ‘exact’, ‘egoless’, and ‘eternal’ (Alexander C. , 1979; Dawes & Ostwald, 2017). These features give an idea of the multi-dimensional nature of the ‘unnamed quality’ which produces a dynamic and at the same time a cohesive environment.

According to Alexander (1979(, this quality is present in every individual and it can be reflected in the environment they shape. Moreover, there is a continuing reciprocal influence between the people and their environment. If there are places that have this quality it will be reflected in people, and the ones that have identified that quality they will use it to create better places. The environments that possess ‘the quality without a name’ are healthy, viable, sustainable and coherent, and if there is a lack of it, they are ‘sick’, ‘dead’, fragmented and ‘self-destroying’ (Alexander, 1979). Another important issue is that, ‘the quality without a name’ can work only in societies where people are involved in the process of creating their environment, in a democratic process of shared values and knowledge (Alexander, 1979; Dawes & Ostwald, 2017).

The second book, ‘A Pattern Language’ aims to demonstrate the theory in more concrete principles by forming a kind of design guide that includes piecemeal actions integrated with each other. The book contains a very detailed explanations of 253 patterns that work as algorithmic rules for generating design. “Each pattern describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over, without ever doing it the same way twice” (Alexander, Ishikawa, & Silverstein, 1977, p. x). The ‘patterns’ are organized in a sort of hierarchy starting from the regional scale and going until the details of small structures. To reach the ‘unnamed quality’, the adaptation of solutions to local problems and the harmony of patterns in different levels by creating a coherence, is very important (Alexander, Ishikawa, & Silverstein, 1977). The structure of patterns consists of some important sub-categories: firstly, it identifies the pattern by illustrating it with a typical example; secondly, it describes in a paragraph the context where the pattern is meaningful; thirdly, it represents the basis of the problem and facts that confirm the legitimacy of the pattern; then it gives the solution for the realization of the ‘unnamed quality’ by completing with description and a graphical illustration; and finally the structure defines other patterns that are related and complete the quality of the current pattern (Alexander, Ishikawa, & Silverstein, 1977; Beirao, 2012; Dawes & Ostwald, 2017). It is emphasized that the patterns are not static but have flexible nature, open for improvement of patterns or creation of new ones by respecting the defined frame (Alexander, Ishikawa, & Silverstein, 1977; Beirao, 2012; Dawes & Ostwald, 2017).

The final publication of the trilogy - The Oregon Experiment - elaborates a trial for implementing the concept of ‘patterns’ in the design of campus for the University of Oregon. In this work Alexander (2002a) explains the needed procedures for providing the implementation of small projects and step-by-step development that can occur in large projects with a single client. The theory of pattern language is appropriate to analyze the generative nature of an existing settlement, although later, Alexander (2002a) refined the concept of ‘patterns’ by replacing them with ‘centers’, because he thought they were not very suitable for generating a design language (Dawes & Ostwald, 2017).

Table 2.5 : Alexander's core concepts of pattern language theory (Alexander C. , 2002b, pp. 344-345).

1. In traditional cultures, successful environments were always built by using pattern languages. They showed people how to make an almost infinite variety of buildings by combining and recombining the patterns and contained within the process a modest guarantee that the buildings would be successful. Hence the great variety and beauty of buildings built by traditional societies.
2. Each culture had its own pattern language. The pattern languages reflected differences from culture to culture, and often nearly embodied the culture as a whole, in the form of rules which defined the spatial structure of the built environment.
3. The patterns were, for the most part, based on human needs, understanding, and necessity. They reflected the deep practical daily concerns of people and were, as rules, expressed in a form which made it possible to put these things into the built environment in an immediate, practical, and effective form.
4. At the same time, although patterns vary from culture to culture, and while human needs vary and are highly specific in different human cultures, there is a core of material – a central invariant structure – which is common to all cultures. A portion of this invariant core – or at least a sketch of such a thing – is described in *A Pattern Language* (Alexander et al. 1977, 1171).
5. It is possible to create pattern languages from our own time, which, like traditional languages, embody knowledge, cultural subtlety, human need, and empirical information about the structure of living environments, in a form which may then be used to generate living centers by a combinatorial unfolding process.
6. It is possible to invent and create new pattern languages, artificially, by trying to see what new patterns will solve problems that exist in a given context. Although these may be new, in the sense that they are newly defined, many of them may, obviously, be versions of ancient patterns, familiar in different cultures, but so deep that in some form they are still relevant to our new era and new settings.
7. The objectivity of the patterns is context-sensitive, and always includes a built-in reference to the context for which that pattern works.
8. The patterns, because of their explicitness, allow discussion, debate, and gradual improvement of the material.
9. The artificial language will work well only to the extent that it embraces *a whole* – that is to say, to the extent that it comprises everything that needs to be said about a given building situation, and that the various patterns it contains work together as a whole system, which accounts for all the morphology that is required to design, plan, or make, a complete building of that type and its immediate surroundings.
10. These artificial languages, like traditional languages, can then be used to steer processes of design and building, just as traditional languages played that role in traditional societies.
11. For *any* new building project it is necessary to construct such a language, merely to provide a clear functional basis for the character and organization of the building. The language that is written down, at the beginning of a project may be invented from scratch, composed of known languages that have been re-combined, or may be a modification of a known language developed earlier. This will vary, according to the degree that the project is new, not yet fully understood, or old and familiar.

While explaining the core concepts of pattern language, Alexander (2002b) makes a detailed description (Table 2.5) regarding their features, use and importance.

An important aspect about patterns is their nature that includes two important dimensions, first, the pattern includes the rules of generating a 'living center', and second, it defines the relationships with other patterns (Alexander, 2002b). So, the pattern is not an isolated concept, but it includes both the principles of forming a unit and the rules of establishing relationships with other patterns, which might form a larger system (Alexander, Ishikawa, & Silverstein, 1977; Alexander C. , 2002b). "The pattern both describes a generic center and describes a generic relation among other generic centers" (Alexander, 2002b, p. 345). It is important to notice that the rules do not define a specific form but more than that they define the principles. This means that with the same principles you can create an endless variety of patterns having that quality (Alexander, 2002b).

The background of Alexander in the field of mathematics and physics helped him to develop a system thinking where elements are transformed to a system of wholeness. His main inspiration comes from processes in natural system where there is a strong order in the relationships between the whole and its parts. In this aspect, the pattern language comes as result of defining relations rather than things, relations that can form a wide variety of meaning similar to the system of a language where the combination of letters, words, and sentences form different meanings (Alexander, Ishikawa, & Silverstein, 1977; Mehaffy, 2016). More than a set of modules, the patterns represent mediums that define the principles of connections between modules. The theory of patterns appreciates the fact that connective mediums, such as intermediate zones, connection elements, and the boundaries, that accommodate human activity, are very crucial to create a coherent urban space (Salingaros, 2000). The design of intermediate connective layers of architectural and urban systems should be as important as the design of modules (Salingaros, 2000).

The pattern language possesses an algorithmic structure that is flexible for different generic design solutions. This structure allows them to form infinite compositions because the patterns create a set of continuous relations with each other due to the connective nature that they have (Alexander, Ishikawa, & Silverstein, 1977; Beirao, 2012). This concept is structured in a very abstract way, so it provides space for interpretation and implementation in different design tasks (Alexander, Ishikawa, & Silverstein, 1977; Beirao, 2012). However, many researchers have not considered enough the generic structure of the patterns which has the capacity to produce new entities. Patterns include both the identification of a former existing situation and the consequence due to its generic algorithmic structure (Beirao, 2012). In this sense, they are appropriate to be used for both analyzing an existing circumstance and generating new design solutions (Beirao, 2012)

The theory of patterns has been a guide for many different research disciplines. Among them, the field of computer sciences has reached one of the most successful use of this concept. Noting the algorithmic nature of pattern language, Gamma et al. (1995), used this concept to develop a programming design method called design patterns. The concept of design patterns, tries to solve different software design problems by including a code sample which provide more accurate and effective use of patterns` algorithmic structure (Beirao, 2012). The use of design pattern can give solutions to explicit software design issues and provide flexibility and reuse in object-oriented programming. In this concept, the structure of pattern language is articulated in a more defined structure which is appropriate for computer programming (Beirao, 2012).

After the concept of design patterns, there have been many studies that try to elaborate and interrelate the formal dimension developed by Gamma et al. (1995) with Alexander`s concept of patterns. The focus has been on building computer-based design approaches which can be able to generate design alternatives according to a specific problem (Salingaros, 2000; Montenegro, 2010). Actually, the phenomenon of urbanism and architecture is much more complex and cannot be handled as a linear design procedure.

The design process is very related to contextual forces that can be elaborated through unlimited formal compositions for a specific circumstance (Beirao, 2012). Aware of that, Alexander intentionally did not focus on defining formal solutions, in order to provide flexibility and freedom in design process with patterns. In this aspect, there is a significant difference between the generic nature of Alexandrine patterns and the specific design patterns developed by Gamma et al. (Beirao, 2012). Although they are close in their conceptual dimension, their focus is somehow different. While, Alexander`s pattern language is more abstract, conceptual, with generic nature, and open to individual interpretations, design pattern presented by Gamma et al. are more accurate, deal with problem solving, possess formal structures that act as algorithms with a code frame that generate solutions for a specific problem (Alexander, Ishikawa, & Silverstein, 1977; Gamm et al. 1995; Beirao, 2012). Both are appropriate to be used in developing an urban design methodology (Beirao, 2012).

Alexander refined the concept of pattern by calling them ‘centers’ and developed other articulated concepts such as ‘living structures’ and ‘wholeness’ by defining many principles (Alexander, 2002b). The generative approaches of his theory have attracted different scholars, especially in the last two decades. For example, Pontikis (2007) uses his principles in developing Greek housing complexes. Salingaros et al. (2006b) also integrates Alexander`s generative principles in his studies of informal settlements in Latin America (Pontikis 2007). Pagliardinin et al. (2010) uses the term ‘urban seeding’ and not urban planning for the projects built with bottom-up generative processes.

This study uses the concept of pattern language to understand the generative character of an existing historic settlement. In this context, the pattern language theory is used more for analytical purposes, rather than their potential for being used as a design tool. The main aim is to identify the complexity, richness, dynamism and generative nature of the study area by using the pattern language structure.

2.6 The Fractal Geometry

“Fractal geometry will make you see everything differently” (Bamsley, 1988, p. 1). The natural systems consist of very organic forms and complex compositions. In the same way, cities also are manmade environments built on a system of non-linear and complex relationships. The form of both is difficult to be analyzed an understood through conventional methods of Euclidian geometry which is based on the straight lines and planes (Batty & Longley, 1994)

After the second half of the 20th century, a new approach of geometry which can analyze the complex organic forms emerged and challenged the conventional methods (Batty & Longley, 1994). This new geometry of nature suggests that units with organic structure, which might seem irregular in Euclidian geometry, usually possess an order within this complex irregularity (Batty & Longley, 1994). Components that are formed by lines which are not smooth can demonstrate an order in overall which is more elaborated and complex than the units with straight lines (Mandelbrot, 1983). These structures that represent similar irregularity in different scales are called ‘fractals’, a term developed and promoted by Mandelbrot (1983, 1990), and the geometry that studies such structures is called ‘fractal geometry’ (Mandelbrot, 1983; Batty & Longley, 1994). The term fractal is a derivation form Latin word ‘fractus’, which means ‘broken’ (Ben-Hamouche, 2011). Mandelbrot (1983) defines fractals as way to see the infinite.

A fractal is a structure that has a repeated irregularity in different scales, but which form an order in the overall composition because of the similarity of irregularities (Batty & Longley, 1994). A similar explanation is done by Lauwerier (1991) who defines the fractal as geometrical shape that includes a particular motif that repeats itself in many scales. ‘Repetition’ and ‘self-similarity’ are two essential terms that can explain the nature of fractals. This feature of form repetition in different scales produces the nature of self-similarity which is a common phenomenon in complex natural and artificial systems. Fractal is a very useful tool to analyze, understand and explain the irregular forms in nature and manmade environment which look very fragmented, directed and irregular but in essence has a hidden order within it (Gleick, 1987). For example, cities, which demonstrate a self-similar structure in repetitive orders of centers and neighborhoods can be analyzed through fractals (Batty & Longley, 1994). In order to calculate the self-similarity of structures across scales, mathematicians have developed a methodology called ‘fractal dimension D” which analyzes the relation between the number of units and the reduction factor (Bechhoefer & Bovill, 1994; Bovill, 1996; Ben-Hamouche, 2011).

2.6.1 The background of the term

The concept of fractals developed by Mandelbrot (1983), is result of long work starting from 1950s but its broader spread was after the publication of his well-known book ‘The Fractal Geometry of Nature’. This method was very useful to produce very realistic computer visualization for natural environment. Meanwhile, it contributed to increase the interest of other disciplines regarding the science of form. This new geometry was also helpful for mathematicians who used it to develop solutions for dynamic, irregular, discontinuous and chaotic systems. The core concept is based on the idea that although the world might seem chaotic and disorder in the in terms of conventional geometry, actually it is built in a complex system that produce order and a balanced set of relationships (Batty & Longley, 1994). The new geometrical approach challenged the old methods that saw order in a simplified nature of smooth objects and straight lines. In this aspect, except rare cases, the world must be considered as a large system of fractals (Batty & Longley, 1994). The importance of fractal theory is also highlighted by Gleick (1987, p.1) who states that: “The most passionate advocates of the new science go so far as to say that twentieth-century science will be remembered for just three things: relativity, quantum mechanics and chaos” and Batty and Longley (1994, p.v) adds that “this includes the geometry of chaos – fractals”.

The concept of fractals has been known also before Mandelbrot`s work. One of the pioneers who mentioned about it is Richardson (1961) in an article writing about the coastlines and national boundaries. But Mandelbrot, inspired by the work of Richardson, was the first who elaborated it in detail and more clearly in his paper "How Long is the Coast of Britain?" (1967). In this study Mandelbrot discusses the issue that the form of coastline should have a fractal dimension between 1 and 2 by explaining that a straight line has dimension of 1 and a plane a dimension of 2 in the Euclidian geometry. In this sense, the coastline which has an organic structure formed between a line and a plane should have a dimension value between 1 and 2 (Mandelbrot, 1967). Based on this logic, the mountains would have a dimension between a plane and a cube which is something between 2 and 3. Here he argues that fractals were not just irregular forms, but they had a self-similarity in different levels, organized within an order, built in a hierarchy and distinguished by fractal dimension (Mandelbrot, 1967; Batty & Longley, 1994). The developments in computer tools and the publication of the second edition “The Fractal Geometry of Nature” (1983) by Mandelbrot helped a lot in the establishment of the fractal theory and its wider spread in academic environment (Batty & Longley, 1994).

2.6.2 Types of fractals

2.6.2.1 The Koch curve

To understand the logic of fractals, the concept of Mandelbrot can be implemented by defining two basic components: the initiator and the generator, the first one is a simple object and the second one is a repeated shape applied to the first one at every step in different scales (Batty & Longley, 1994). In this way, the derived fractal form is the initiator of the next step where another generator is applied. Following this procedure in every step will generate a detailed fractal structure which composed by many imitators and generators (Batty & Longley, 1994). This process can continue infinitely but practically it is interrupted at a level where the shape of the first initiator is not visible anymore (Batty & Longley, 1994).

This procedure is represented very clearly in the concept of Koch curve which was developed by the Swedish mathematician Koch in 1904. The idea of Koch curve is about constructing a continuous curve which is not straight and not dependent to the concept of tangent lines. As shown in Figure 2.4, the Koch curve is built by starting with a straight line as an initiator. The next step is to apply the generator which divides the line in three equal segments and then replaces the middle segment with a triangle. This procedure continues with further steps by constructing a curve that has no smooth parts (Batty & Longley, 1994; Bovill, 1996).

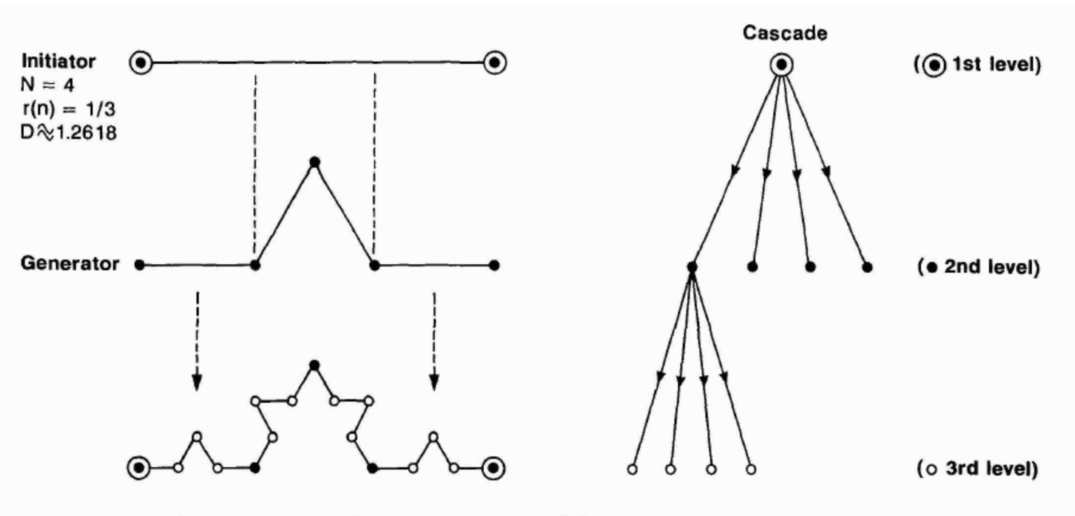


Figure 2.4 : The steps of constructing a Koch curve (Batty & Longley, 1994).

Figure 2.5 (left) represents a development of Koch curve in four stages. As it can be seen the smooth lines are getting smaller through the developing process. Although the following steps in the iterative process look similar, they are different (Bovill, 1996). The real Koch curve can be completed just in the limit to infinite where there are no straight lines anymore (Bovill, 1996).. This is based on the mathematical concept that shows that real fractals exist only in the limit stage of an infinite number of iterative steps (Peitgen, Jurgens, & Saupe, 1992).

A better and more ordered structure that represents the stages of fractal structure development is diagrammatized in the Koch island shown in Figure 2.5 (right) In this example, the first phase starts with an equilateral triangle. The further stages of generation continue by applying a smaller triangle, whose side is one third of the length of the first triangle (Batty & Longley, 1994). Then, this smaller triangle is attached to each side of the previous triangle composing a fractal structure of order and self-similarity (Batty & Longley, 1994)

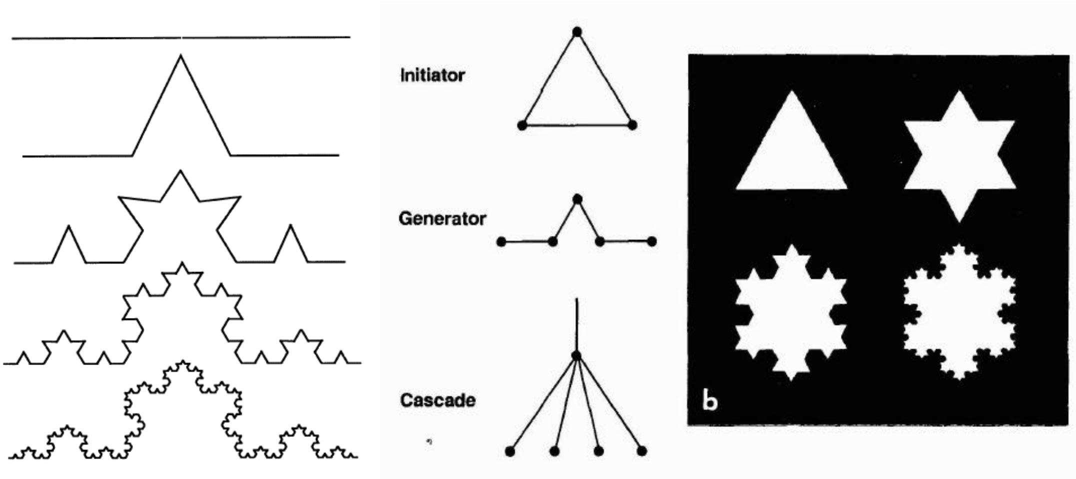


Figure 2.5 : Koch curve in four stages (left) and Koch Island (right) (Bovill, 1996) (Batty & Longley, 1994).

2.6.2.2 The Minkowski curve

The concept of Koch curve is so general that can be implemented in many similar shapes with even more complex and dynamic structures. Minkowski curve is such an example where the curve in each step grows in a faster mode than the Koch curve (Bovill, 1996). As shown in Figure 2.6 in each stage the generator implements a longer curve of eight segments on a straight line of four segments generating a high fragmentation in overall (Bovill, 1996).

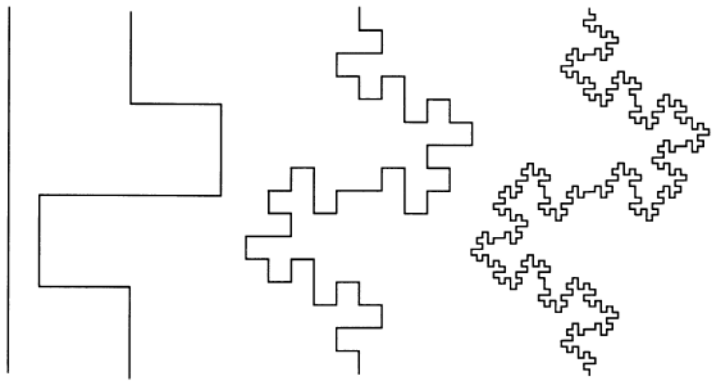


Figure 2.6 : Minkowski curve implemented in four stages (Bovill, 1996).

2.6.2.3 The Sierpinski gasket

Another concept that supports the geometry of fractals was developed by Polish mathematician Waclaw Sierpinski in 1919. The Sierpinski (1919) gasket is built in a process which starts with an equilateral triangle as an initiator shape. The next stages are iterative steps of removing a triangle whose form is shaped by the connection of the midpoints in the sides of the previous triangle. The Sierpinski gasket is what remains after repeating this procedure in an infinite number of steps (Peitgen, Jurgens, & Saupe, 1992; Bovill, 1996). The Figure 2.7 shows the generation of Sierpinski gasket applied in four stages.

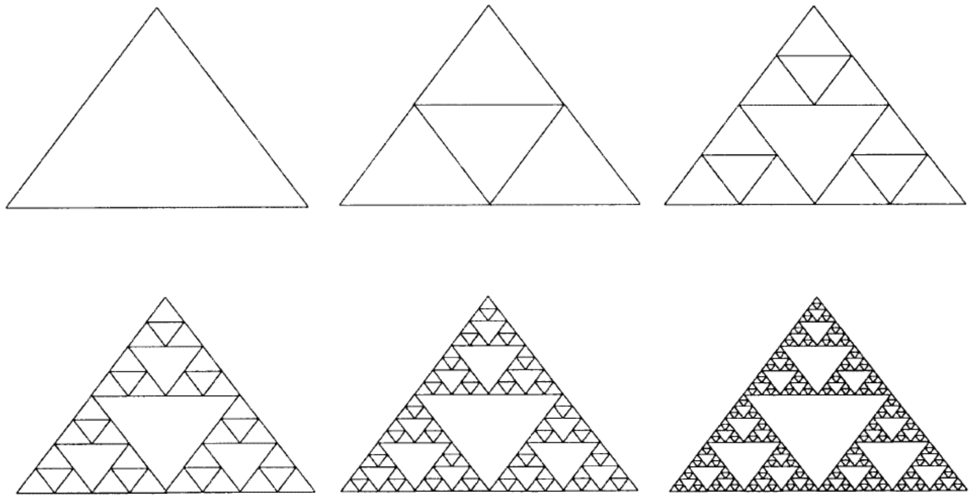


Figure 2.7 : The generation of Sierpinski gasket in four stages (Bovill, 1996).

2.6.2.4 The Peano curve

An interesting curve supporting the concept of fractals was developed by Giuseppe Peano in 1890. The Peano curve is generated from a straight line which is divided in three segments (Bovill, 1996). The generator is composed of nine segments that are applied continuously infinitely in the initiator shape (Figure 2.8). In this process the lines with three segments are substituted by new form which is composed of nine segments (Peitgen, Jurgens, & Saupe, 1992). The result after an unlimited number of applications is very interesting, it somehow fills the plane totally (Bovill, 1996).

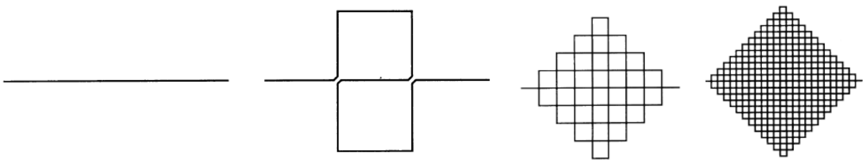


Figure 2.8: The generation of Peano curve (Bovill, 1996).

2.6.2.5 Self-similarity

A core principle that explains the concept of fractals is self-similarity across scales. Based on mathematical definitions, a structure is self-similar if it has gone through a change and its dimensions were rearranged by the same scaling factor (Bovill, 1996). This is the situation in all fractal structures. Although the structure goes through different transformations regarding its scale, size or orientation, its shape still has similar attributes. Here, the similarity can be understood as unchanged proportions and internal angles. A simple example that illustrates this process is the reduction of the size of a document in a copy machine. Natural and manmade environments are full of examples that represent forms with self-similar structures. The hierarchical branch system in trees, rocky coastlines and weather changes or the alternations on the stock market are some examples that can be mention regarding this issue (Bovill, 1996).

Batty and Longley (1994) summarize and describe the order that is present within the irregularity of fractal structures in three main aspects:

- Firstly, the fractal forms are organized within the principle of self-similarity.
- Secondly, hierarchy is another parameter which is present in fractal structures among various scales and levels.
- Finally, fractals are irregular forms without straight lines but in overall, they represent and organized complexity and a system of order.

2.6.3 Fractals in nature and man-made environment

Benoit Mandelbrot (1983), one of the pioneers of the theory of fractal geometry, would call it as ‘the geometry of nature’, highlighting the issue that fractal features are present in almost all natural structures. Many studies have shown that the fractal concept is also very useful to analyze and understand the features of man-made systems, since many of them represent fractal geometry in their organization (Batty & Longley, 1994). The methodology of fractal concept is very appropriate to explain the composition of natural structures and phenomena, but also it can be very helpful to understand the features of complex man-made systems such as economical systems or the organization of cities. For example, the plasma fractal or cloud fractal approach is very suitable to understand the geometry of natural landscapes. In this context, applying this methodology in analyzing the structure of a mountain will show that it is composed of smaller parts that have similar features with the overall form of the mountain. The same approach of fractal geometry can be used to analyze the structure of molecules. If the structure of DNA walk, which represents the DNA sequence, is extracted, it will be visible that it is constructed with fractal properties. Moreover, the geometry of fractals composes the structure in any plant. The continuous branching process in plants form a fractal structure like a tree which have a hierarchical system and repeats the self-similar forms in every level of its organization (Garg, Agrawal, & Negi, 2014). The idea of the presence of fractal geometry in many natural and artificial systems is also highlighted by Doxiadis (1968), who explains that by giving examples of human body, the structure of the trees and the organization of street network in a city (Figure 2.9). According to him, the structure of the vascular system in human body represent a typical fractal form starting from aorta and going to small capillaries (Doxiadis, 1968). The similar properties can be seen in skeleton structure, the form of a tree or the network of roads in cities (Doxiadis, 1968).

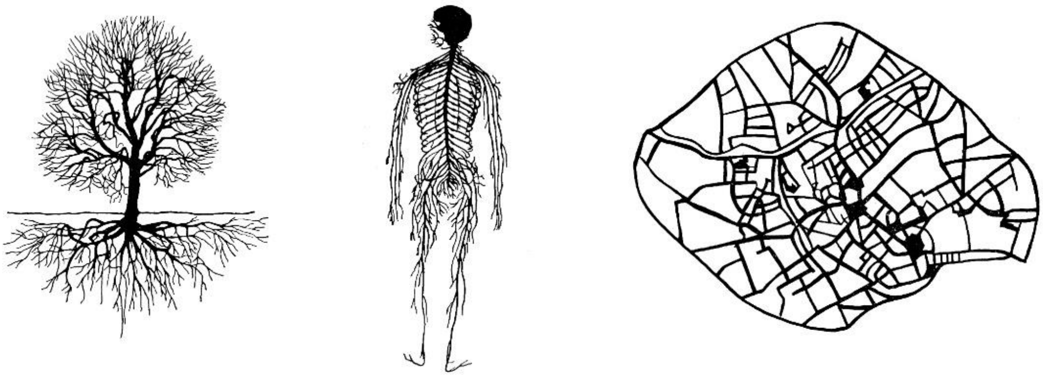


Figure 2.9 : The fractal properties in tree structure, human skeleton and urban street network (Doxiadis, 1968).

Bovill (1996) gives also different examples of fractal concept in different man-made systems. He speaks about order, repetition and the surprising effect in fractal systems. An interesting example is the musical melody which represents a fractal structure. A good music is organized in a continuous order and rhythmical repetitions but also it should have a sequential surprising effect (Bovill, 1996). The similar concept can be mentioned in the evaluation of good architecture. A successful architectural composition is dependent on the level of harmony and relationship that is created between the general form and the details (Bovill, 1996). This is a feature of fractal geometry which implements the self-similarity principle and establishes a strong harmony among different levels of any structure (Bovill, 1996).

The concern of this study in aspect of fractal geometry is its relation to the organization of cities. There are many scholars who discuss that the theory of fractals can help in understanding, analyzing, describing or designing cities. The city is a complex system which is difficult to be analyzed through a Cartesian approach. In this aspect, the fractal geometry is very useful to explore the complex structure of cities. Jacobs (1961) considers the city as a system of organized complexity and this problem can be analyzed through a method such as fractal geometry which deals with complex structures. The city is an output of a process of multi-layered sociological and economical forces composed within natural and artificial geometry (Batty & Longley, 1994). All these non-linear and complex relationships form a fractal structure in cities. As a result, "… cities are fractal in form" (Batty & Longley, 1994). The fractal properties are present in all geometrical components of the city, from one-dimensional to third dimensional forms (Batty & Longley, 1994). Cities are fractal not just in their physical aspect but also their socio-economic dimensions have features of self-similarity in different scales. The organization of city in clusters, neighborhoods districts and urban zones are examples of these features (Batty & Longley, 1994). Furthermore, transport network and the concepts of geography regarding the organizations of settlements and economic activities in a hierarchical order, are typical examples of fractal structures (Batty & Longley, 1994).

The development of scientific disciplines that aim to analyze and understand the city phenomenon have been focused mainly on artistic and architectural approaches. Concepts such as Garden City, the City Beautiful and Modern Movement are results of this type of approach. These views are very much concentrated on the idea that the order is dependent on the smoothness of geometry, homogeneity and statistical order (Batty & Longley, 1994). The diversity, irregular geometry and organic structures are considered as phenomena of disorder (Batty & Longley, 1994). Actually, this approach has not changed too much in contemporary discussion on cities. Although there is an increasing awareness of interpreting the city as an organized complexity, the planning and design disciplines still try to dictate the idea of an order based on straight geometry and simple forms (Batty & Longley, 1994).

There is a common categorization of cites as planned and 'naturally' or "organically" grown cities (Kostof, 1991; Batty & Longley, 1994). Despite this, it is difficult to differentiate clearly these two typologies of cities since in many cases there is a presence of both approaches in the process of their growth. However, there are essential differences that can help to identify the properties of each concept. For instance, two important aspects that might help to distinct either a city is naturally grown or planned, are the speed of growth and the scale of expansion. Organic cities are grown in a slower process than the planned cities. Another dimension is that the organically grown city is a result of many individual actions while planned cities are developed through the decisions of a small group of actors who imposes their ideas on the majority (Batty & Longley, 1994). Planned cities have a monumental character, contain centrality and organized in more strict geometry, while organic cities represent a complex layout of irregular morphologies that form a whole system (Batty & Longley, 1994). A final aspect is that, organic cities contain a process that include both growth and decline, on the other hand, it is difficult to identify decline in planned cities since their objective is urban growth (Batty & Longley, 1994).

For a long time, especially the modern planning ideology, has ignored the qualities of organic or 'naturally grown' city and has considered it as a spontaneous environment without order (Batty & Longley, 1994; Ben-Hamouche, 2011). But, after the second half of the 20th century there is an increasing discussion about new paradigm regarding this issue. The theses of Jane Jacobs, Alexander, Rapoport, Venturi and many other important scholars that criticizes the modern planning approach and suggest a new paradigm highlighting the importance of complexity, and the qualities of vernacular settlements, have been important developments in this discourse (Jacobs, 1961; Alexander, 1979; Rapoport, 1982; Bhatt, 2010). Since the elaboration of these theories about complex order, the concept that the organic cities are more successful, sustainable, dynamic, democratic and work better has continuously increased its acceptance (Batty & Longley, 1994).

The concept of fractals is an important cornerstone in the environment of theories dealing with the complex order and the way cities are organized and function. It establishes a strong methodology which help to understand the features and qualities of organic structures. Especially, this new geometry has been a very essential tool in analyzing and explaining the system of order in organic cities (Batty & Longley, 1994; Bovill, 1996; Salingaros, 2006a; Ben-Hamouche, 2011). According to Ben-Hamouche (2011), the theory of chaos and fractal geometry establishes an important new approach in exploring and explaining the morphology of Muslim cities, which were considered as disordered settlements by Cartesian approach and Euclidian geometry. Islamic cities are typical examples of organic, 'naturally grown' cities. Researches after the mid of 20th century started to show findings of complexity and order in the components that shaped the Islamic cities (Hakim, 1988; Ben-Hamouche, 2009). Recent works have shown that the non-smooth geometry of urban morphology in these cities is a representation of complexity and hidden order rather than a manifestation of disorder (Akbar, 1988; Ben-Hamouche, 2011). The organic Islamic cities are organized in a system of fractal concept (Ben-Hamouche, 2011). The idea of sustainability of vernacular settlements and their strong relation with fractal concept is also supported by Salingaros (2006a). In his studies of "subconscious urbanism" he elaborates the issues of complex rules that people implement in a process of urban growth. According to Salingaros (2006a), the traditional cities are more successful and sustainable in comparison with planned cities. He claims that, an essential contributor to the sustainability and authenticity of these cities is the fractal nature of their structure (Salingaros, 2006a).

There are several methodologies of fractal geometry but one of the most used is the box counting method. The fractal dimension calculated through the box-counting method is a representation measured and covered dimensions. Bovill (1996) explains the procedure of box-counting is conducted in several steps. Firstly, the shape is juxtaposed with a grid of squares at a particular size. The size of the grid is indicated as *(s)*. Then, the number of boxes that are intersected with the shape are counted giving the value *N(s)*. This procedure is repeated in further steps where the size of the grid *(s)* is reduced, and the number of boxes superimposed with the shape *N(s)* is counted in each step. In both dimensions, the following step is to implement log [N(s)] versus log (1/ s) on a log-log diagram. The slope of the smooth line is an estimation of the box-counting dimension (Db). The fractal dimension (Db) is calculated through following formula.

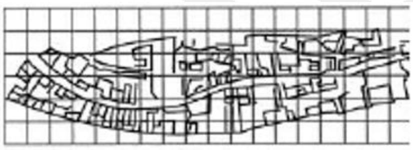
$$\mathrm{Db} = \frac{[\log(\mathrm{N(SII)}) - \log(\mathrm{N(SI)})]}{[\log(1/\mathrm{SII}) - \log(1/\mathrm{SI})]} \qquad (2.2)$$

Db: The value of Fractal dimension or line slope

N (SI): The number of boxes intersected with the shape in the first step (I).
N (SII): The number of boxes intersected with the shape in the second step (II).
N (SIII): The number of boxes intersected with the shape in the third step (III).
1/SI: The number of boxes in horizontal axis (x) in the first step.
1/SII: The number of boxes in horizontal axis (x) in the second step.
1/SIII: The number of boxes in horizontal axis (x) in the third step.

Fractal geometry has been a very useful method in measuring the complexity of organic structures (Bovill, 2000). Mandelbrot (1983) used this concept in his studies of irregular natural and artificial forms. Later, this methodology has been used in many other studies exploring complex compositions in architectural and urban scale. For instance, Bovill (1996) used this methodology to analyze the features of different buildings and urban patterns; Cooper et al. (2003, 2008) studied street skyline and vistas; Stamp (2002) also used this methodology in studying the skyline; Batty and Longley (1994) explored the urban borders (Toofan & Larkham, 2010).

Table 2.6 : The fractal dimension values of different components conducted in the city of Amasya (Bechhoefer & Bovill, 1994) (Table elaborated by the author).

Components	**Scale range**	**Box-counting dimension**
The mountain	100-50 meters	**1.63**
	50-25 meters	**1.67**
	25-12.5 meters	1.40
The site plan	50-25 meters	**1.63**
	25-12.5 meters	**1.70**
	12.5-6.25 meters	1.50
	6.25-3.13 meters	1.23
	3.13-1.56 meters	1.10
The housing elevation	6-3 meters	**1.67**
	3-1.5 meters	**1.67**
	1.5-0.75 meters	**1.70**
	0.75-0.38 meters	1.83

An interesting example of using fractal dimension to analyze different urban and natural patterns was conducted by Bovill and Bechhoefer (1994) in the city of Amasya. Using specifically the box counting method, they analyzed the pattern of a traditional housing complex, the site plan layout of the area, and the mountain in the background of the city. The study showed very interesting findings such as a high similarity between mountain ridge pattern and the composition of the elevation in the traditional housing.

The box counting method was applied in these three different components at different intervals as shown in the Table 2.6. It is evident that there are very close values of fractal dimension in mountain ridge and traditional housing. While street plan layout starts to decrease the fractal similarity at lower intervals. These analyses show clearly the power of traditional knowledge where builders are very careful to fit in the context and aware to create a harmonious environment integrating natural features with man-made structures (Bechhoefer & Bovill, 1994; Yüzer, 2001).

Bovill has done also many other important studies using the same method for architectural scale and even for some art works to understand their compositions in aspect of fractal dimension. For example, he shows some interesting results in analyzing the elevation of the Robie house designed by F. L. Wright, calculating the fractal dimension in various scales (Figure 2.10). The fractal analyses identify a richness of pattern in façade, perception of various details in different distances, and a kind of rule in composition of façade components where a good integration of smaller parts that form a whole is visible. Bovill conducted similar fractal analyses for other objects such as: The Unity Temple, the Villa Savoye, Willits house, Mondrian paintings and many other works in different context and forms (Figure 2.10).

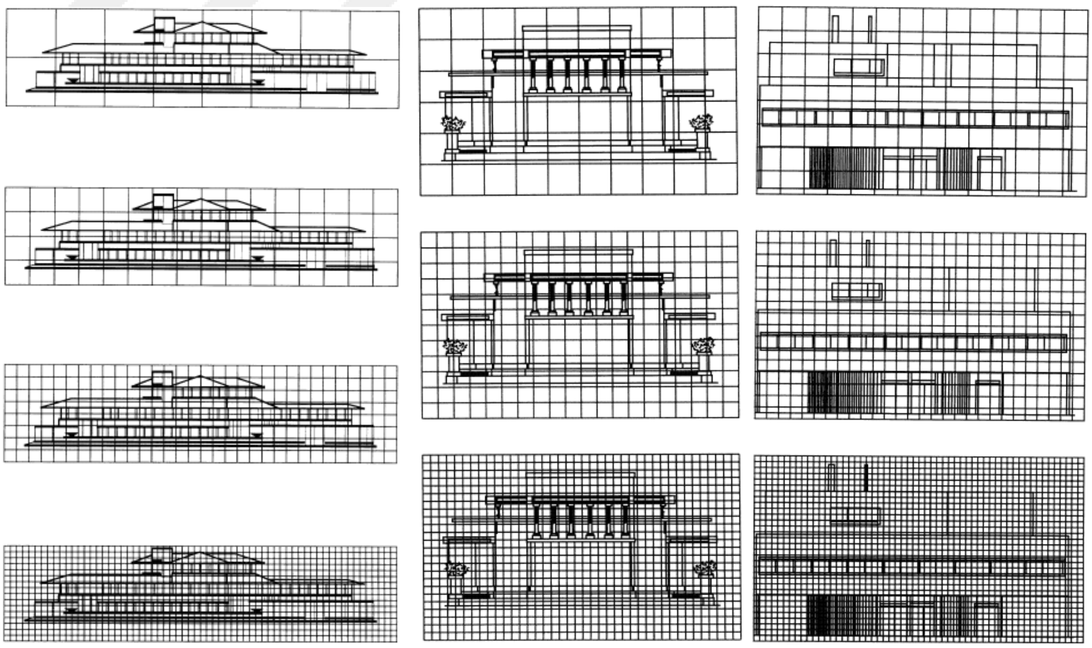


Figure 2.10 : Bovill`s fractal analyses of different architectural buildings, from right to left: Robie house, the Unity Temple and the Villa Savoye (Bovill, 1996).

As shown in previous section, fractal geometry has been a very helpful tool to analyze not only the complex natural forms but also many human-made structures in different scales, from cities to details of buildings. All these studies show the power of this new approach in geometry that somehow uncovers the hidden order and the rules in the complex forms and clarify the composition, and composition of smaller units which form an overall well working system, considered as disorder in conventional methodologies. Fractal geometry is one of the concepts used also in this study to understand the organization of a historic settlement by analyzing it in different scales and mediums, using specifically the box counting method.

3. THE CASE STUDY

3.1 Context and Background

Korça is a city positioned in the southeastern region of Albania and is a main center for the smaller municipalities around it. In the north it is connected with the cities of Pogradec, Elbasan and Tirana, in the south with Gjirokaster and in the east and southeast it has borders with North Macedonia and Greece respectively (Figure 3.1). The favorable geographical position has been an important factor in social, economic and cultural development of the city (LAMP, 2010) and its hinterland. Historically, Korça has been an important urban center for the region and major connection of other centers such Thessaloniki, Gjirokaster, Elbasan and Tirana.

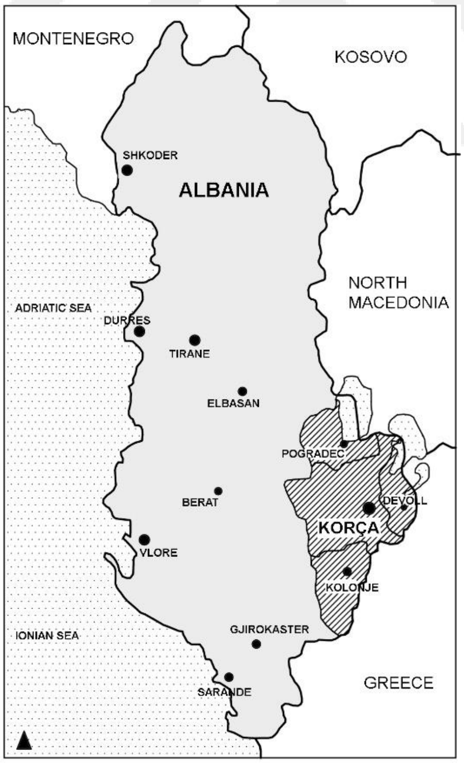


Figure 3.1 : The location of Korça region.

The territory around the city consist of a mountainous terrain with a lot of hills and mountains that covers most of the area. In-between this mountainous relief, there is a large basin where the city of Korça, other settlements, and a lot of agricultural lands are located (Figure 3.2). This flat area, which is around 850 m above the sea level, is surrounded by Morava mountains, Mali i Thate, hills of Grabovica, mountains of Gora, Voskopoja and Vithkuq and mountain of Qarri (Thomo, 1988; LAMP, 2010l; Zeka, 2012). The area of Korça has a continental Mediterranean climate and because of its hilly and mountainous relief there is a cold weather in winter and cool in summer. The settlements in the region of Korça are developed based on contextual conditions, taking into consideration the territorial, climatic and cultural factors. In this aspect, there are mainly three different typologies: flatland settlements (Korça, Bilisht etc.), hilly settlements (Mborje, Drenove etc.), and mountainous villages (Dardhe, Sinice, Vithkuq etc.) (LAMP, 2010).

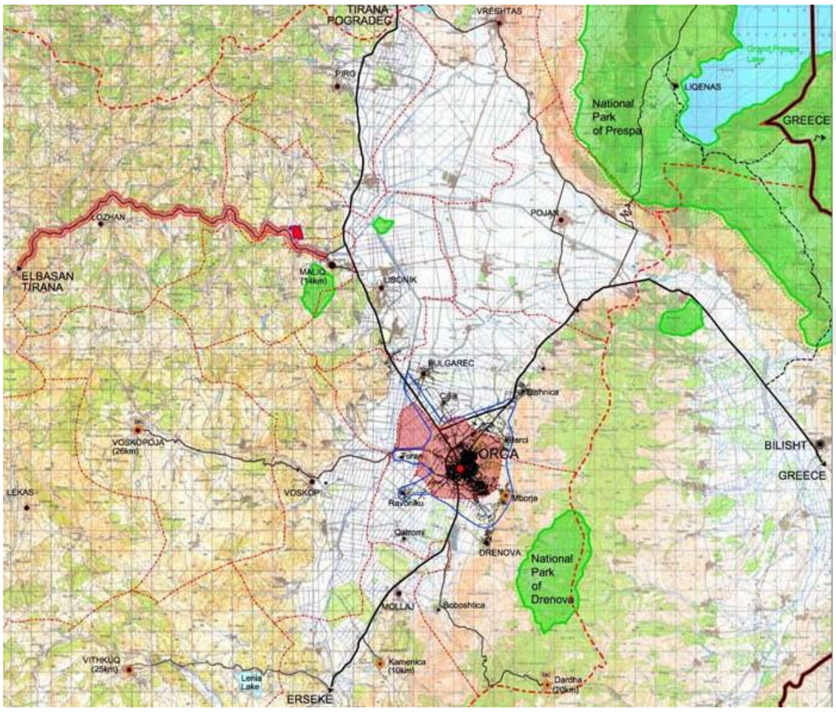


Figure 3.2 : The city of Korça located on a large basin (LAMP,2010).

Regarding demographic features, Korça is the biggest city in the zone with a population around 87,000 inhabitants followed by Pogradec as the second one.

3.1.1 Historical background

Korça is a city with a rich history including different periods which has influenced the social, economic, cultural structure as well the urban and architectural environment. Luckily, Korça has succeeded to protect and maintain a lot of its historical urban zones and buildings. Nowadays, it is easy to read the pattern and the layers of the old city, being able to understand and analyze some of its features.

Until the 15th century the region of Korça consists of a small castle and rural settlements spread in different locations based mainly on agricultural activities. The invasion by Ottoman empire brought some changes that would trigger the urbanization of the area. In this aspect, the end of the 15th century is an important turning point, especially after Iliaz Bey started the urban nucleus by bringing the bazaar in the village of Peshkopia and building here an 'imaret' a mosque and a school (Thomo, 1988; Zeka, 2012). Those developments were important steps for starting to establish an urban center that would later merge the small settlements into a compact town that contains important social, cultural and commercial activities for the whole region (Thomo, 1988; Zeka, 2012).

After these developments in the end of 15th century the city of Korça continued to grow in a typical ottoman style city, with the bazaar at the core area and the residential neighborhoods spread along organic narrow streets, surrounded by low rise and compact courtyard houses, walls, and gates. After the urban fabric got more consolidated in the following periods, the city of Korça was formed by a clear structure with three main districts: the Bazaar, Kasaba, and Varosh (Figure 3.5). The bazaar was a lively place functioning as an important social and economic hub, offering many services for the daily life. Small handcraft workshops, textile shops, culinary products, domestic animal bazaar, hans, and other activities spread along cobblestone streets forms a rich spatial, social and psychological experience. Kasaba, the neighborhood where Muslim community lived, was organized around the bazaar with the mosque and other social facilities in the central part. Varosh, the neighborhood of Christian community was positioned on the eastern part organized around the church. The two neighborhoods were divided by a small water stream coming from the village of Mborje (Thomo, 1988; Zeka ,2012).

The urban fabric represents a typical medieval ottoman town. All the main commercial and social functions are concentrated in the bazaar area which has a more compact and organized layout. The residential zones are formed in the neighborhood concept (*mahalle*) based on religious or kinship structures. In the center of the neighborhood there is the religious institution and some small services for the inhabitants. Although the city has a horizontal development, it has a compact and concentrated structure surrounded mainly by agricultural lands. The urban morphology consists of an organic pattern structured within curvilinear streets, small plazas and irregular housing plots. The interesting narrow streets defined by walls, gates, courtyards and building facades offer dynamic perspectives and surprising spaces. Almost every house has its own courtyard that is an important component for daily activity of the family. The introverted housing units strengthen the concept of privacy which is an important aspect in ottoman cities. In overall, the settlement provides a human scale environment, has a dynamic morphology, offers interesting streetscape perspectives, built with local materials in an incremental process (Figure 3.3), flexible for addition of new structures and adaptation for new conditions. Fortunately, Korça has succeeded to maintain and protect these historical neighborhoods, although they have changed at a particular level, and this is a good opportunity to analyze their features and learn from this traditional knowledge. One of these old neighborhoods is selected as a study area for further analyses in this thesis.

Figure 3.3 : Images from the historic neighborhood in Korça, in the left V. Mio painting.

Korça had a gradual, normal growth until the 19th century when it entered a new phase of urban development and some important changes in the socio-economic structure of the city. By that time, Korça had been already an important social, economic and cultural center for the whole region but especially after the mid of the 19th century the changes are more visible. The city attracted a considerable migration form the rural areas and the population reached the number of 10.000 inhabitants in this period. Changes in economic, social and cultural dimension, developments in building technology and materials, influences of western culture and architecture were some important factors affecting the transformation of urban morphology. Thomo (1988), defines two main phases in this process of transformation and a kind of modernization. In the first period, the city went through an adaptation process of accommodating the new conditions. There were some interventions on existing typologies regarding the organization of inner spaces, façade treatment, and introduction of some new architectural and decorative elements. Besides that, there is an intensification of built-up areas as a result of placing additional structures in the empty spaces of the courtyards which created more compact and dense settlements (Thomo, 1988; Zeka, 2012).

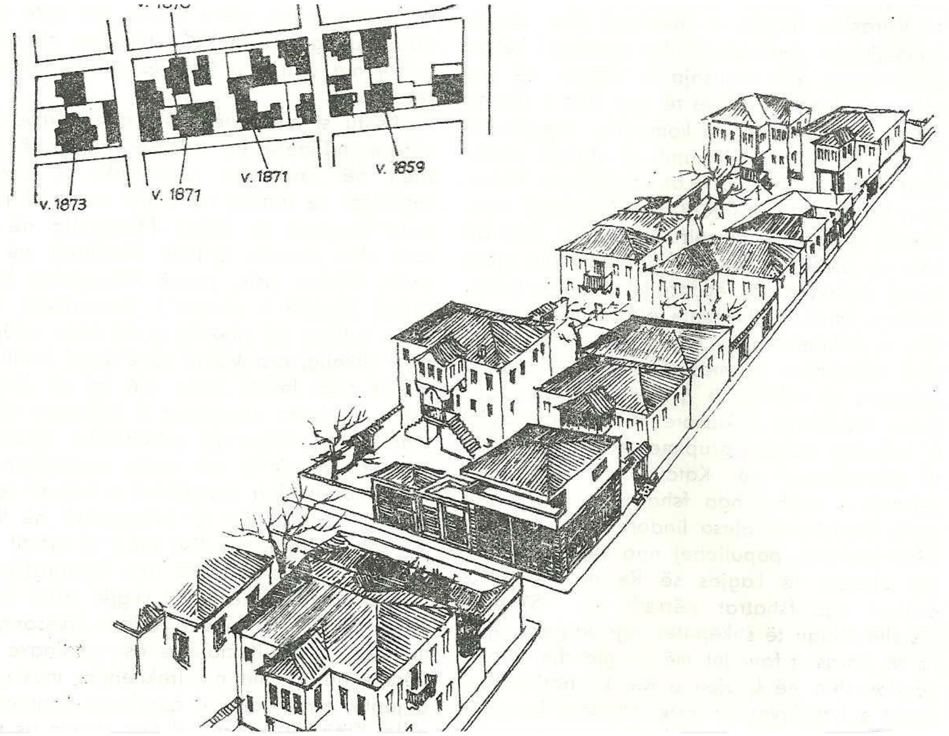


Figure 3.4 : Grid layout in new developed areas in Korça (Thomo, 1988).

In the second stage, the changes in urban morphology were more drastic in the aspect of the layouts and typologies that were emerging. During this phase there is a new urban development in the northern and north-eastern parts of the existing city, as a result of the population growth. These new areas were developed in a quite different way comparing to the old organic urban fabric. The housing blocks and street network were structured within a very rigid grid layout (Figure 3.4). These new residential zones were developed along a wide boulevard (nowadays Republika Boulevard) which was opened during this period. This new boulevard represents a modernization process highlighting the monumentality and ceremonial dimension of the urban space by challenging the humble and human scale character of the old city. The modernization process was also reflected in the typology of buildings by bringing new architectural styles, larger units, different relationship with the street and organization within the parcels. The new typologies were more monumental, larger in size, and ornamented with many decorative elements. The courtyard is larger, with decorative planting and surrounded by transparent fencing (Thomo, 1988). So, the old introverted typology was replaced by an extraverted one which wants to exhibit itself to the public space. Especially this approach is very evident along the main boulevard but also present in the inner parts of the neighborhoods.

The transformation process affected also the structure and organization of commercial activities social facilities. In this period, the bazaar was renovated by using new building materials and techniques. It went also through a re-organization of sectors operating there. Despite these transformations, the bazaar was not capable to satisfy the needs of new economic and social situation. As e result, new commercial activities and social facilities started to locate along the main roads triggering a decentralization process of economic activity (Thomo, 1988; Zeka, 2012).

The modernization process of the city continued also after the independence of Albania from the Ottoman Empire (1912). The period between two World Wars (1914-1944) was not a very stable for Albania, having different invasions, interferences and influences from different countries, political actors and cultures. However, during this era, some significant developments happened in Albania regarding improvements in infrastructure, urbanization and industrialization in different cities. This is a period, where Albania is very much dependent politically, economically and culturally to western countries. Especially the western influence (particularly Italy) in the field of architecture and planning is very visible in the projects that were drafted ore implemented during this period (Miho, 2003). In this time, the city of Korça continued to grow in the north direction based in similar grid structure. The new areas consist of individual courtyard houses representing the architectural style and techniques of the time. Here we see also the influences of western architecture in some public buildings or villas that were designed in a kind of neoclassical style. There is something worthy to be noted regarding the transformation of the city that happened between the mid-19th and mid- 20th century. Firstly, although the process of modernization brought new building typologies and urban fabric, it was in coherence and harmony with traditional patterns, at least regarding the scale. Secondly, an important aspect is that it influenced some changes of existing fabric, but these were in small scale and did not assimilated the identity of the traditional fabric. Most of the new developments were happening in vacant areas in the north part of the city. So, in some aspects it was a positive approach that brought new things without demolishing the existing heritage.

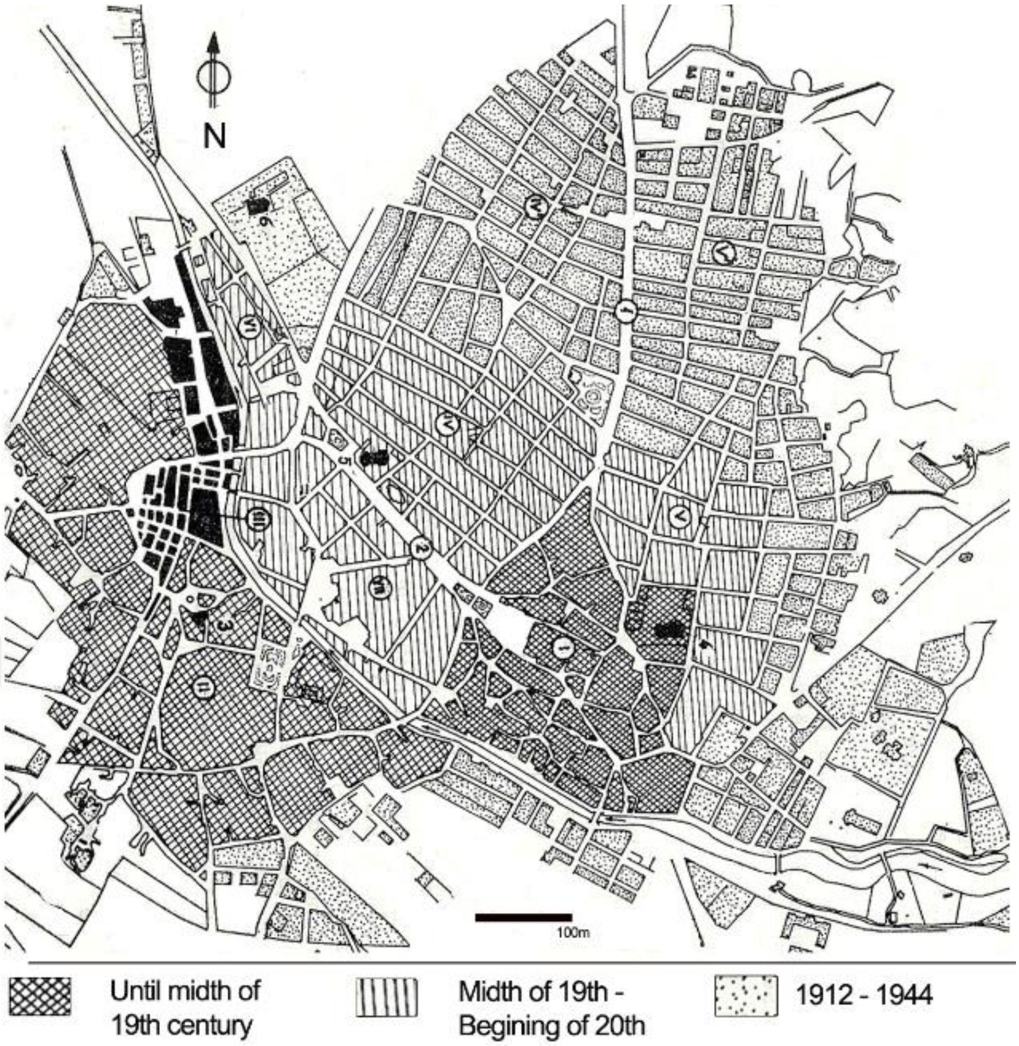


Figure 3.5 : The urban development of Korça until 1944 (Thomo, 1988).

The end of the second World War in 1944 would be an important turning point for Albania, followed by an era of drastic changes and the establishment of a dictatorial regime that would last for around 45 years. This new regime, referred as socialist or communist period, built a new system that changed radically the political, economic and social structure of Albania, and had a huge impact on the transformation of spatial structure and the organization of cities. Urban and interurban infrastructure, industrial complexes in peripheries, many collective apartments, new institutions and public facilities were some of the common developments in most of the cities, especially bigger ones. Cities were developed under a total central control and planning policies. The modern planning concept combined with communist ideology and the power of a totalitarian regime found ground in Albanian cities and produced a totally new urban morphology and architecture.

Korça went through some similar processes in its development during communist period. The city expanded a lot by the construction of apartment blocks and some industrial plants toward north, west and south direction (Figure 3.6). Most of the urban development was in these new areas but there is also an intervention on existing urban fabric. This intervention was mainly in the central zone by widening some of the main roads and constructing new building along them to accommodate new functions for administrative, service, commercial or cultural activities. These interventions on the center and the expansion towards the periphery was a drastic immediate change, formed by simplistic layouts and pure shape architecture by contrasting strongly the traditional urban fabric. However, it is important that the most part of historic neighborhoods and the bazaar was not demolished, as it happened in the case of Tirana. After the collapse of Communist regime in the beginning of 1990s, Albania would face another drastic change by establishing a multi-party political system and a kind of liberal economy. Passing from a total isolated authoritarian regime to an environment of free market, combined with the institutional deficiencies and many other complex factors, provided the ground for big transformations in most of cities in Albania. In these conditions, many cites attracted huge flows of migration from rural zones, resulting in high urbanization and considerable changes of their previous structures. Many zones were transformed by the construction of high-rise buildings within the urban boundary and in the periphery. Besides that, a lot of informal settlements emerged in the periphery of the cities. Furthermore, most of old structures were adapted to new conditions by making physical and functional transformation in existing buildings. In some cities, especially Tirana, this wave of transformations cleared out or damaged a lot the traditional urban fabric. The phenomenon of migration and similar urban transformation happened also in the city of Korça (LAMP, 2010; Zeka, 2012). However, it was at limited level and fortunately the historic neighborhoods were not affected too much from this process. Of course, many spaces and buildings were transformed and adapted to new economic and social circumstances, but the city managed to maintain its historical identity.

To conclude, Korça is a city that contain different urban patterns which represent various historical background and contexts. Simply, four main phases and their respective reflection on urban morphology can be identified: The ottoman city, the period between two World Wars, the Communist era and the Pos-communist period

(Figure 3.6). These typologies represent very different and distinct characteristics but meanwhile altogether they form a rich and dynamic urban fabric.

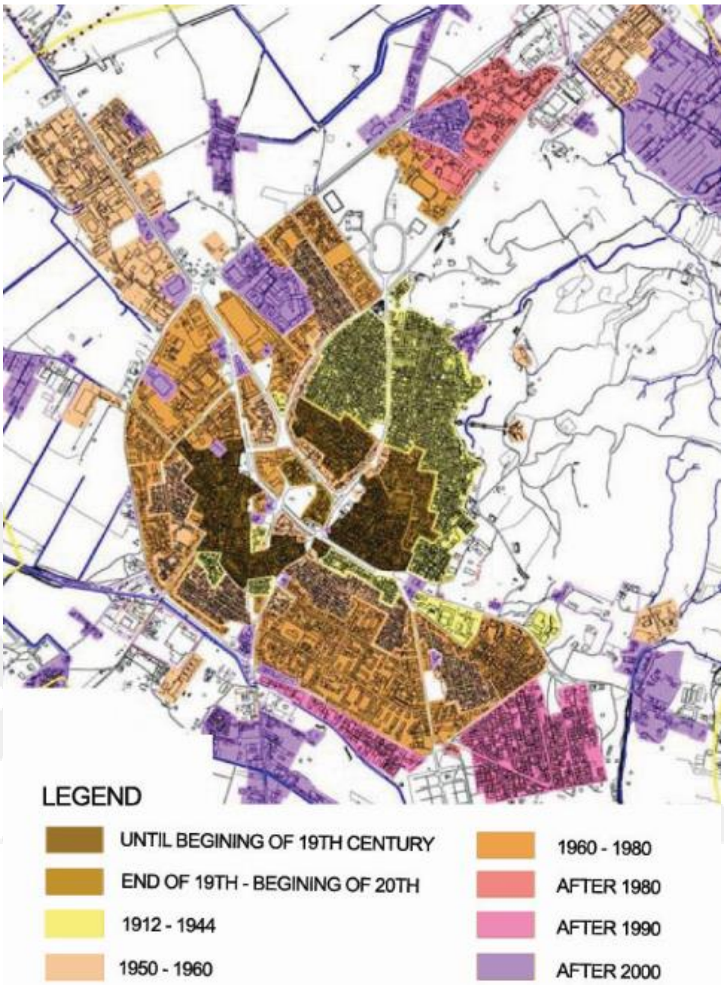


Figure 3.6 : The urban development in different periods (LAMP,2010).

3.2 Study Area Analyses

The concept of this study is related to the critique done to the modern planning principles that are based on a top-down approach, by not considering too much the complexity and dynamic relationships of an urban environment. It supports the idea that traditional knowledge implemented in vernacular urbanism is much more successful in aspect of considering the complexity of urban system and establishing an appropriate set of relationship which work well and create sustainable cities. The main objective is to analyze if the self-organized settlements, are built in a process that possess many important features which create rich, dynamic, flexible and living urban habitat, attributes that are neglected in the modern planning philosophy. Another aim of this work is to search for ways of learning from the knowledge represented in vernacular settlements and try to find tools of integrating their principles in contemporary urbanism issues. In order to reach its objectives, the study raises the following research questions:

- Do the vernacular, self-organized cities have features that provide sustainable and living urban environment?
- What are the features or principles that generate sustainable neighborhoods?
- Is there any order in the structure of these organic, irregular settlements?
- Can some of the attributes of these urban morphology measured?
- What can be some tools that help to integrate these principles in the future processes of shaping our cities?

To answer these research questions, the study uses a hybrid methodology which is implemented in the analyses of a historic neighborhood in the city of Korça as the case study. This methodology consists of pattern language analyses, fractal dimension analyses, and geometrical measurements of physical morphological components. Firstly, the study uses the pattern language principles, developed by Christopher Alexander, to identify if the selected study area possesses these features that make a neighborhood sustainable. Secondly, it applies the method of measuring the fractal dimension of the settlement by implementing it in different scales and morphological units such as streets, blocks, plots and buildings. This method is helpful to find out if there is a coherence and meaningful relationship among different components of the settlement, that represents an order of irregular organic settlement. In the next step, the study uses a method to extract the spatial features of the settlement by making a lot of formal measurements. Finally, it tries to develop a synthesis which intend to develop a frame for structuring the extracted spatial principles for the use of any possible future model of urban development.

As mention previously, the unit of analyses is a historic zone in the city of Korça (Figure 3.7). It is located immediately in the southern part of the city center and is one of the oldest neighborhoods in the city. It is bordered by two wide streets in the north-west and south-west sides, opened at later times. The areas along these streets have gone through bigger morphological and functional transformations, while in the inner parts these changes are at a lower level, maintaining the historical character of the urban fabric. The neighborhood is organized in an organic pattern of streets and plots. It consists mainly of low-rise courtyard houses, forming a compact urban fabric that covers the area which has a slight lope towards the east direction. The morphological elements provide a dynamic pattern and a rich spatial experience with narrow curvilinear streets, fragmented by small plazas and surrounded by small compact housing units.

Figure 3.7 : The study area, orthophoto (ASIG 2015).

The main reason for selecting this zone as a study area is because it represents a typical self-organized settlement, formed in long timeline by small local actions within a bottom-up process. An important fact is that this neighborhood has achieved to maintain and protect its original urban structure, although it has gone through many transformations and adaptations. Mainly, the organic street pattern and the morphological character of housing blocks at larger scale has not changed too much. But, in smaller scale, at building level, we see many transformations such as new buildings, extensions, additions, small structures or other adaptations in spatial components. However, this is still a generative process coming from individual actions, it is not an imposing planned process. The neighborhood is an example that represents its historic identity and a richness of patterns developed by people themselves, not by a 'planner' or any other central authority. All these features make it an appropriate case for understanding the features of self-organized cities.

3.2.1 Pattern language analyses

"The people can shape buildings for themselves, and have done it for centuries, by using languages I call pattern languages. A pattern language gives each person who uses it the power to create an infinite variety of new and unique buildings, just as his ordinary language gives him the power to create an infinite variety of sentences." (Alexander, 1979, p. xi).

The concept of pattern language developed by Alexander and his colleagues has a very comprehensive approach including many features extracted through long observations on urban habitat, especially traditional settlements. A main attribute of pattern language theory is that the principles or patterns are considered as parts of a larger system, strongly related to each other, forming an organized complexity. Another important feature is that they have a generic character which means that they can be used as tools for developing new designs. This study uses the concept of pattern language for analytical purposes in an existing settlement. The aim is to identify which patterns are present in the study area and how do they form a larger whole. Among 50 patterns (principles) observed in the zone, twenty-one of them are explained in detail through morphological analyses of the study area, dealing with different scales and aspects (Table 3.1). The pattern analyses in the study zone are represented through abstracted diagrams elaborated on materials and data gathered from many site observations.

Table 3.1 : Pattern language principles analyzed in the study area (Alexander, Ishikawa, & Silverstein, 1977).

no	Principles	no	Principles
1	Identifiable neighborhood	12	Row houses
2	Four-story limit	13	Looped local roads
3	Sacred sites	14	T-junctions
4	Access to water	15	Green Streets
5	Life cycle	16	Network of Paths and cars
6	Activity nodes	17	Children in the city
7	Promenade	18	Quiet back
8	Shopping street	19	Small public squares
9	Household mix	20	Connected play
10	Degrees of publicness	21	Public outdoor room
11	House cluster		

3.2.1.1 Identifiable neighborhood

The neighborhood concept has been a crucial organization unit in vernacular settlements, not just in spatial dimension but also regarding sociological and psychological aspects. Alexander emphasizes the importance of a well-defined settlement unit where people feel the sense of belonging (Alexander, Ishikawa, & Silverstein, 1977). Furthermore, he suggests also parameters that are related with distances, unit area, number of population, and ways of community organization (Alexander, Ishikawa, & Silverstein, 1977).

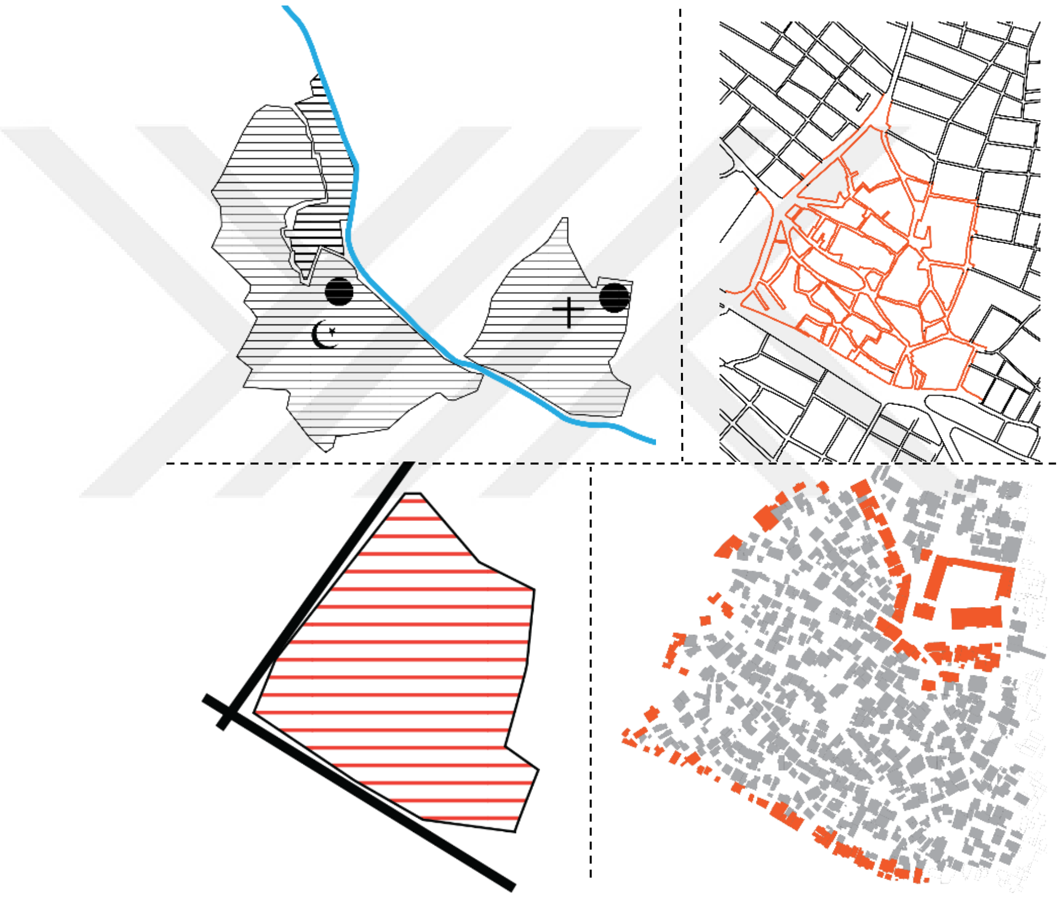


Figure 3.8 : Features forming an identifiable neighborhood in Korça.

The organization of the urban structure based on neighborhood concept has been a determinant factor in the urban development of Korça. In its early development process, we see three identifiable units; the Bazaar, the Kasaba and the Varosh. The two residential neighborhoods are very well defined based mainly on religious differences, Kasaba is the Muslim neighborhood and Varosh is the Christian neighborhood (Thomo, 1989). The Muslim neighborhood is organized around the mosque and ‘imaret’ while the Christian community has the church in the center. Both neighborhoods reflect respective characteristics regarding their spatial and social organization. Through time the strong division and the features identifying different neighborhoods have been fading. However, Varosh neighborhood, which correspond – approximately - to the boundary of the study area, has managed to keep many features that still make it an identifiable neighborhood (Figure 3.8). Firstly, the physical urban structure, consisting of organic pattern of streets and plots, is very easily differentiated from all the surrounding urban fabric, which is structured in a grid layout. Secondly, the neighborhood is identified strongly by boundaries of two main streets and differentiations of functions in the ground floor in the peripheral building. Finally, the religious functions and some other cultural and commercial activities located around a small plaza form a strong center and activity node for the neighborhood. In addition, the neighborhood is framed within some appropriate walking distances, coherent with the principles given by Alexander.

3.2.1.2 Four-story limit

The human dimension of any settlement is related directly with the height of the buildings forming it. The problems of high-rise building crate in this aspect are widely discussed in the field of planning and architecture. Alexander criticizes strongly the approach of constructing high rise buildings in modern cities by supporting his opinion with many scientific researches in the field of medicine, psychology, sociology and economy. According to him, high-rise buildings, particularly in residential zones, create serious social, mental and physical problems for human, especially for children and old people (Alexander, Ishikawa, & Silverstein, 1977). They have problematic issues because they break the relationship between human and soil and separate people from daily activity happening in the street (Alexander, Ishikawa, & Silverstein, 1977). Further they are not efficient in environmental and economic aspects because high-rise development prevents the buildings to have an appropriate amount of sunlight, air and wind, and they have higher maintaining cost (Alexander, Ishikawa, & Silverstein, 1977). In this context he proposes an urban fabric that do not exceed four floors for residential areas, arguing that building until that height create a better urban habitat in many dimensions (Alexander, Ishikawa, & Silverstein, 1977). In this point of view, the study area analyses show that houses there are built in total accordance to this principle, not exceeding four floors (Figure 3.9). Most of the houses are one or two floors, forming a low-rise but compact urban space in the horizontal direction. This type of organization has many advantages since they provide better environmental conditions and create a human-scale environment, allowing for more social interaction and connection with nature.

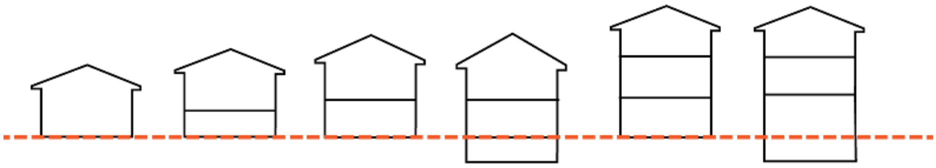


Figure 3.9 : Variations of building heights in the study area, not exceeding 4 floors.

3.2.1.3 Sacred sites

Another interesting pattern identified by Alexander as important, is the presence of sacred places. He sees sacred sites as significant elements that maintain the roots of a community and strengthen the connections with the past (Alexander, Ishikawa, & Silverstein, 1977). The sacred places, no matter if they are natural sites or man-made spaces or structures, should be protected and integrated with other spatial elements that intensify the experience in there (Alexander, Ishikawa, & Silverstein, 1977). The influence of this pattern can also be seen in the studied neighborhood, although not at a high level due to the secular approach that the modern life imposes. However, we can say that the church complex, located near the neighborhood plaza (Figure 3.10), surrounded by other social and commercial facilities serves as a landmark that somehow makes a connection with the past and increase the feel of belonging to this community.

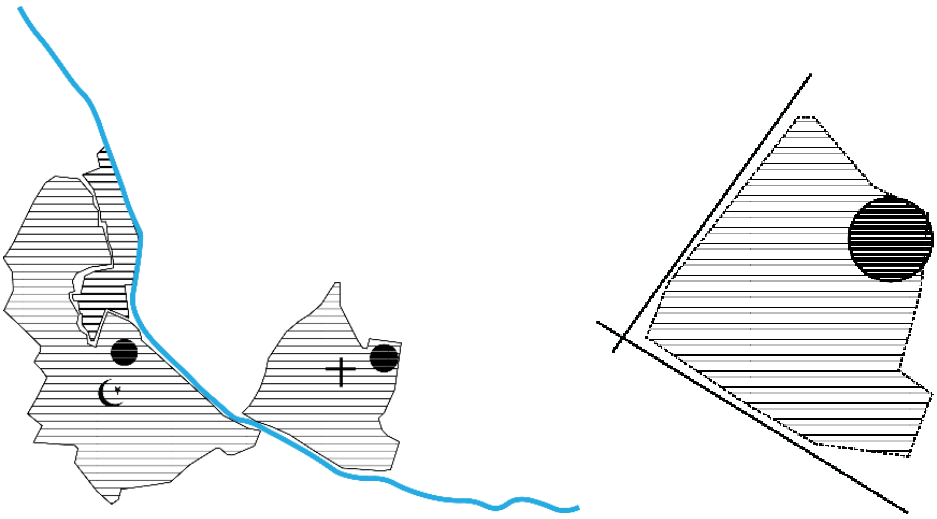


Figure 3.10 : Sacred sites in the neighborhoods.

3.2.1.4 Access to water

The pattern 'access to water' refers to the importance of water features such as rivers, lakes and seashore in urban habitat. In the case of Korça, there is no large water body at this significance, and we cannot speak about benefits of this pattern as explained by Alexander. However, other types of water features have been components of the social life in the neighborhoods. For example, in previous times, a water stream coming from the village of Mborje was passing in between two neighborhoods, acting as an element of boundary. Furthermore, public wells (Figure 3.11) and drinking water fountains, located in small plazas or street intersections, usually associated with a large tree and sitting elements, were important meeting and socializing spots for local inhabitants. Of course, nowadays this pattern is not functioning anymore in this dimension due to changes in infrastructural services and lifestyle.

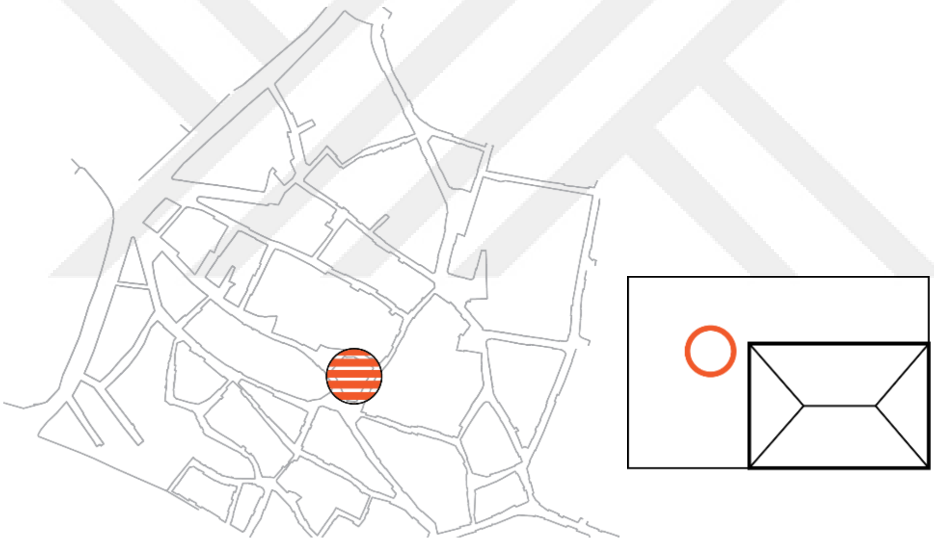


Figure 3.11 : The pattern 'access to water'.

3.2.1.5 Life cycle

The presence of different age groups is fundamental for having a diverse community and living neighborhood. It is important to have a neighborhood that provides a balanced lifecycle, so people from different ages can benefit from each other, building a healthier communal life. In this way, the neighborhood can serve as a broad stage of rich human experiences. It is significant also to provide spaces and facilities that encourage diverse activity for different age groups from small children to very old people. Unfortunately, the zoning concept of modern planning has contributed too much in decreasing this quality in urban environment, resulting in different types of segregation (Alexander, Ishikawa, & Silverstein, 1977).

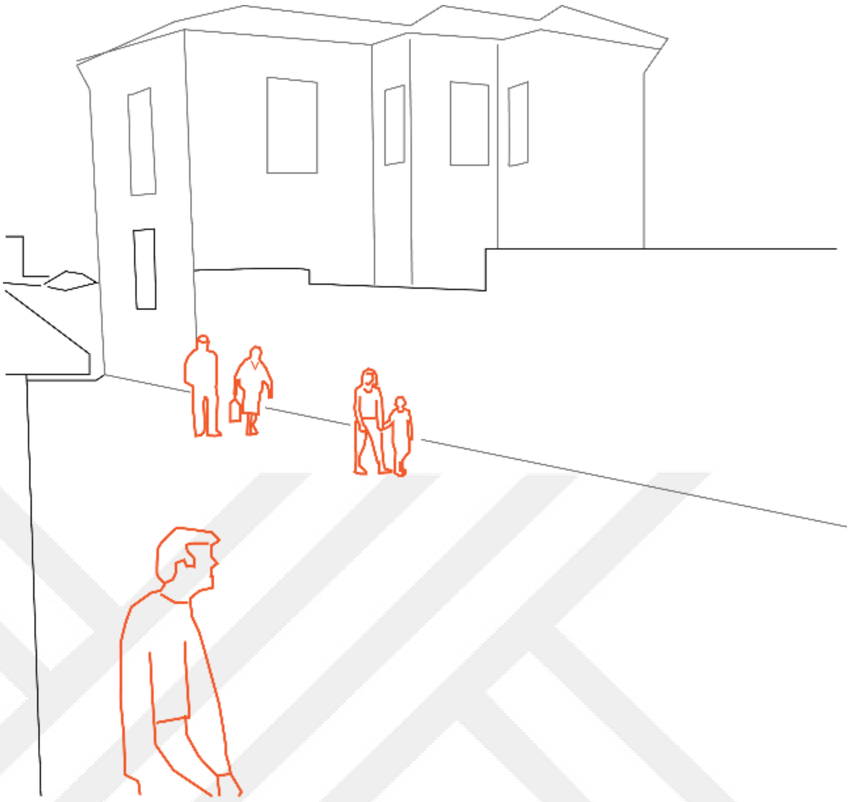


Figure 3.12 : Illustration showing the presence of different age groups in the neighborhood.

Observations in the study area have shown that there is a particular diversity of ages living in this neighborhood. As shown in the diagram below (Figure 3.12), during a walk in the neighborhood you can see people of different ages, including children and old people. However, it is a fact that Korça has lost a considerable number of its young population due to the huge immigration to Greece and migration to bigger cities after 1990s. Although, this study does not make a statistical investigation in the neighborhood, observations from site visits show that there is a lower rate of young generations. Furthermore, even though the urban space in the neighborhood is very suitable for pedestrian activity there is a lack of recreational facilities that can encourage the use of public space by different ages.

3.2.1.6 Activity nodes

The concentration of various activities in particular zones is seen by Alexander as an important principle in the organization of urban space. He suggests that various facilities that support each other should be gathered at specific points to create an integrated node of social interaction and living public space (Alexander, Ishikawa, & Silverstein, 1977). According to him, these activities should be allocated around small squares, at accessible distances, connected well through pedestrian axes, and equipped with recreational components (Alexander, Ishikawa, & Silverstein, 1977). Considering the study area in this aspect, it can be said that this pattern is realized to some extent.

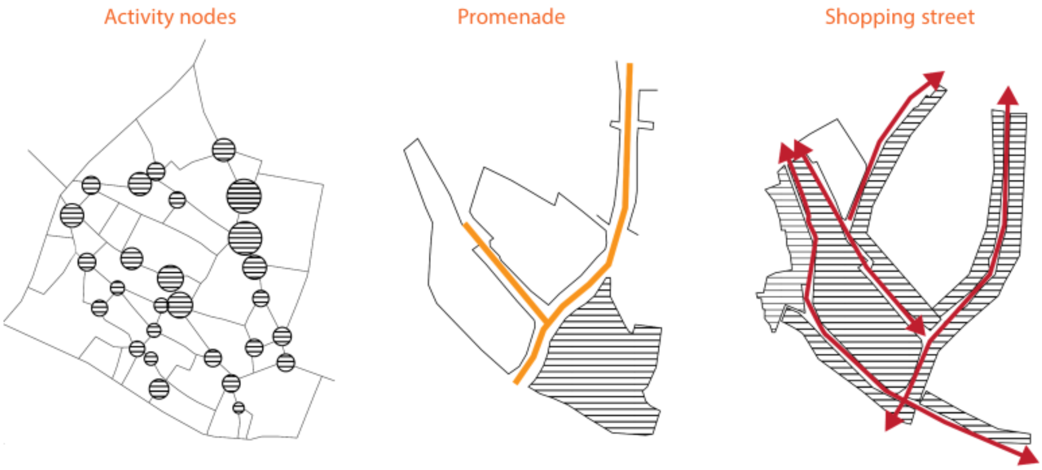


Figure 3.13 : Diagrams showing the patterns: 'activity nodes', 'promenade', and 'shopping street' in the study area.

There is a concentration of social and commercial activities in the neighborhoods' main plaza, which is easily accessible from the other parts. Furthermore, the pedestrian character of all the streets in the neighborhood, characterized by a very low vehicle traffic and a human-scale environment, make it easy to access this activity node. The pattern of the urban fabric, including many small plazas connected with an organic path network, has bigger potential for increasing the number of activity nodes within the neighborhood (Figure 3.13). In most of the cases these small plazas are defined just by residential functions and do not have recreational infrastructure, and this decrease their potential to be activity nodes.

3.2.1.7 Promenade

The promenade is seen as fundamental component for the socializing of the community and as a connection of various activity nodes. This social infrastructural element in linear form should be well-defined by diverse social activities, prioritize pedestrian movement, be easily accessible within walking distances, and have a starting and destination point (Alexander, Ishikawa, & Silverstein, 1977). The study area is very close to two main promenades of the city of Korça, the 'pedonale' and ‘bulevardi Republika’ (Figure 3.13). These two urban zones, are among the most used public spaces in the city scale, offering many social, commercial and public facilities. The promenades are linear elements connecting three main public spaces, the cathedral plaza, the theatre plaza and the large park in the north-eastern part. The ‘pedonale’ is total pedestrian zone surrounded by cafeterias, cultural activities (library, art gallery, museums), municipal services and other facilities. ‘Bulevrdi Republika’ is a longer axe connecting the cathedral plaza with the park, open to vehicle traffic, having wide sidewalks for pedestrians, and an active street edge with many social, recreational, cultural and commercial functions. Both the areas are in accordance to most of the principles described by Alexander. Although the study area does not have a strong promenade within the boundaries of the neighborhood, it is very close (five minutes walking distance) to these main promenades.

3.2.1.8 Shopping street

Having areas that offer retail services and are full of human activity is seen as an important issue by Alexander. He proposes that the shopping streets should be located near main vehicular traffic and parking areas, but the inner zones should be pedestrian friendly and not disturbed by traffic (Alexander, Ishikawa, & Silverstein, 1977). Vehicular traffic can be allocated in the surrounding or may intersect at particular frequencies with the pedestrian shopping street, while parking plot can be positioned in the back parts of the commercial zone. In this way a good integration of multi-modal accessibility can be provided (Alexander, Ishikawa, & Silverstein, 1977) As seen in Figure 3.13, the study area is located close to the city center, which is a zone full of shopping streets, offering a diversity of retail activities, mainly in the ground floor. As explained in the ‘promenade’ pattern, ‘pedonale’ and ‘bulevardi Republika’ are two linear streets that integrate in a good way both pedestrian and vehicular circulation, offering many commercial functions on both sides. Parking areas are provided in adjacent streets or along the Republika boulevard. Among these two streets, the commercial activity is extended also in some other arteries such as Bulevardi Fan Noli, Bulevardi Gjergj Kastrioti and many other retail streets, where the quality of pedestrian comfort is not at the same level due to higher vehicular traffic and many parking areas, not integrated well.

3.2.1.9 Household mix

The pattern of household mix is very related with the principle 'life cycle' in the neighborhood. It is significant that a residential zone includes different housing typologies to provide a mix of households, such as families, young couples, large families etc. The segregation of housing types, based on zoning concept is very problematic creating homogenous zones that do not offer social diversity (Alexander, Ishikawa, & Silverstein, 1977). As explained in the pattern of 'life cycle', observations in the study area show that there is a particular diversity of age groups. There is also differentiation of house types, regarding their spatial composition and size. However, no matter what the size of the house is, the main typology is for single family homes, creating a kind of homogenous structure. Furthermore, the changes in the lifestyle - very different from traditional families - and the phenomenon of emigration has decreased the potential of having a dense and diverse population in the neighborhood. There are many large houses occupied just by old couples or other houses that are not occupied at all.

3.2.1.10 Degrees of publicness

The balance between publicness and privacy is very fundamental to fulfill the psychological and social needs of people. The spatial organization in any neighborhood should provide different qualities of space regarding publicness or privacy. According to Alexander, there is a need of distinction between three kind of residential spaces, the ones that are quite and more private, the ones that are more exposed to crowded streets, and the ones in between these two (Alexander, Ishikawa, & Silverstein, 1977). The nuances that emerge in this wide gradient are also very important to create a rich and diverse experience. The neighborhood in the study area has been developed in a way that offers different degrees of publicness by providing a wide variety of spaces, from the most private one to totally public zones. For example, the neighborhood is laid out in a structure that includes many open spaces or street intersections connected through a dense network of paths. These small plazas are nodes of activity and the zones located near them are much more exposed to the public life (Figure 3.14). The allocation of other commercial or social functions near these plazas, especially the main square, contributes in increasing the publicness in these areas.

Figure 3.14 : Degrees of publicness.

There are also many other factors that contribute to create e very rich pattern of spaces in the gradient of privacy and publicness. For instance, there is a hierarchy of open spaces form semi-private to most public ones. This piecemeal growth starts from the individual courtyard - which is the gathering space for the family - and continues with an increasing level of publicness passing in different spaces such as: dead-end streets, small pockets, small district plaza and ending in the main plaza, which is the largest public space in the neighborhood (Figure 3.15).

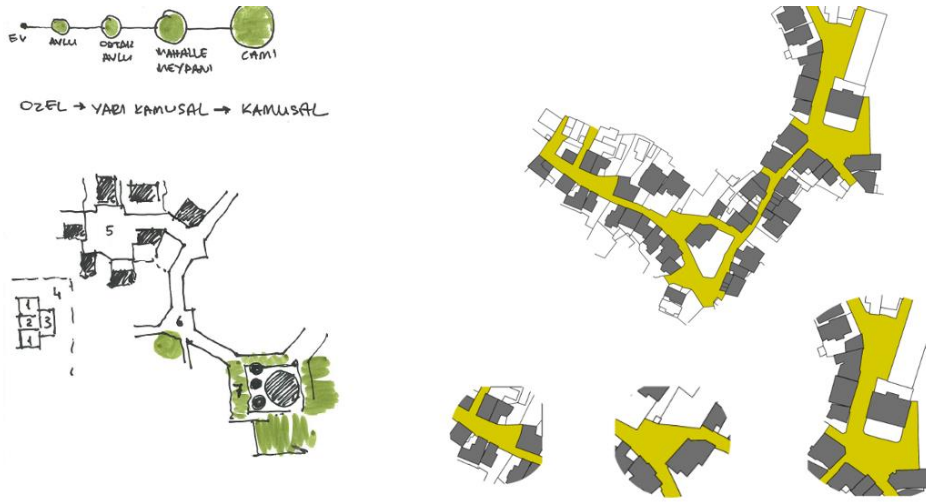


Figure 3.15 : Degrees of privacy/publicness through the hierarchy of open spaces.

Regarding the hosing layouts, there is a very rich pattern organizing different types of relationships between the privacy and publicness (Figure 3.16). One of them is the shifting in building orientations which provides different distances from different parts of the houses, increasing the level of privacy. Another component that arranges the level of privacy is the division of the street space from the courtyard with solid walls or transparent fences. Some houses are surrounded by walls, creating more private courtyard space, while some others offer visual access to their courtyards through the transparent fences. The position of the building in relation to the street is another factor creating different degrees of privacy/publicness.

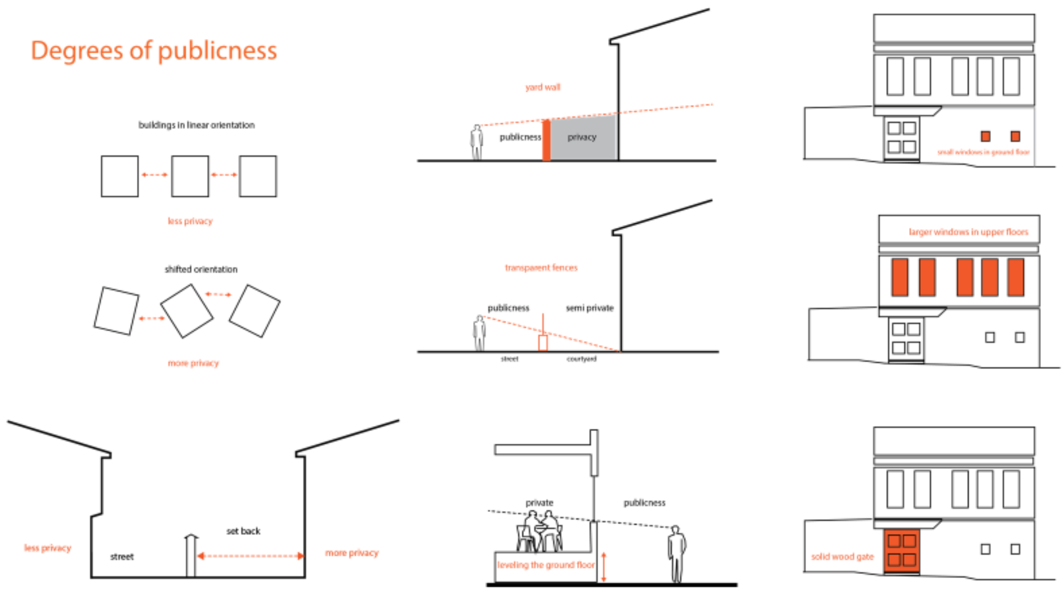


Figure 3.16 : Degrees of publicness in housing layouts.

The houses that set back from the street have a higher degree of privacy in the indoor areas. While the ones that are located directly on the street edge are more exposed to the public activity. But there are also some arrangements that provide different level of privacy for these houses too. Some of them are oriented introvertly, facing the street with their back or side façade. Leveling the ground floor to decrease the visual access from the street is another typology of privacy. Finally, façade design of buildings facing the street considers the issue of privacy and publicness. In many cases, the ground floor that is in the street level has non-transparent wood gates or doors and very small windows, while the upper floors are more transparent having larger and higher number of windows (see Figure 3.16). All these patterns offer to the inhabitants a variety of experiences such as: quite private spaces, small gathering spots or larger common areas where they can have an intense interaction with their community.

3.2.1.11 House cluster

Clustering is another principle related to the need of socializing and being part of a larger whole in any settlement. Alexander claims that this is crucial pattern that make people feel more comfortable in their neighborhood (Alexander, Ishikawa, & Silverstein, 1977). He suggests that a group of houses should be clustered around a common area, which is managed by the people living there, to create an interaction point for the neighbors (Alexander, Ishikawa, & Silverstein, 1977). The study area has an urban fabric that is formed by many small clusters, creating identifiable sub-groups of districts. These clusters are organized around different typologies of common land, as illustrated in the Figure 3.17.

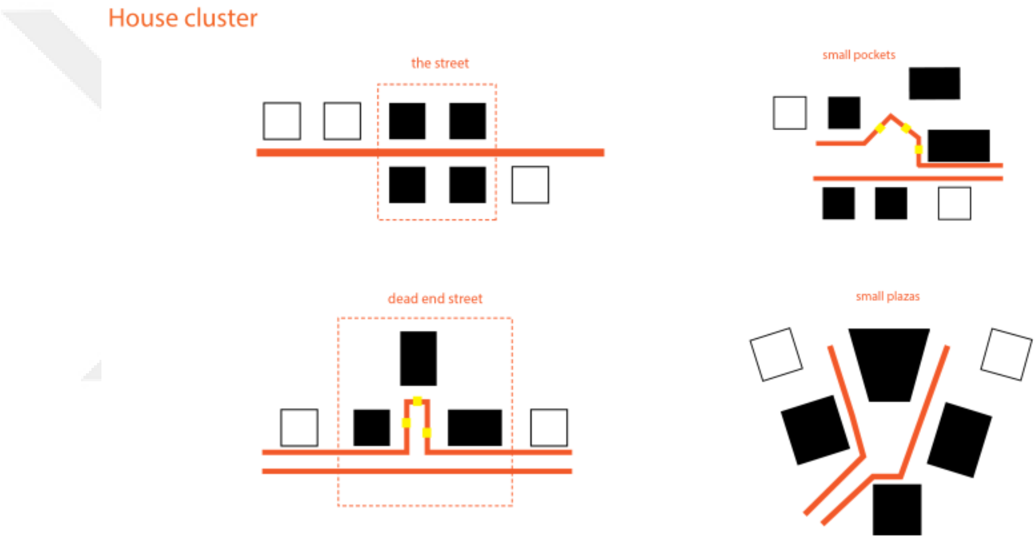


Figure 3.17 : Different house cluster typologies in the study area.

Firstly, the street itself has a pedestrian friendly character that can act as a common area for interaction. Its human scale features in aspect of form, size, length etc. are very appropriate to create small clusters for close neighborhoods. Another component is the small pocket, formed by the widening of the street and repeated very frequently in the neighborhood, that creates some interesting spots for interacting with your neighbors. The dead-end street is also a typical arrangement, that form an intimate, yet common area for the houses or courtyards that are opened to this small path. Finally, the small plazas located in main street intersections, especially when they have non-residential functions around them, provide very useful spaces for community interaction and clustering of activity.

3.2.1.12 Row houses

The compactness of urban fabric is essential to create a well-defined space and a strong interaction among people. The detached layouts of suburban housing, developed in a high homogenous approach, have problems of appropriate density and intensity of social interaction. Row houses are considered as a solution to create a proper density and urban compactness. On the other hand, standard row housing with narrow frontages have problems with daylight. In this line, Alexander proposes row houses that face the street with a long façade or layouts that have crinkling outline (Alexander, Ishikawa, & Silverstein, 1977). In the case of Korça, we see a neighborhood composed of hybrid housing layouts, including detached, semi-detached and attached houses. This morphology creates a balanced proportion between void and built-up area, providing a better environment for air circulation and daylight access. Although there are many detached houses, they are very close to each other, forming a compact urban pattern. In situations where many houses are attached to each other, there is a broken outline in the perimeter of the houses (Figure 3.18) forming small voids in the plan and creating a rich rhythm in the facades.

3.2.1.13 Looped local roads

The residential areas should be accessible by vehicles, but they should not be transitional zones for fast traffic. A street network that discourages through traffic but at the same time provide access to houses is more appropriate for residential districts. The streets should be designed in a way that form small loops and avoid straight wide lanes (Alexander, Ishikawa, & Silverstein, 1977). The neighborhood in Korça represents a good example of network of organic paths, forming small loops at different frequencies. The narrow streets, formed in organic curvilinear shapes, with many directional changes decreases considerably their use as through traffic routes (Figure 3.18). This street network has a structure that give accessibility to almost every house in the neighborhood, but it has also a frame where small looped rings are connected to each other, forming a continuity in circulation.

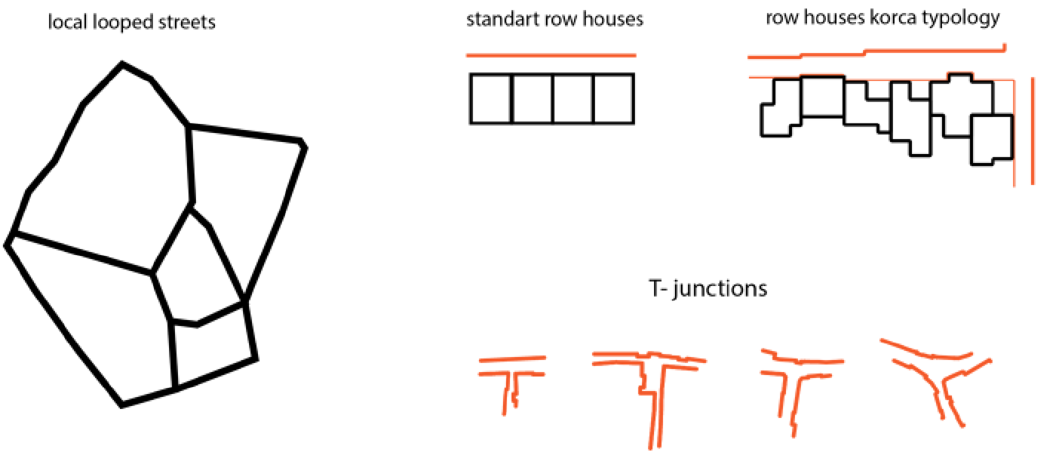


Figure 3.18 : Illustrations showing patterns of local loops, row houses and T-junctions in the study area.

3.2.1.14 T junctions

This pattern is more related with having a better traffic circulation and less accidents in major street intersections. T junctions, possibly at perpendicular angles, are better than four-way intersections because they have less collisions and reduce the number of accidents (Alexander, Ishikawa, & Silverstein, 1977). In the studied neighborhood the vehicle traffic is very low, so this principle regarding intersection type is not very important. However, there are many T junctions in the street network (Figure 3.18). This type of junction, rather than reducing accidents, have more significance in aspect of providing human scale length and create interesting perspectives in the streetscape. Beside T junctions, there are many Y junctions, or other types of intersections with streets meeting at wide angles that are even more suitable for generating dynamisms, human scale and enjoying perspectives in the street space.

3.2.1.5 Green Streets

The wide us of asphalt or concrete even in local streets, reducing the use of greenery and other materials, is an issue creating many problems in various aspects. Alexander defends the idea that asphalt and concrete are not very appropriate for local streets with low traffic flow (Alexander, Ishikawa, & Silverstein, 1977). He suggests an approach that increases the use of green elements and the combination with other materials such as stone or gravel. This type of street is better in aspects related with environmental issues, drainage, pedestrian use, recreation and socialization, and yet provide also access for cars (Alexander, Ishikawa, & Silverstein, 1977). There are several patterns that contribute to the concept of a green street in the study area. Instead of asphalt, the streets are paved in cobblestones, providing the grass to grow in different streams in-between stones. In additions, there is a greenery growing wild in the edge of the street. There are also many plantings covering the fences or spread on the walls, tree branches extended from the gardens to the streets, vegetables or flowers visible from the street, and vineyards covering the entrances or terraces that create a green street environment (Figure 3.19).

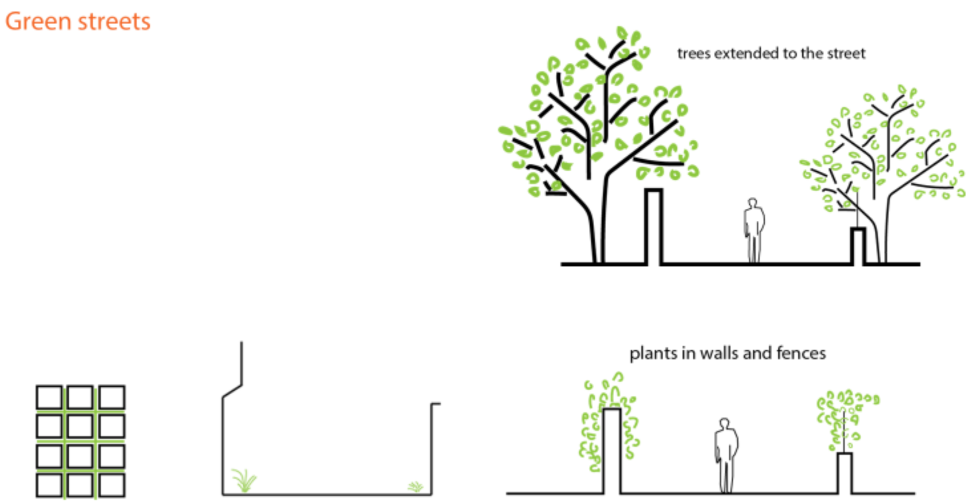


Figure 3.19 : Patterns creating a green street.

3.2.1.6 Network of paths and cars

There are different discussions on how to separate pedestrian circulation from the vehicular traffic. Alexander suggests that total separation is not a good solution. According to him, urban life happens when we have a good integration of both vehicular and pedestrian movement (Alexander, Ishikawa, & Silverstein, 1977). He proposes a system where vehicular circulation and pedestrian priority paths form a network that intersect frequently at perpendicular angles. This is more valid in areas with a considerable amount of traffic, while low-traffic zones can work very well with the concept of shared street (Alexander, Ishikawa, & Silverstein, 1977). The case study represents such a situation. The very low vehicular traffic does not disturb pedestrian movement, so the street is suitable to be shared by different types of circulation (Figure 3.20). In this way everyone can walk easily and comfortably in the neighborhood, access their houses with cars, and park at individual plots or on the street.

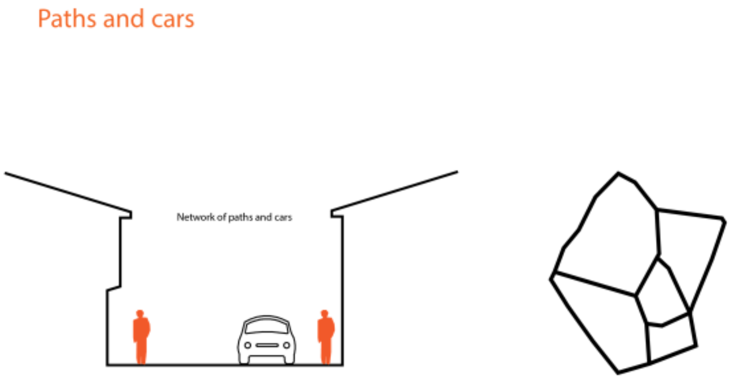


Figure 3.20 : The pattern of ‘cars and paths’.

3.2.1.17 Children in the city

One of the dimensions to measure the quality of a settlement is its ability to be children friendly. In many contemporary cities, children are isolated in homes or schools, since the streets do not provide a safe environment for them. On the other hand, it is very important that neighborhoods are designed in a way that make children use the public spaces frequently. Beside playgrounds, the urban space should provide other facilities such as continuous pedestrian paths, connections, bike paths, active ground floor uses, sitting components and other elements that encourage children to use the outdoor space in a safe way (Alexander, Ishikawa, & Silverstein, 1977). The presence of the children in the public space is for sure a complex issue that is related not just with physical character of the space. In the study area, as shown in Figure 3.21, there is a frequent presence of children in the streets, adapting the space for different playing activities. This is related with many features that this settlement poses such as: the size of the neighborhood, walkable distances, human scale environment, low vehicle traffic, pedestrian friendly and safe narrow organic streets, small plazas, neighborhood relationships, and many other factors. In this neighborhood children can interact with their friends, explore the nature and the city, and grow healthier.

3.2.1.18 Connected play

This pattern is very much related with the previous one, dealing with the issue of integrated playing spaces. Alexander speaks for the significance of having a common land, which is structured along a pedestrian path, is not disturbed by vehicle traffic, and connects some spots that can be used by children to play (Alexander, Ishikawa, & Silverstein, 1977). In the case of Korça, the neighborhood has a very suitable structure for establishing a connected play. All over the area there are many small plazas that are connected through narrow paths, mainly used by pedestrians (Figure 3.21). However, though the urban structure has this potential, it does not include organized spaces and infrastructure for playing. Streets or small open spaces are used by children in a spontaneous way for playing.

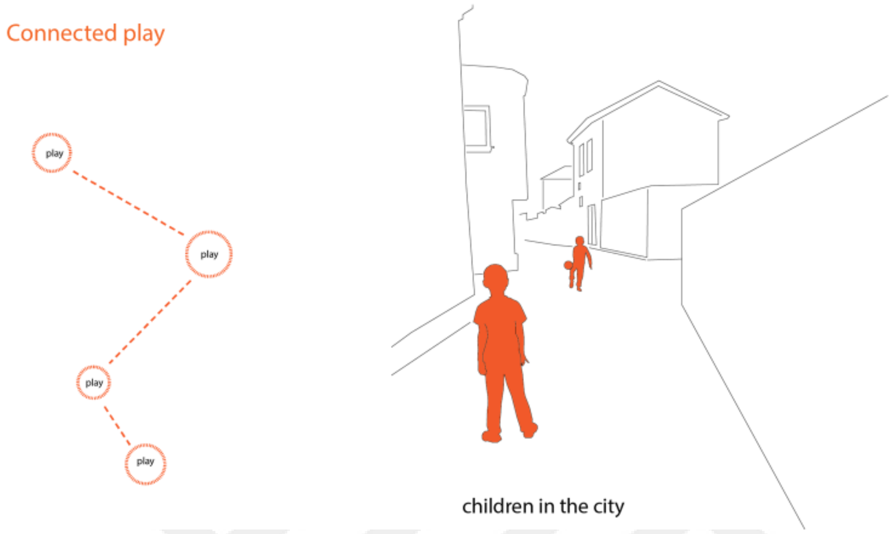


Figure 3.21 : Illustration showing the patterns of 'connected play' and 'children in the city' in the study area.

3.2.1.19 Quiet back

The intensity of activities in the urban life is crucial for having a living city and strong social interaction but everyone needs also some pause to stop, reflect and be refreshed. In this sense, it is fundamental to provide some quiet, natural spaces, separated from crowded and noisy areas to give people an opportunity for resting, relaxing or other experiences of quite atmosphere (Alexander, Ishikawa, & Silverstein, 1977). The neighborhood in Korça can be considered as a quiet district compared to other zones in the city. It is located nearby the city center that is a crowdy and noisy area. But the neighborhood, somehow hidden behind the main large cathedral, is a very quiet residential zone.

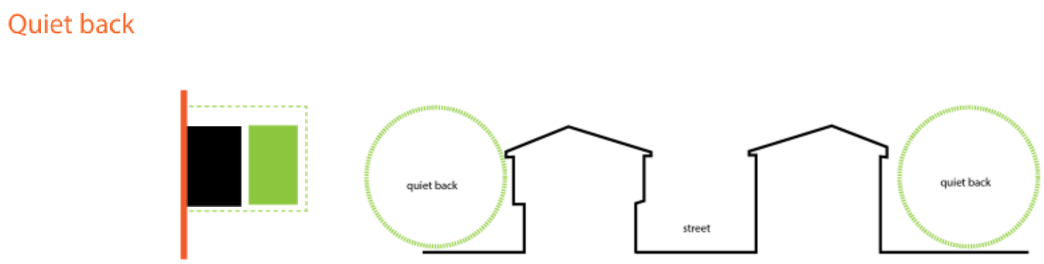


Figure 3.22 : Courtyards as spaces the provide a quiet atmosphere.

Looking at a smaller scale, courtyards are also spaces that fulfill the criteria of a quiet place (Figure 3.22). Especially courtyards that are located at the back part of the plot or the ones that are surrounded by solid wall provide intimate spaces apart from the activity in the street.

3.2.1.20 Small public squares

The issue about the size, location and other features of squares is something widely discussed among designers and scholars. Alexander defends the idea that small plazas can work better than large squares because they allow more interaction and are livelier spaces (Alexander, Ishikawa, & Silverstein, 1977). Contrary to that, big squares may result in large unused and dead spaces. He suggests that these small plazas should be positioned near street intersections and tries also to give particular dimensions of a good plaza (Alexander, Ishikawa, & Silverstein, 1977).

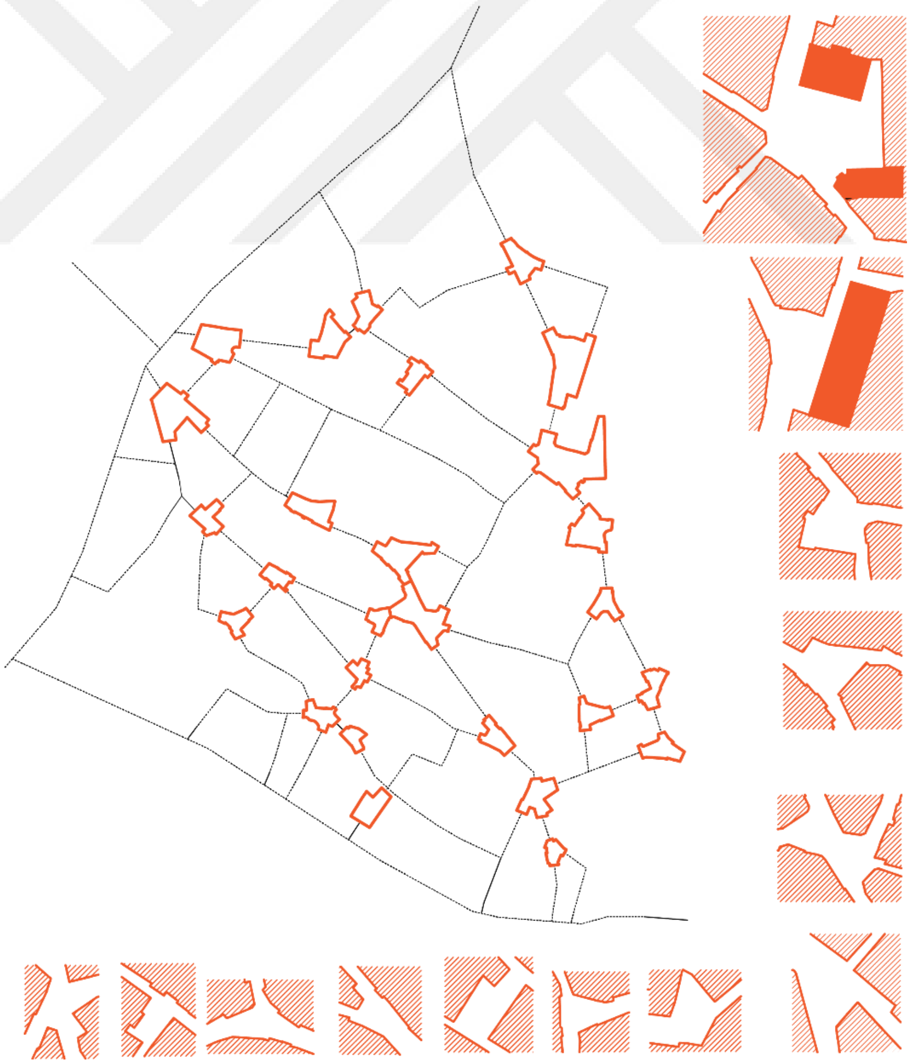


Figure 3.23 : A neighborhood with many small plazas.

The idea of the small plaza is also supported by Sitte and Gehl, claiming that they establish a better habitat of socialization, are compact, and human scale (Sitte, 1965; Gehl 2010). The study area is very coherent to this principle. As can be seen from Figure 3.23, instead of a very large square, there are many small plazas spread around the neighborhood in different positions and scales. Although few of them are accompanied by commercial functions, socio-cultural facilities or recreational infrastructure, their morphology is very appropriate for having a network of decentralized open spaces. These small plazas form a sequence of pauses in the urban morphology, offering a human scale environment and areas for compact relationships.

3.2.1.21 Public outdoor room

Another pattern related with public space and its use is the ‘public outdoor room’. In explaining this pattern Alexander focuses on the importance of spaces that are semi-closed, semi-covered, semi-protected or semi-defined as attractive spots for sitting and interacting (Alexander, Ishikawa, & Silverstein, 1977). These permeable structures can be allocated at corners with rich vistas and accessible by the main paths (Alexander, Ishikawa, & Silverstein, 1977). This pattern is present in the study area at different scales and features. The semi-closed spaces exist in almost every house and courtyard. Besides that, in the public space there are also some spatial compositions that can be considered as public outdoor rooms. For example, the siting places in the main square that are covered by a large old tree is a typical example a semi-protected outdoor space. Other examples can be the sitting spots below the extended upper floors that cover them or in front of courtyard gates, where the gate act as e defining structure. These are interesting semi-covered spots that provide small spaces for sitting, interacting and sometime just watching the people passing by (Figure 3.24).

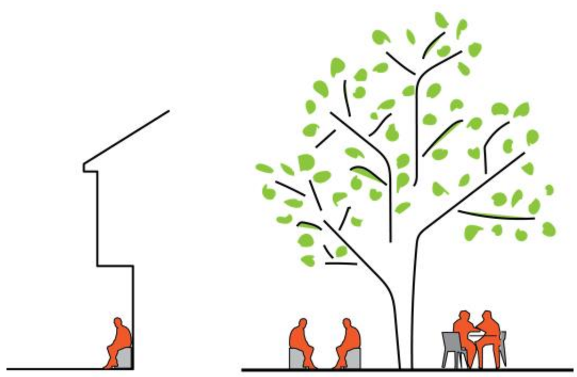


Figure 3.24 : Public outdoor rooms in Korça.

3.2.2 Fractal analyses

The second methodology implemented in this study uses the fractal dimension analyses to understand if there is any coherence and order among the urban morphological elements in the study area. The concept of fractal geometry is very useful to analyze the features of organic forms, particularly the similarities and relationships of their morphology in different scales. There are different ways to calculate the fractal dimension, but this study uses only the box counting method to measure fractality of various morphological components in the study area. The analyses are implemented in three morphological units: streets and blocks, buildings, and plazas (Figure 3.25).

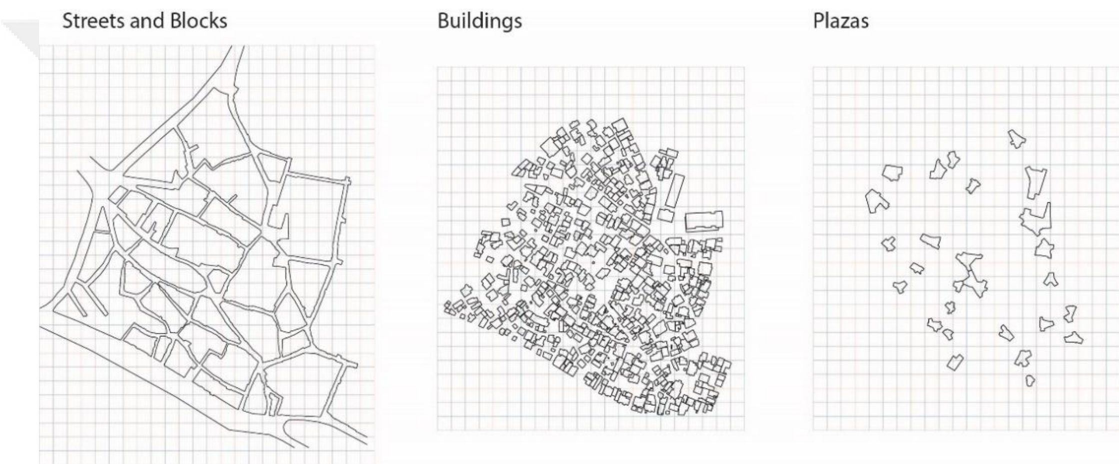


Figure 3.25 : The implementation of fractal analyses in three morphological units.

Moreover, the fractal measurements are done in different scales for each unit. For example, as shown in Figure 3.26, the fractal of buildings and streets is measured in three different scales: neighborhood scale (the whole study area is included), smaller district scale (including some blocks) and block scale (including just one block). The same procedure is done for plazas but just in two different scales (neighborhood scale and small scale including just one plaza). In order to make it easier for explaining the three different scales, the upcoming part will be referred as: first scale, second scale and thirds scale.

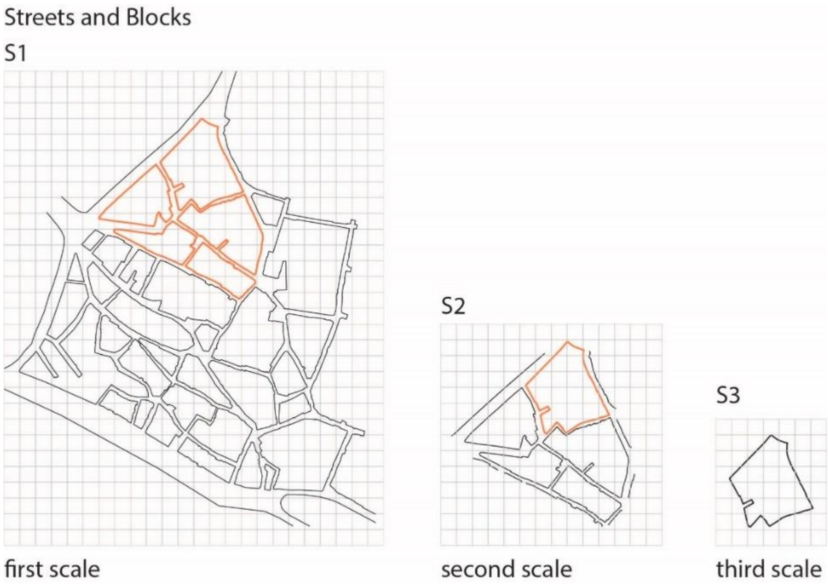


Figure 3.26 : Fractal measurement for each unit in different scales.

A grid of three different box dimensions, particularly 20x20m, 10x10m and 5x5m, is implemented in each scale to calculate and compare the fractal dimension for each of them. For smaller scale the grid is applied in 10x10m, 5x5m and 2.5m x 2.5m (Figure 3.27).

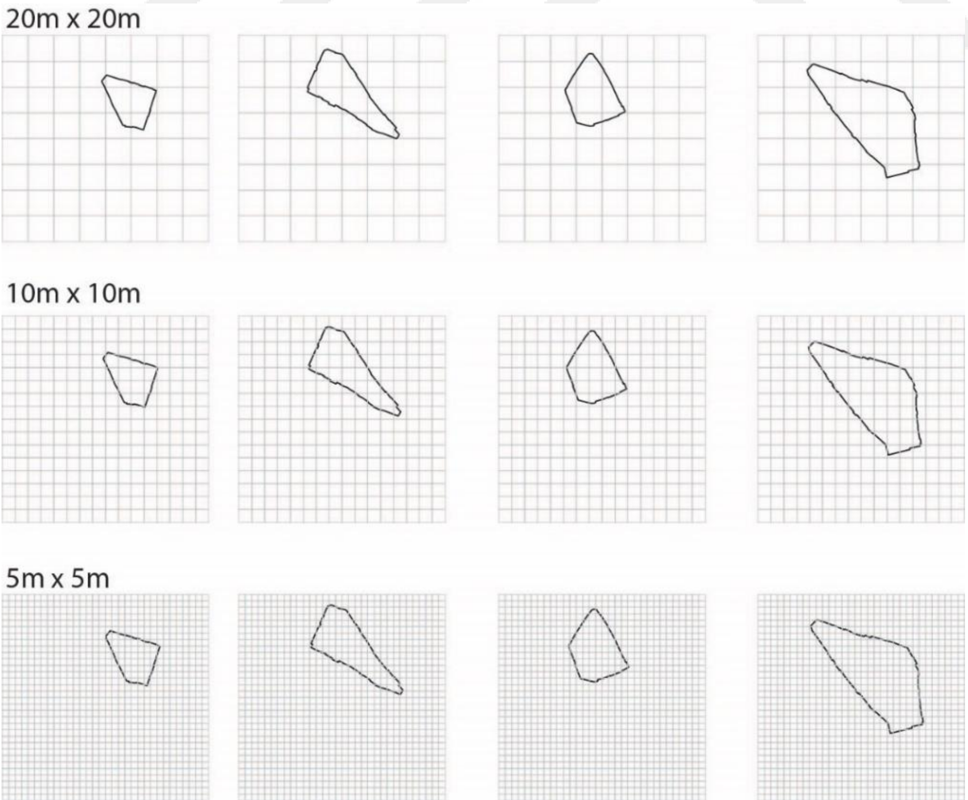


Figure 3.27 : Implementing different grid sizes for fractal analyses.

The fractal dimension is calculated by using the following formula:

$$\mathrm{Db} = \frac{[\log (\mathrm{N(SII)}) - \log (\mathrm{N(SI)})]}{[\log (1/\mathrm{SII}) - \log (1/\mathrm{SI})]} \tag{3.1}$$

Db: Shows the fractal dimension's value.
N (SI): The number of boxes where the shape is located in the first step (I).
N (SII): The number of boxes where the shape is located in second step (II).
N (SIII): The number of boxes where the shape is located in third step (III).
1/SI: The number of boxes in x axis in the first step.
1/SII: The number of boxes in x axis in the second step.
1/SIII: The number of boxes in x axis in the third step.

The calculated fractal dimension is used firstly to understand the fractality of each component within itself. Secondly, it is useful to make comparisons between different components and scales. In this context, the first comparison consists of looking to different morphological units at the same scale. For instance, comparing the fractal dimension of streets, buildings and plazas at neighborhood scale (first scale) represents this one. Another comparison is between the fractal values of the same morphological unit at different scales. Comparing the fractals of building fabric at first, second and third scale is an example of that. Besides that, a comparison of the same morphological unit at the same scale is also important. Comparing the fractal of different plazas or building blocks at the same scale is an example of this comparison. Finally, there is conducted a wide comparison between different components at different scale. All these comparisons are important to understand the self-similarity within each structure and secondly to identify if there is a coherence or strong relationship among different components and different scales. Cases where the values are close or similar to each-other show the existence of a complex order in the organic composition of the settlement and coherence of morphology.

3.2.2.1 Fractal of streets

The first fractal analysis is implemented in the overall structure of street pattern at three different ranges of box dimensions (Figure 3.28).

Figure 3.28 : Fractal of streets and blocks at first scale_S1.

Table 3.2 : Calculations for the streets at first scale.

	Number of boxes	Number of boxes in x	Dimension of boxes
S1	354	24	20m
	939	48	10m
	2363	96	5m

$$\text{Db }(S1)\text{streets }(2-1) = \frac{[\log(939) - \log(354)]}{[\log(48) - \log(24]}$$

$$\text{Db }(S1)\text{streets }(2-1) = \frac{[0.424]}{[0.301]} = 1.41$$

$$\text{Db }(S1)\text{streets}(3-2) = \frac{[\log(2363) - \log(939)]}{[\log(96) - \log(48)]} = 1.33$$

Table 3.3 : Fractal values for streets at first scale at two different ranges.

Scale range	Box counting dimension/S1
20- 10 meters	1.41
10-5 meters	1.33

The analyses of the fractal dimension of the whole street pattern plan show that its morphology is fractal at a considerable level, having closer values such as 1.41 at 20-10 meters scale range and 1.33 at 10-5m scale range. The second analysis is implemented at a lower scale (second scale) for three subdistricts (S2a, S2b and S2c), calculating the fractal dimension of just street pattern plan (Figure 3.29). As shown in Table 3.4, the subdistricts have very close values with each other and with the larger scale. Some of them have the same fractal dimension. This means that there is a high coherence of street morphology in different zones of the neighborhood. Moreover, district S2b has very similar fractality (1.33 and 1.34) at different scales, showing a strong relationship between the smaller scale and larger morphology of the same component.

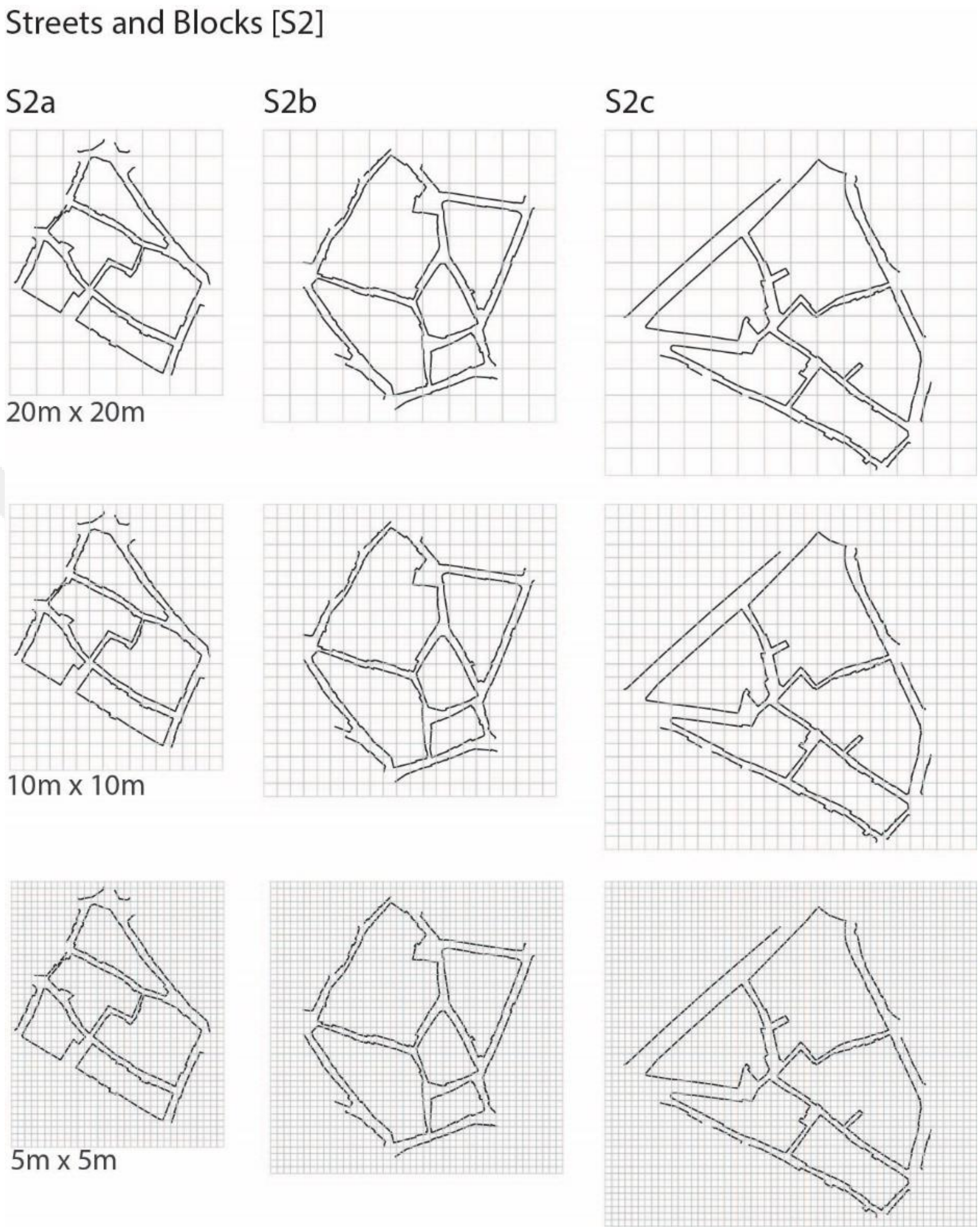


Figure 3.29 : Fractal of streets and blocks at second scale_S2.

Table 3.4 : Comparing fractal values for streets at first and second scale.

Scale range	S2a dimension	S2b dimension	S2c dimension	S1
20- 10 meters	1.40	1.33	1.40	1.41
10-5 meters	1.33	1.34	1.28	1.33

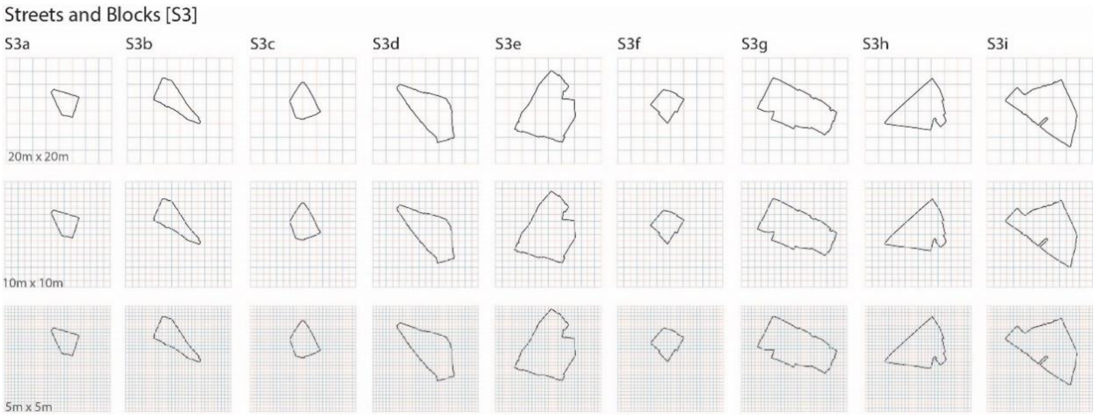


Figure 3.30 : Fractal of streets and blocks at third scale_S3.

The third analysis regarding the street plan is implemented in third scale (block scale) for nine different block patterns (Figure 3.30). Looking to the measurements in this scale we can say that it has a higher fractality in overall, going up to 1.79. This mean that these smaller blocks have a larger level of detail. The fractal values of 20-10 meters and 10-5 meters are close to each other but not at the level that represents a very high coherence between two range scales. But an important fact is that there are different blocks with very similar fractal values, especially at 10-5m scale range. As shown in the Table 3.5, there is a high number of similar values among different blocks, representing a significant correlation of form, despite their different organic shapes and sizes.

Table 3.5 : Comparing fractal values for streets at third scale_S3.

Scale range	S3a	S3b	S3c	S3d	S3e	S3f	S3g	S3h	S3i
20- 10 meters	1.32	1.34	1.32	1.43	1.55	1.18	1.60	1.63	1.57
10-5 meters	1.63	1.66	1.73	1.78	1.77	1.62	1.74	1.75	1.79

Table 3.6 illustrates a matrix that compares the fractal dimensions for all morphological units of street pattern plan at three different scales (S1, S2 and S3) for two scale range of three box dimensions (20-10m and 10-5m). The comparisons represented here show that at smaller scale (S3) there is a higher fractality of street morphology than the two upper scales (S1 and S2). Moreover, the values show clearly that there is a high similarity of street plan form between first, second and third scale, having very close values between 1.32-1.34, and 1.40-1.41. These fractal values speak for a high coherence of morphology between different scales and morphological units. Finally, the analyses show that different morphological units of the same category and

scale (especially S2 and S3) have a high harmony of form because of the very close fractal dimensions that they possess.

Table 3.6 : Comparing fractal values for streets at all scales.

	20-10	10-5
S1	1.41	1.33
S2a	1.40	1.33
S2b	1.33	1.34
S2c	1.40	
S3a	1.32	1.63
S3b	1.34	1.66
S3c	1.32	1.73
S3d	1.43	1.78
S3e	1.55	1.77
S3f		1.62
S3g	1.60	1.74
S3h	1.63	1.74
S3i	1.57	1.79

3.2.2.2 The fractal of buildings

Another basic component that defines the urban morphology is the building fabric. To understand the fractal features of the building fabric in the study area, a similar analysis is conducted in three different scales. The fractal dimension is calculated for all the buildings (B1) in the first stage, implementing a grid of 20x20m, 10x10m, and 5x5m (Figure 3.31).

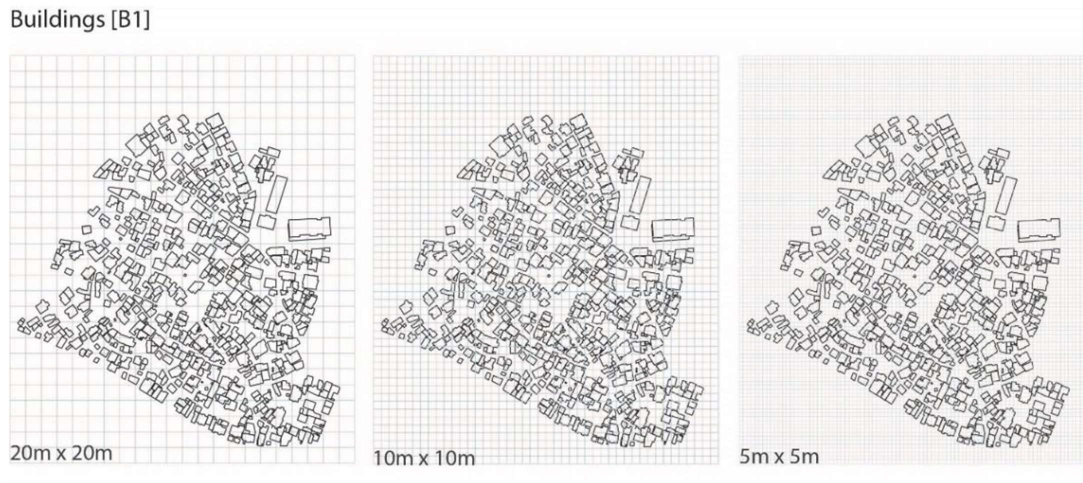


Figure 3.31 : Fractal of buildings at first scale_B1.

Table 3.7 : Calculations for the buildings at first scale.

	Number of boxes	Number of boxes in x	Dimension of boxes
B1	314	22	20
	1115	44	10
	3662	88	5

Table 3.8 : Fractal values for buildings at first scale at two different ranges_B1.

Scale range	Box counting dimension/B1
20- 10 meters	1.83
10-5 meters	1.72

The calculations show that the building fabric has a higher fractality than the street pattern in the first scale, going up to 1.83. This is due to the morphology of building pattern which is subdivided in smaller units and forms. In the second range scale (10-5m) the fractal dimension is decreased to 1.72, meaning that there is lower level of detail at 5 m scale range compared to the upper scale, but still is at a considerable level (Table 3.8).

Figure 3.32 : Fractal of buildings at second scale_B2.

Table 3.9 : Comparing fractal values for buildings at first and second scale.

Scale range	B2a dimension	B2b dimension	B2c dimension	B1
20- 10 meters	1.78	1.64	1.81	1.83
10-5 meters	1.72	1.73	1.69	1.72

A further analysis is conducted at the second scale (B2) by calculating the fractal dimension of buildings in three different districts and comparing them with each other and with the fractal of the upper scale (Figure 3.32). The measurements show very a significant similarity of fractal dimension among different units of the building fabric for both scales. A shown in the Table 3.9, B2a, B2c and B1 have very close values at 10-5m scale range. The similarity is increased at 10-5m scale range giving almost the same fractal dimension for four analyzed units. Considering this fact, it can be concluded that there is very strong coherence, harmony and order among the form of building units in different locations and scales.

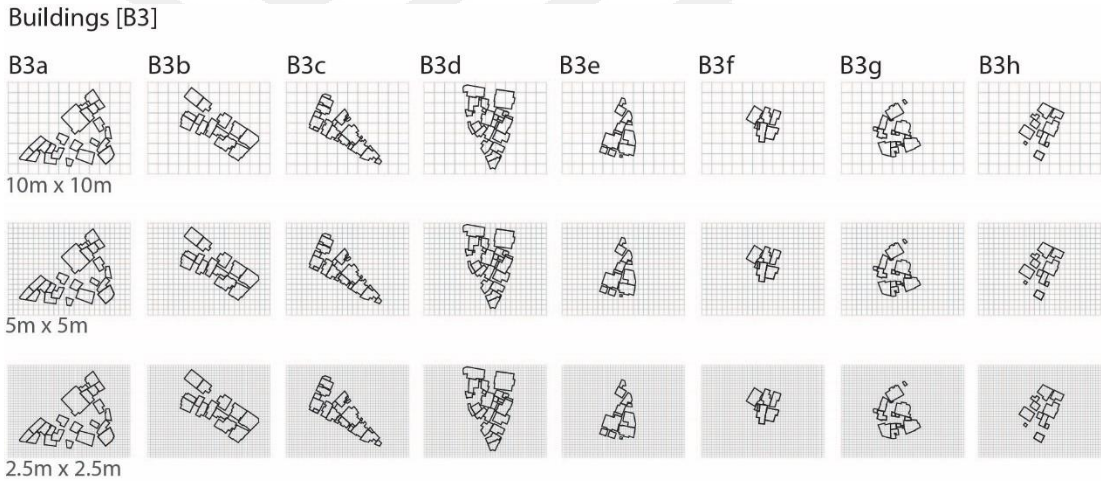


Figure 3.33 : Fractal of buildings at third scale_B3.

Table 3.10 : Comparing fractal values for buildings at third scale_B3.

Scale range	B3a	B3b	B3c	B3d	B3e	B3f	B3g	B3h
10-5 meters	1.65	1.66	1.57	1.69	1.43	1.55	1.68	1.59
5-2.5 meters	1.58	1.72	1.66	1.71	1.76	1.70	1.62	1.61

The fractal analyses for the building fabric in the third scale (B3) is implemented in eight different building clusters at 10-5m, and 5-2.5m scale range of box dimensions (Figure 3.33). The results given in Table 3.10 show that fractal dimension is slightly decreased at this scale, but the similarity of different clusters' fractal is still at a high degree. This show that harmony of form in building fabric continues even in smaller scales and details.

Table 3.11 : Comparing fractal values for buildings at all scales.

	20-10	10-5	5-2.5
B1	1.83	1.72	
B2a	1.78	1.72	
B2b	1.64	1.73	
B2c	1.81	1.69	
B3a	1.65		
B3b		1.66	1.72
B3c			1.66
B3d		1.69	1.71
B3e			1.76
B3f			1.70
B3g		1.68	1.62
B3h		1.59	1.61

Comparing the fractal dimensions of the building fabric in three different scales (B1, B2 and B3) shows that in many cases there is a strong coherence among them (Table 3.11). Out of 12 clusters spread in three scales and three box dimension ranges, there are nine very close fractal dimensions in intervals between 1.68-1.73, seven values between 1.59-1.66, and three values between 1.78-1.83. This can be considered as a high correlation of form and an evidence of order in the form of organic building fabric.

Going a step further and comparing the fractal dimensions of the streets and buildings can be important to understand the degree of harmony and coherence among two different morphological units in different scales and details. In this aspect, the Table 3.12 shows some interesting results. There is a considerable amount of close fractal dimension values in both morphological units. Thus, there are five fractal values from street pattern (S3) that are very close with six ones in building fabric (B2 and B3) in an interval between 1.61-1.66. In addition, there three values of street pattern (S3) similar with ten values from building pattern (B1, B2, B3) in an interval of 1.68-1.74; three values from S3 with three ones from B1 in an interval of 1.77-1.83; and two values from S3 with four ones from B3 in an interval of 1.55-1.59. As can be seen, there is a strong similarity of different scales of building pattern with the smallest scale (S3) of street pattern, but this similarity is decreased in upper scales of streets (S2 and S1).

Table 3.12 : Comparing fractal values for streets and buildings at all scales.

S/B	20-10	10-5	5-2.5
S1	1.41		
S2a	1.40		
S2c	1.40		
S3a		1.63	
S3b		1.66	
S3c		1.73	
S3d	1.43	1.78	
S3e	1.55	1.77	
S3f		1.62	
S3g	1.60	1.74	
S3h	1.63	1.74	
S3i	1.57	1.79	
B1	1.83	1.72	
B2a	1.78	1.72	
B2b	1.64	1.73	
B2c	1.81	1.69	
B3a		1.65	1.58
B3b		1.66	1.72
B3c		1.57	1.66
B3d		1.69	1.71
B3e		1.43	1.76
B3f		1.55	1.70
B3g		1.68	1.62
B3h		1.59	1.61

3.2.2.3 The fractal of plazas

Rob Krier (1979) defines the plaza as a basic morphological unit that identifies the features of the urban space. In this context, analyzing the fractal dimension of the plazas in the study area would give important information about settlement's morphology.

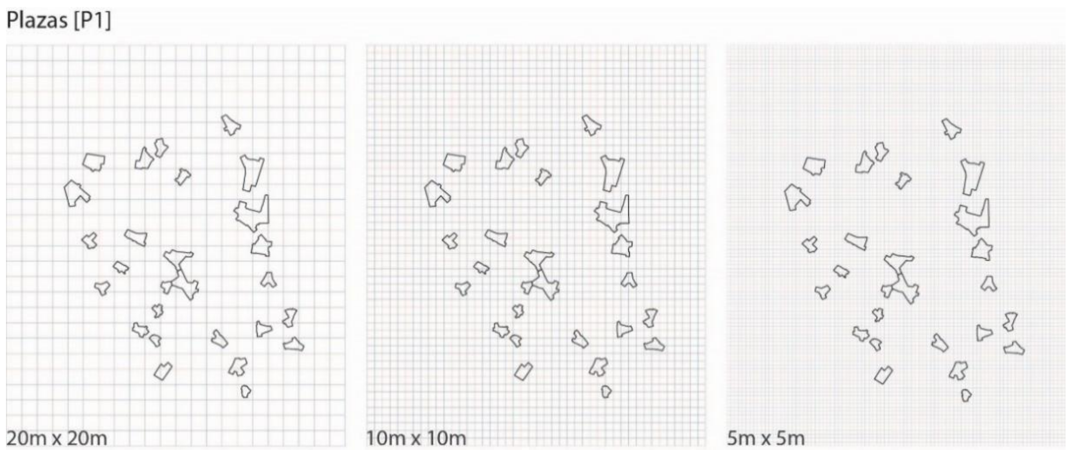


Figure 3.34 : Fractal of plazas at first scale_P1.

The procedure of fractal analyses for this component is done in two different scales: neighborhood scale (P1) and plaza scale (P2). The first one includes all identified small plazas in the area, and the second one analyzes each plaza individually at planar level (Figure 3.34).

The analyses include 13 plazas in different shapes and sizes, spread around the neighborhood. The fractal dimension of the first scale (P1) is calculated as 1.25 and 1.39 in intervals of 20-10m and 10-5m respectively (Table 3.13 and Table 3.14). This can be considered as low fractal value. There might be several reasons for that such as: the low number of shapes included in the analyses (just 13 compared to buildings that is above 300); including just the area shape of plazas; and the box dimensions.

Table 3.13 : Calculations for the plazas at first scale_P1.

	Number of boxes	Number of boxes in x	Dimension of boxes
P1	105	22	20
	249	44	10
	654	88	5

Table 3.14 : Fractal values for plazas at first scale at two different ranges_P1.

Scale range	Box counting dimension/P1
20- 10 meters	1.25
10-5 meters	1.39

The analysis in the second scale for each plaza is implemented by using a smaller box dimension for the grid, 10x10m, 5x5m and 2.5x2.5m (Figure 3.35). In general, the values represent a higher fractality (up to 1.71), although in some cases it decreases even lower than the first scale going down to 1.00. The values at 10-5m and 5-2.5m are close but not at a significant level that represents a high fractality within itself for each plaza.

However, there are some important results regarding the similarities of fractal dimension between different plazas, although they have organic different shapes and sizes (Table 3.15). For example, among thirteen components there are nine very close fractal values between 1.59-1.65, some of them are even similar values (1.59 is repeated four times). In addition, there are seven close fractal values between 1.44-1.49 and four values between 1.66-1.71. In conclusion, can be said that plazas have lower fractal dimension compared to buildings and some of the streets, but still there is a very high similarity of fractal dimension between 13 different plazas. This shows that even though the plazas have various shapes and sizes they have a very strong coherence in their morphology.

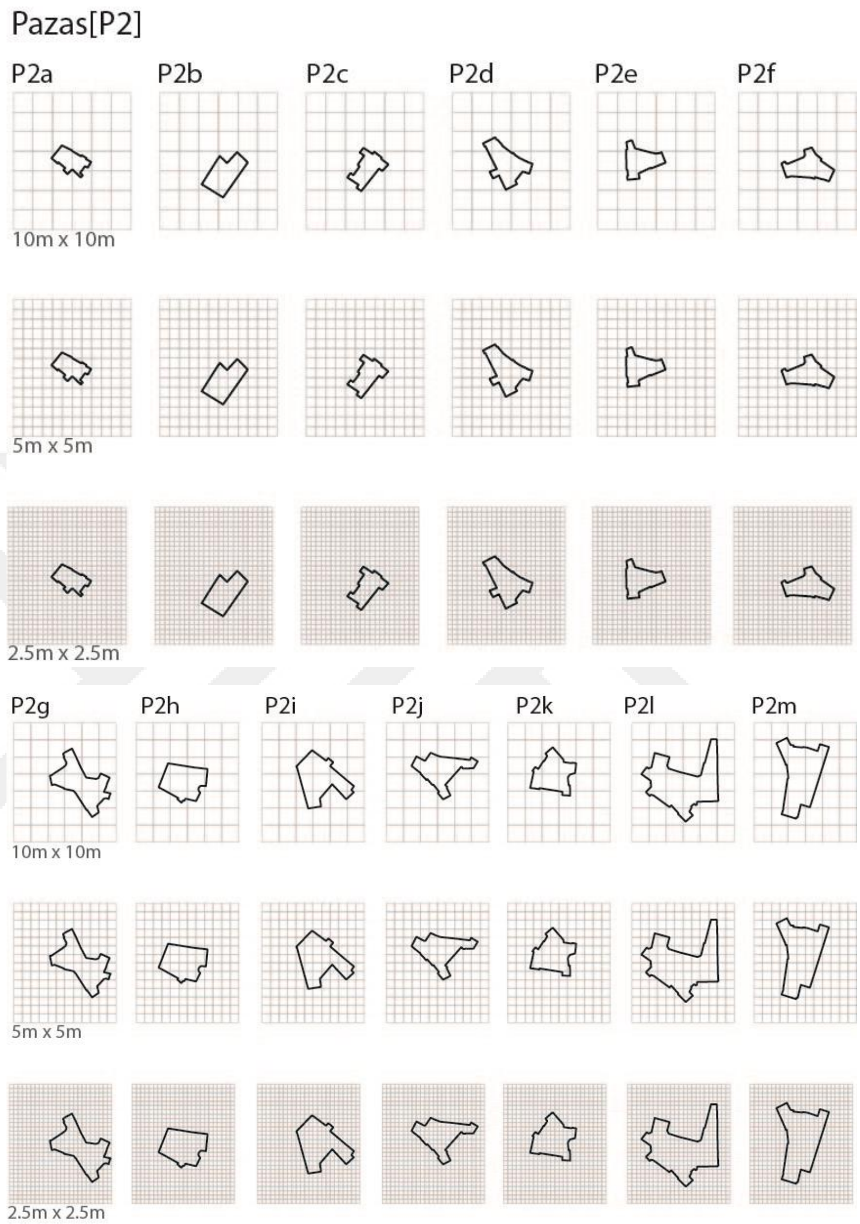


Figure 3.35 : Fractal of plazas at second scale_P2.

Table 3.15 : Comparing fractal values for plazas at second scale.

Scale range	P2a	P2b	P2c	P2d	P2e	P2f	P2g	P2h	P2i	P2j	P2k	P2l	P2m
20- 10 meters	1.10	1.39	1.00	1.18	1.28	1.44	1.59	1.49	1.42	1.71	1.49	1.59	1.53
10-5 meters	1.45	1.63	1.47	1.59	1.59	1.66	1.62	1.60	1.69	1.49	1.63	1.68	1.65

The final analysis consists of comparing the fractal dimension of plazas with the one of streets and buildings. This is done for the purpose of understanding the relationship among these various units and the coherence of the organic morphology in the overall. In this dimension, as shown in the Table 3.16, a significant similarity between street pattern and the form of plazas is identified.

Table 3.16 : Comparing fractal values for all components at different scales.

S/B	20-10	10-5	5-2.5	S/P	20-10	10-5	5-2.5	B/P	10-5	5-2.5
S1	1.41			S1	1.41			B1	1.72	
S2a	1.40			S2a	1.40			B2a	1.72	
S2c	1.40			S2c	1.40	1.28		B2b	1.73	
S3a		1.63		S3a		1.63		B2c	1.69	
S3b		1.66		S3b		1.66		B3a	1.65	1.58
S3c		1.73		S3c		1.73		B3b	1.66	1.72
S3d	1.43	1.78		S3d	1.43			B3c	1.57	1.66
S3e	1.55	1.77		S3e				B3d	1.69	1.71
S3f		1.62		S3f	1.18	1.62		B3e		1.76
S3g	1.60	1.74		S3g	1.60	1.74		B3f	1.55	1.70
S3h	1.63	1.74		S3h	1.63	1.74		B3g	1.68	1.62
S3i	1.57	1.79		S3i				B3h	1.59	1.61
B1	1.83	1.72		P1	1.25	1.39		P1		
B2a	1.78	1.72		P2a		1.10	1.45	P2a		
B2b	1.64	1.73		P2b		1.39	1.63	P2b		1.63
B2c	1.81	1.69		P2c		1.00		P2c		
B3a		1.65	1.58	P2d		1.18	1.59	P2d		1.59
B3b		1.66	1.72	P2e		1.28	1.59	P2e		1.59
B3c		1.57	1.66	P2f		1.44	1.66	P2f		1.66
B3d		1.69	1.71	P2g		1.59	1.62	P2g	1.59	1.62
B3e		1.43	1.76	P2h			1.60	P2h		1.60
B3f		1.55	1.70	P2i		1.42	1.69	P2i		1.69
B3g		1.68	1.62	P2j		1.71		P2j	1.71	
B3h		1.59	1.61	P2k			1.63	P2k		1.63
				P2l		1.59	1.68	P2l	1.59	1.68
				P2m			1.65	P2m		1.65

There are five values from street pattern measurements that are very close to ten fractal values of plazas in the intervals between 1.59-1.66 (blue color). There are also, four similar values for each pattern (eight in total) between 1.39-1.45 (red color) and lastly, there are three values from both components that have close values between 1.68-1.74 (green color).

In the analyses that compare the fractal dimension of plazas and building fabric we can identify also an important similarity. As illustrated in Table 3.16, there seven values of building fractals (B2 and B3) that have very close values to nine values of plaza fractals (red color) and thirteen values from B1, B2 and B3 that are close to four values of P2 (blue color). This fractal values are an important evidence that show the similarity and form coherence among the two different morphological units.

In conclusion, the study area which has an organic form and is developed in a spontaneous way might seem chaotic and irregular in terms of conventional geometric approach but, fractal analyses implemented here, have shown clearly that this self-developed settlement, possess a complex, hidden, spontaneous order and a high-level of morphological coherence.

3.2.3 Urban morphology measurements

The final part of analysis, this thesis deals with measuring the spatial features of the urban morphology in the study area. This procedure includes many geometrical calculations related with attributes that show distances, proportions, dimensions, angles, sizes and other properties of different morphological units in the studied neighborhood. In order to identify which components to measure, the study uses the morphological units defined by Conzen as basic elements of urban form: the street, the parcels and the buildings (Moudon, 1997). It adds also another morphological unit which is a derivate of above-mentioned components formed by a cluster of parcels surrounded by streets, the block (Figure 3.36). The measurements consist of identifying physical attributes of each morphological unit and it also tries to understand different spatial relationships among various components. For example, identifying the location of a building in the parcel and its position in relation to the street is an analysis that explains the relationship of three morphological units: the building, the parcel, and the street. As can be seen in the Table 3.17, there are around 25 measurements criteria grouped in five main categories, starting from the larger neighborhood to building scale. Each measurement defines at least one of the following attributes: the quantity, the area, the distance, the proportions, the dimensions, the orientation and the angle. This mechanical procedure that gathers an important amount of data does not have just a descriptive character but also is fundamental to understand the common patterns of spatial composition. This is done through data analyses that extracts the most and less common frequencies of a particular pattern. For instance, by measuring the area of each parcel we can understand easily the minimum, maximum and the most common size of a parcel. The extracted percentages and frequencies for each calculation provides a good synthesis of information regarding physical form of the settlement. All this information is very useful for establishing a framework that can be used to build a development model for any possible future settlement because it defines spatial principles that can be taken into consideration. It is important to notice that it is not in the focus of this analysis to identify the social, economic, cultural or environmental factors that shape this morphology. It explores the physical dimension and the spatial composition, which is a result of many factors, mentioned above.

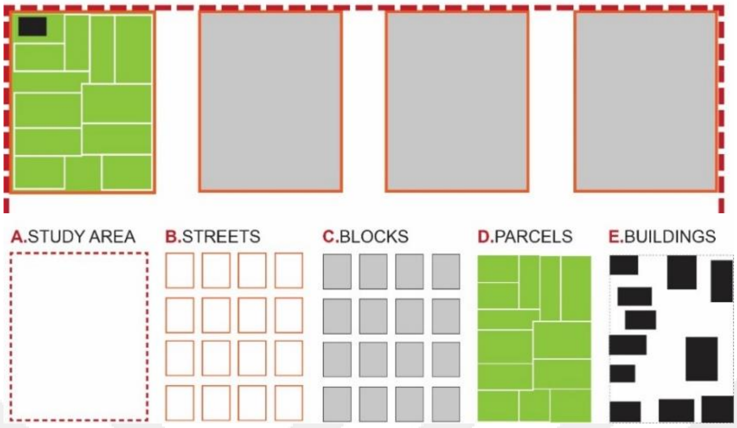


Figure 3.36 : The morphological units that are measured (Zeka & Yüzer, 2019).

3.2.3.1 General measurements

The first category of measurements consists of eight different criteria that gives information about: a1- the size of the neighborhood, a2-total number of streets, a3-total area of streets, a4- total length of streets, a5-total number of blocks, a6- total number of parcels, a7-total number of buildings, and the general plot coverage ratio (Figure 3.37). These calculations are important to understand some general features of the neighborhood and the sub-units that define its structure. Firstly, the size of neighborhood, calculated as 11.6 ha, is spread in a way the distances between the boundaries and the center does not exceed 500 meters. This mean that the settlement is structured within walking distances. The size of the neighborhood can be useful also to find information about population density and land use. Other parameters like the total number of streets, total area of streets and total length of streets have a more mechanical character that can be helpful to understand the ratio of public space (the street), the level of accessibility, land distribution, human scale dimension, urban compactness and other features. According to calculations there are 77 streets in the neighborhood and their surface covers around 2.15 ha which is about 2% of the total neighborhood area.

Table 3.17 : The structure of main morphological units, criteria and measurement parameters (Zeka & Yüzer, 2019).

		Number value	Area	Distances	Proportions	Dimensions	Orientation	Angle
	Criteria							
A	**Study area/District**							
1	Total area		x					
2	Total Number of Streets	x						
3	Total Area of Streets		x					
4	Total Length of Streets			x				
5	Total Number of Blocks	x						
6	Total Number of Parcels	x						
7	Total Number of buildings	x						
8	Plot Coverage Ratio (PCR)[2]	x			x			
B	**Streets**							
1	Orientation of streets						x	x
2	Angular position							
3	Length between intersections			x				
4	Street width			x				
7	Proportions: street width/building height				x			
8	Directional changes angle							x
C	**Blocks**							
1	Area of blocks		x					
2	No. of parcels/Block	x						
3	No. of buildings/Block	x						
4	Plot coverage area /Block	x			x			
D	**Parcels/plots**							
1	Area		x					
2	Dimensions					x		
3	Street orientation						x	
4	Proportions				x			
E	**Buildings**							
1	Location on parcel						x	
2	Orientation						x	
3	Setbacks			x				

The number of blocks is counted as 35 and the number of parcels 395 and the number of buildings 650. Formed in different sizes and shapes the pattern of the blocks, parcels and buildings fragments the total area in a way that creates very dynamic and rich urban space. All these measurements define the parameters of the fractality in the settlement which provides ground for a variety of compositions and small authentic clusters. In any other situation a more homogenous structure with few large blocks, larger open spaces and bigger buildings does not have the same potential for dynamic

[2] Plot Coverage Ratio (PCR)= Area of building footprints/total area of the study zone

and flexible urban morphology. The final measurement in this category represents the plot coverage ratio (PCR), which is the ratio of total building footprint surface to the total surface of blocks. This is fundamental information to understand the solid-void relationship, compactness of settlement or courtyard typologies. The average plot ratio is calculated as 0.55 for the study area. This show a balanced distribution of open space and built-u area. This relationship is spread in a homogenously in the settlement structured among the combination of small-scale buildings and open spaces, creating a human scale environment.

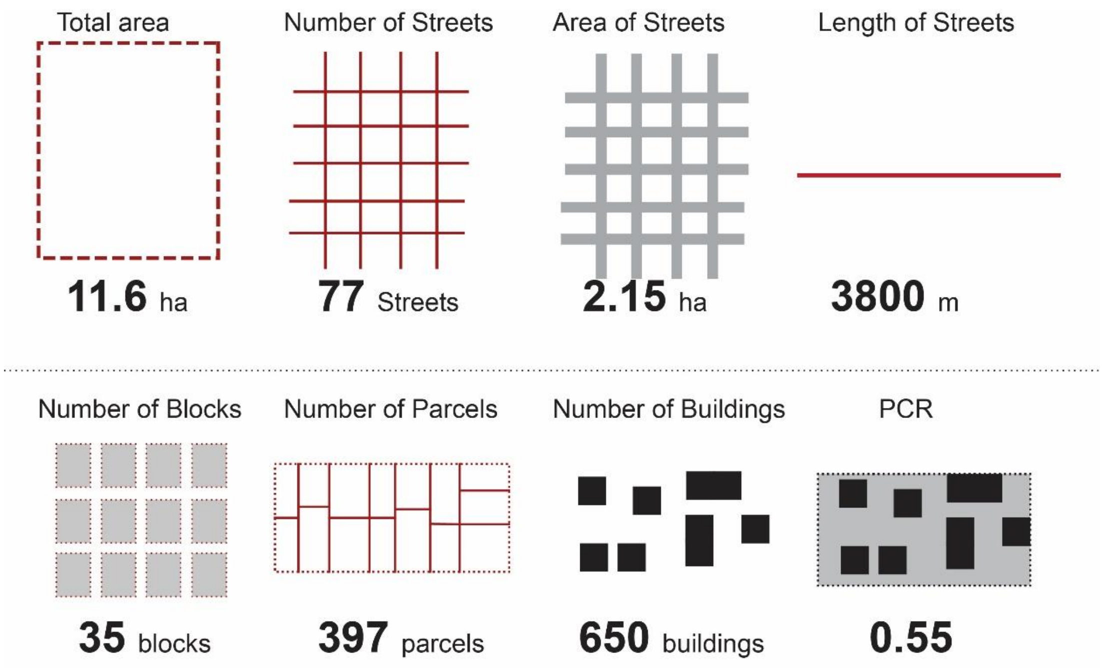


Figure 3.37 : Calculations for Neighborhood scale (Zeka & Yüzer, 2019).

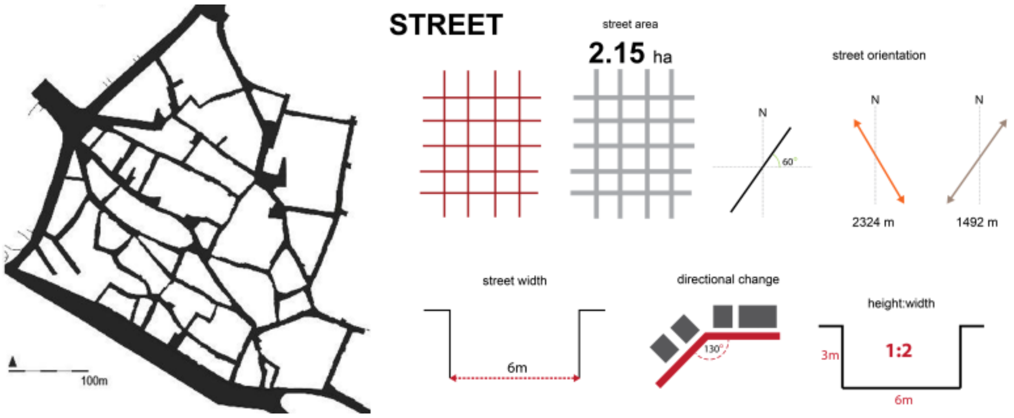


Figure 3.38 : Parameters measured for the street pattern.

3.2.3.2 The street features

The street, defined as a basic morphological unit by scholars, is analyzed separately by measuring many attributes that shape its physical form. As can be seen in Table 3.17, and Figure 3.38, there are six different parameters that are measured to understand the physical character of the street. Firstly, an observation about street orientation is conducted. Analyses show that most of the streets are positioned in northwest-southeast or northeast-south west direction. A main reason for that might be the direction of local winds (Thomo, 1988). There are around 2394 m linear in northwest-southeast direction and 1492 m linear in northeast-south west direction (Figure 3.39).

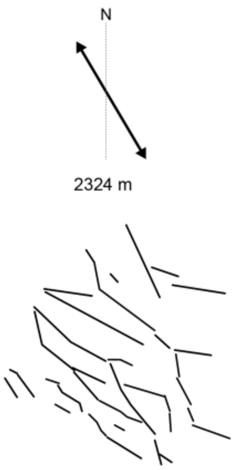


Figure 3.39 : Orientation of streets in the study area.

In addition to the length of the street for each orientation a supportive analysis is done to define the angles of directional shifts in relation to the north direction for each orientation of the street. The most common angles for northeast-southwest direction are between 60º-70º. While for the Norwest-southeast direction there is a more equal distribution of different angles, but the most common angles are between 20º-30º (Figure 3.40, 3.41).

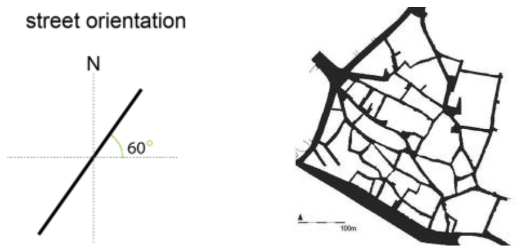


Figure 3.40 : Orientation of streets in the study area.

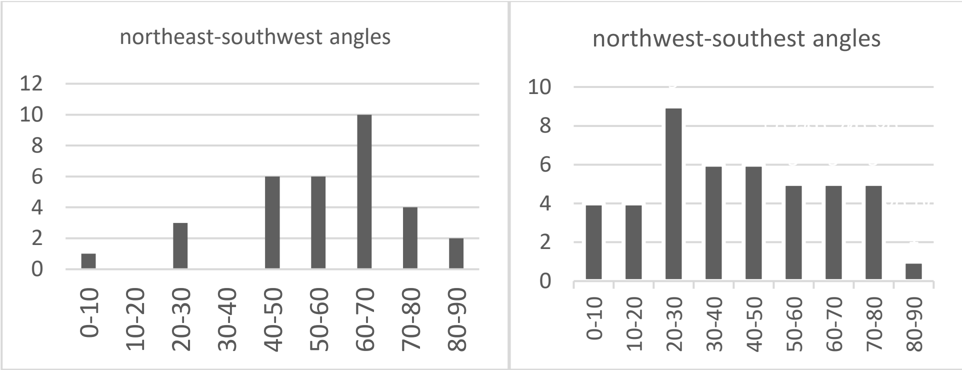


Figure 3.41 : The angles of directional shifts in relation to the north direction.

An attribute that defines the morphology of the street is the distance between two intersection (Figure 3.42). These distances define the length and the scale of the street. The intersections act as frequencies of change in the street scape. The short distances create a better definition and provide a human scale in the street length. In addition, they provide better accessibility and more alternatives of movement. Big distances create long blocks, decrease the human scale and the permeability of the settlement. Measurement in the site show that the majority of intersection are not very long. The most common distance is between 20m-30m, followed by distances between 30m-40m (Figure 3.43). These distances create small blacks, short walking distances, increase the accessibility, provide more alternatives of movement, and a human scale street length.

Figure 3.42 : Intersection distances.

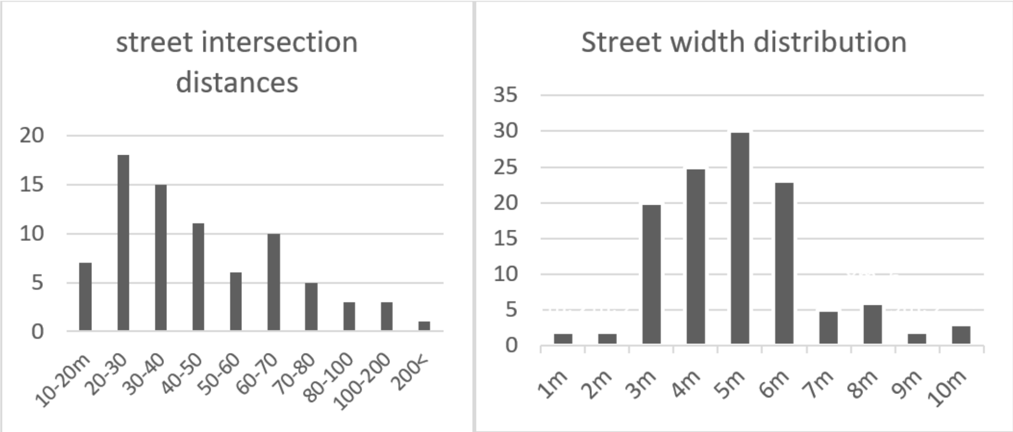


Figure 3.43 : Intersection distances chart.

Besides the intersection distance, another basic feature that strongly defines the street scape and urban morphology is the width of the street. The study area is a historic neighborhood, composed of narrow organic and curvilinear street pattern. As shown in Figure 3.44, the majority of street segment is at a width between 3m-6m. This kind of streets provide an urban space that is well defined, strongly enclosed, human scale. It encourages pedestrian movement and discourages vehicular traffic. Moreover, they form a compact urban fabric that can enhance social interaction and can be advantageous in some environmental conditions. In some cases, especially in very narrow streets, they might have some problems related with the accessibility of services and formation of oppressive spaces. Finally, another significant feature regarding street width is the fact that it does not go in a straight way but changes very frequently, creating a dynamic spatial composition.

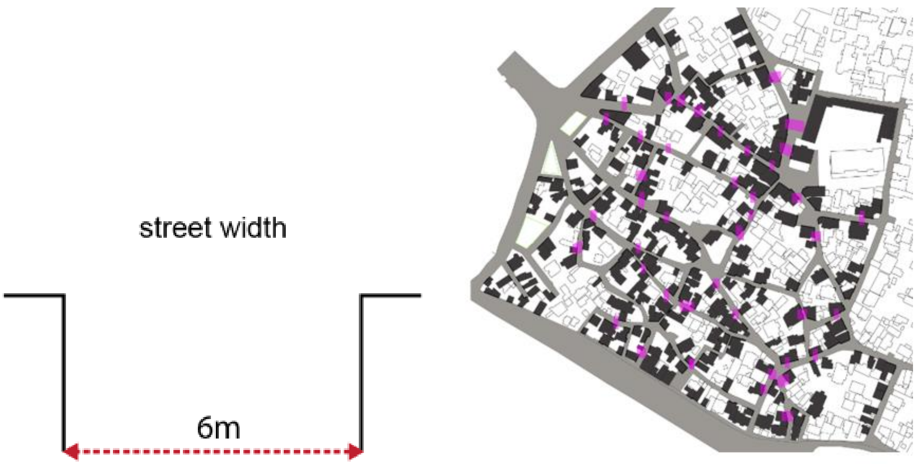


Figure 3.44 : Measurements for the street width.

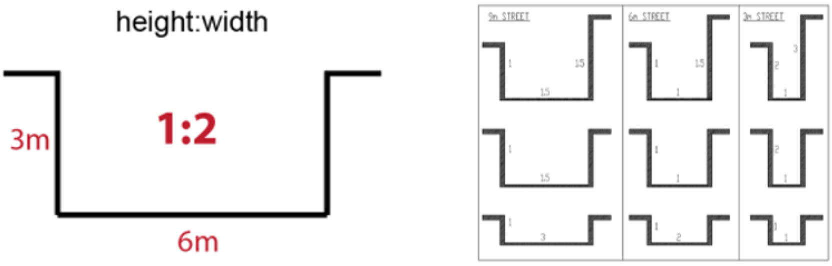


Figure 3.45 : Building height/street width proportions.

Very much related with street width is the height of the buildings that enclose it. The street space is completed in the third dimension by the buildings on its edge. A good street scape is the one that establishes balanced proportions between building height and street width and. If there are wide streets surrounded by low buildings the sense of enclosure and space definition is very poor. On the other hand, if the street is narrow and the buildings very high, the effect can be negative crating a very enclosed and oppressed space that overwhelms the users. The ratios of building heights to the street width that goes over 3:1 (4:1, 5:1) can create poor space definition while ratios like 1:4, 1:5 (height: width) might have the opposite effect. Analyses in the study area show that the most common proportions of height to the street width is 1:1.5 and 1:1 (Figure 3.45, 3.46). This is an evidence that show the good definition and enclosure of the street scape like in many other historical settlements.

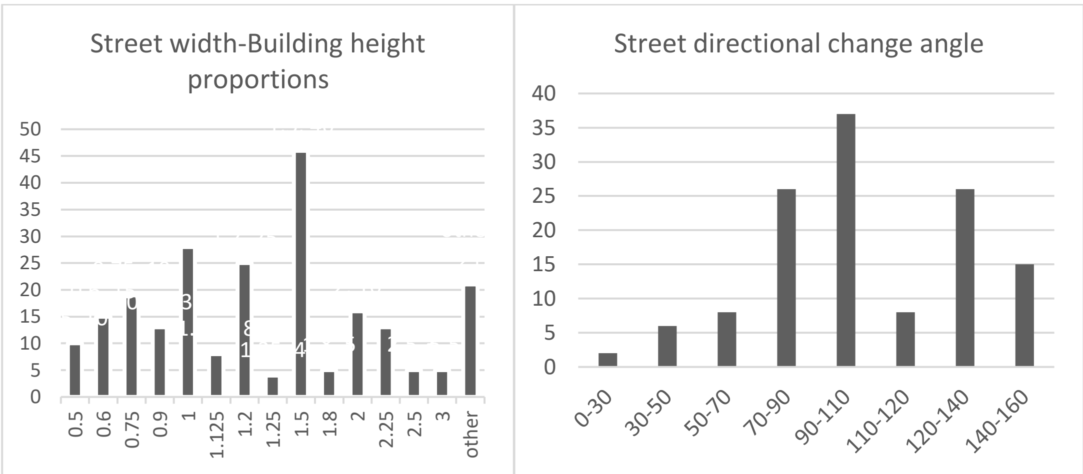


Figure 3.46 : Building height/street width proportions and directional change angles.

Figure 3.47 : Directional changes in street lines.

An interesting pattern in many traditional urban fabrics is the directional changes of the street line very frequently. Streets that go straight or are intersected at perpendicular angles create monotonous environment and decrease the level of human scale. On the contrary, smooth shifting of direction at particular frequencies that are in wide angles (above 90^o) or stronger changes with narrow angles (below 90^0) create very dynamic urban space, interesting street perspectives and provide scale to the street length. Looking to the case study, there is a high variety of different angles for directional changes, creating a rich urban pattern (Figure 3.47). Among 128 measurements, the most common angel is between 90^o- 110^o, followed by 120^o- 140^o and 70^o- 90^o (Figure 46). These types of directional changes provide important spatial organization that is related with principles mentioned above.

3.2.3.3 The plazas

The morphology of plazas is also another basic factor defining the character of urban space. The number of plazas in a neighborhood, their shapes, sizes, location, connections with the streets and their enclosing elements are some crucial components that can produce different types of urban space quality (Sitte 1965; Krier, 1979). The analyses regarding the measurements about plazas in the study area, are limited to three criteria: the number of plazas, their organization based on their sizes, and their connection with the streets. Observations show that there are around 27 plazas spread in the overall territory of the neighborhood (Figure 3.48). The high number of plazas and their location in different districts has the potential for providing a balanced relationship between built-up area and the public open spaces. Although many of them are very small plazas, created by the widening of the street, still they create some frequencies and pauses of the compact urban fabric.

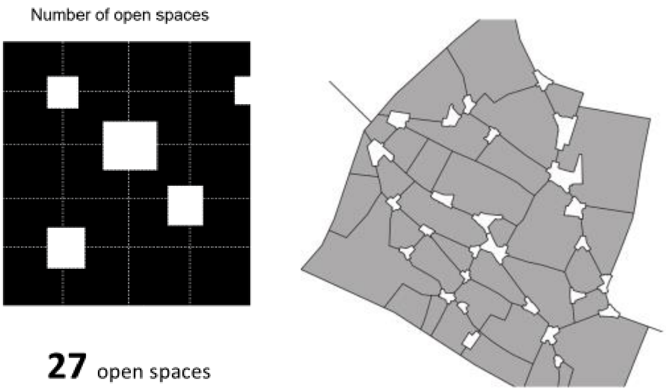


Figure 3.48 : Plazas in the study area.

Another analysis related with open spaces is the one that measures their surface area. The neighborhood has many small plazas, even the biggest one has a human dimension with an area around 1100m square. Differently from big squares, that have the risk of being not well-enclosed and without activities, small plazas can work better to establish a good enclosure, bigger interaction, close to human dimension (Sitte 1965; Gehl, 2010). There is also another interesting issue regarding the 27 small plazas in the neighborhood, they are organized in a kind of hierarchy in aspect of their sizes. As can be seen from the Figure 3.49 and Figure 3.50, there is a clear hierarchy that goes from the biggest main plaza of the neighborhood into many small plazas (pockets) spread around. So, there are sixteen small plazas with an area between 100-300m square, seven plazas between 300-500m square, three plazas between 500-800m square and one plaza around 1000-1100 m square. This distribution of different sizes and location provide a good balance in hierarchy of open spaces that frame the urban fabric.

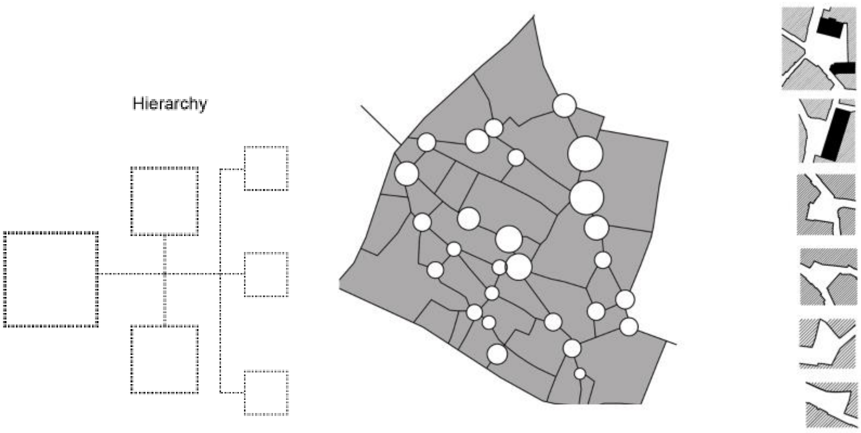


Figure 3.49 : Hierarchy of Plazas in the study area.

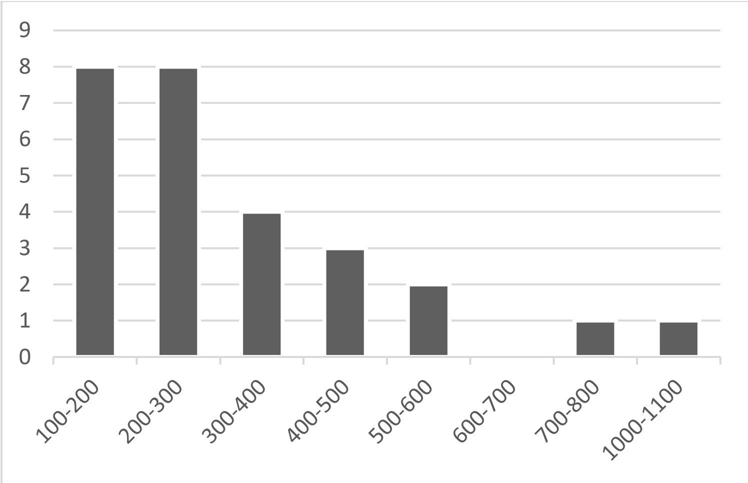


Figure 3.50 : The surfaces of Plazas.

The last analysis of plazas is focused on understanding their relationship with street connections. As Krier (1979) explains, the number, the typology and the location of streets that enter a plaza is important to understand different qualities of the plaza itself. A plaza is well enclosed if there are not many streets entering to it. Besides that, the streets should join the plaza from its corners. This can increase the surprising effect that plazas can have on users entering to them. On the other hand, having few streets that joins the plaza can decrease the accessibility of the public space. Analyses in the study area show that small pockets formed by the widening of the street have just two connections in both sides, small plazas that are located in street intersection have a lower sense of encloser, interrupted by three, four or five streets, and the bigger ones are well enclosed (by three or four streets). Regarding the position of the streets, many of them join the plazas from the corner point, creating surprising spaces, and well-defined pockets for potential activities (Figure 3.51, 3.52).

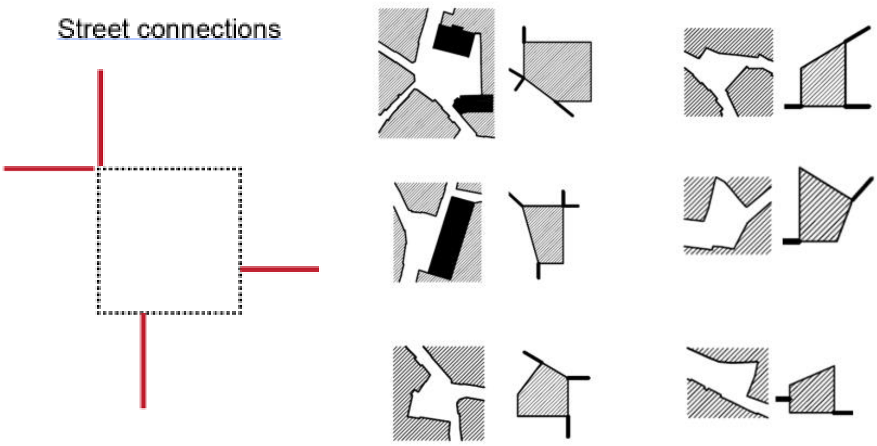


Figure 3.51 : Types of street connections in plazas.

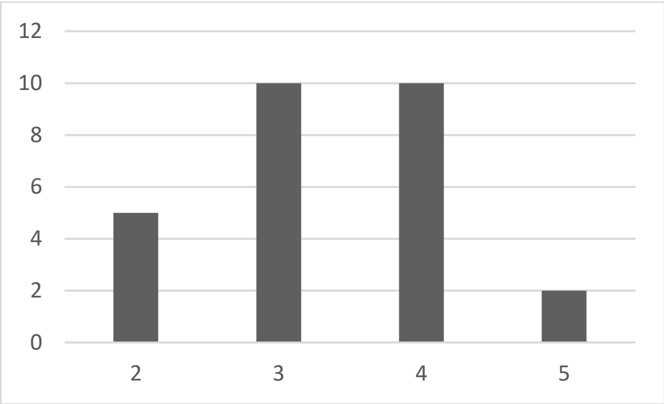


Figure 3.52 : The number of streets joining the plaza.

3.2.3.4 The blocks

The block pattern is directly related with street and parcel form. It is a derivate formed by a cluster of parcels surrounded by streets in all its sides. As shown in Figure 3.53, the study area is composed of many organic blocks in different shapes and sizes. Having an irregular form makes it difficult to implement strict geometrical measurements. However, there are some geometrical features that still can be extracted. Firstly, counting the number of all blocks can be helpful to understand the fragmentation of the settlement. Similar to the number of streets, the number of blocks is considerably high, particularly 35 (Figure 3.54), forming an authentic urban fabric. A settlement like this, which fragmented in smaller parts, establishes a rich layout of urban spaces and dynamic environment. The organic blocks that come together in different angles, form small holistic clusters that are connected by curvilinear narrow streets and small open spaces.

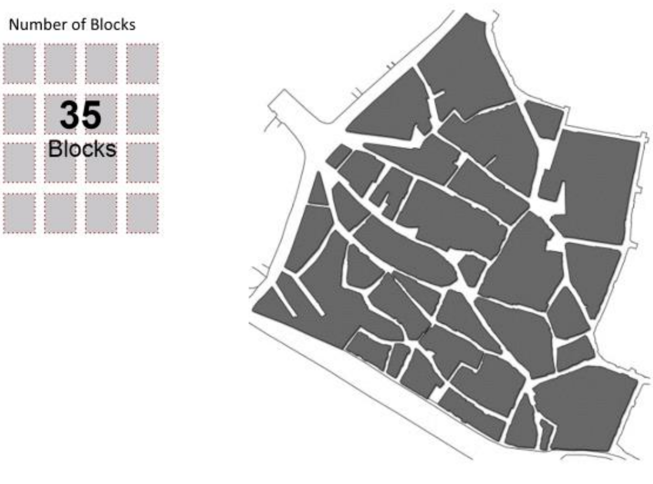


Figure 3.53 : The number of blocks in the neighborhood.

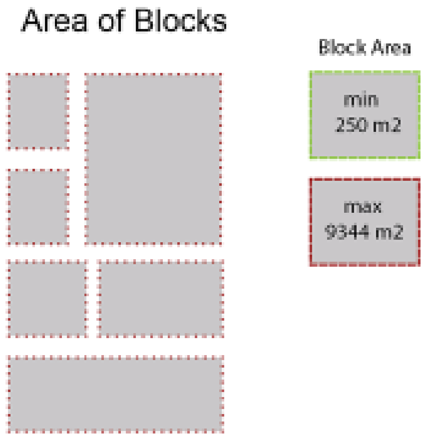


Figure 3.54 : Block surface areas.

The surface area of the blocks is another attribute calculated in this analysis. The surface of the block can be important to understand the typologies of blocks and the urban morphology in overall. The map in Figure 3.53 and Figure 3.55 show that there is a high variety of block sizes, regarding their surface area, creating a rich pattern of clusters. The smallest block is 250 m square while the largest one is 9344 m square. The other block sizes vary in-between these surfaces. The highest range of surface is between 1000m-2000m square, followed by the range 250m-1000m square and 2000m-3000m square. Large blocks over 5000m square are lower in number. Beside the variety of sizes there is also a high variety of shapes, forming rectangular like, triangular like and trapezoid like form that come together in a well-integrated structure.

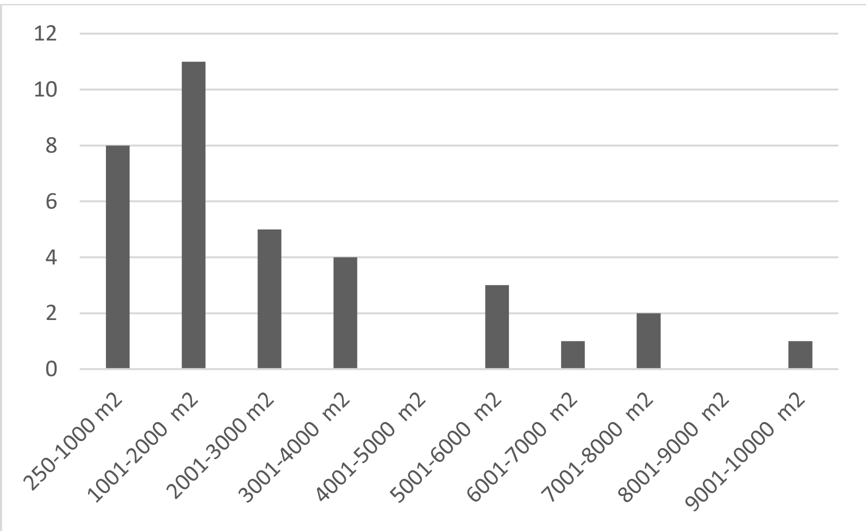


Figure 3.55 : Block surface areas.

The fragmentation of blocks in smaller units is done by parcels (plots). The number of parcels and their form depends on the surface and shape of the blocks and vice versa.

In this sense, the number of parcels in one block can be a useful information. Calculations have shown that the minimum number of parcels forming larger block is two and the largest numbers in one block is 34 (Figure 3.56). These are two extreme cases of one very small and one very large block. The average and the most common numbers are between 5-15 parcels per block (Figure 3.57). These creates a more balanced distribution of individual plots located in a common cluster, the block.

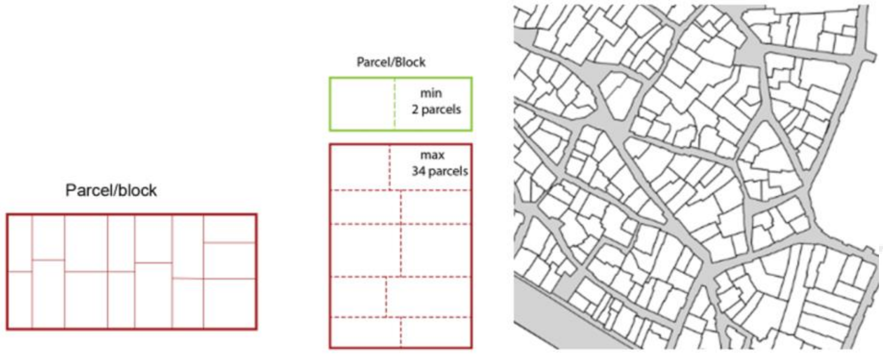


Figure 3.56 : Parcel analyses.

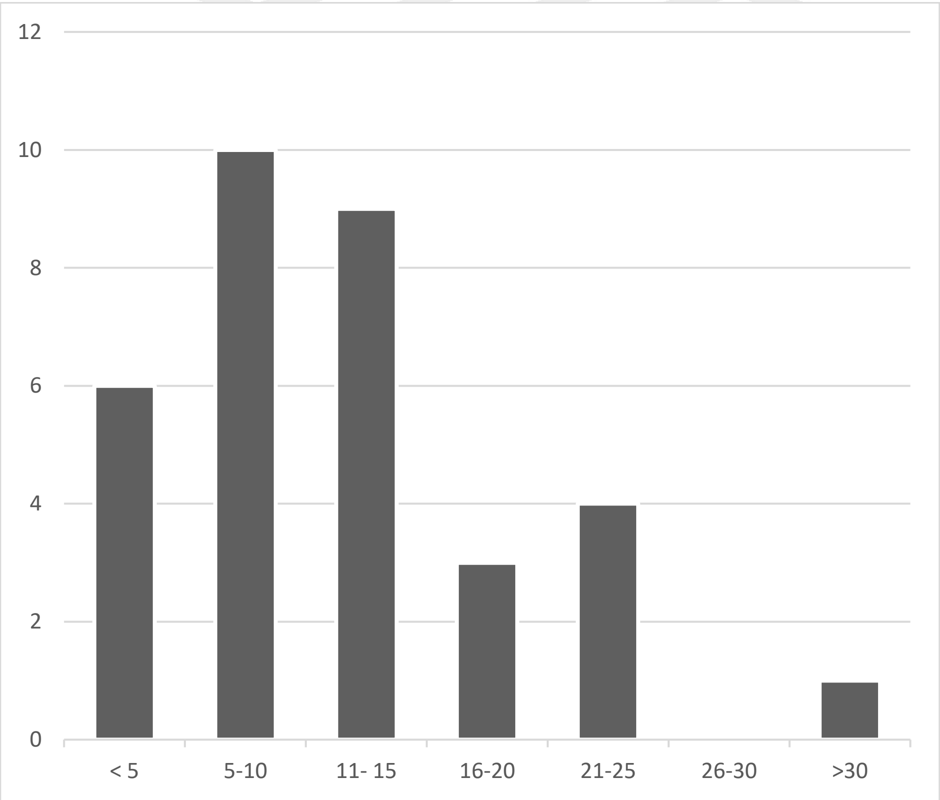


Figure 3.57 : Number of parcels/block.

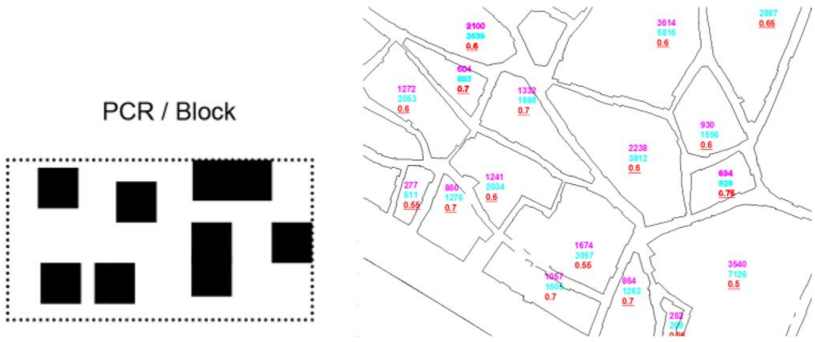


Figure 3.58 : Plot coverage ratio.

The final calculation regarding the blocks is done to measure the plot coverage ratio, which is the ratio of building surfaces to the overall block surface (Figure 3.58). This is crucial analysis to understand the proportion of solid-void or built-unbuilt area. Both surfaces of all buildings and the block is done of each unit and the ratio is extracted. As represented in Figure 3.59, most of the blocks have a plot coverage ratio close to 0.6. Most other values are also close to that ranging from 0.45 to 0.75. These values show two important features of the settlement: firstly, these ratios show that the settlement is very compact; and secondly, they represent a balanced relationship of solid-void in spatial composition.

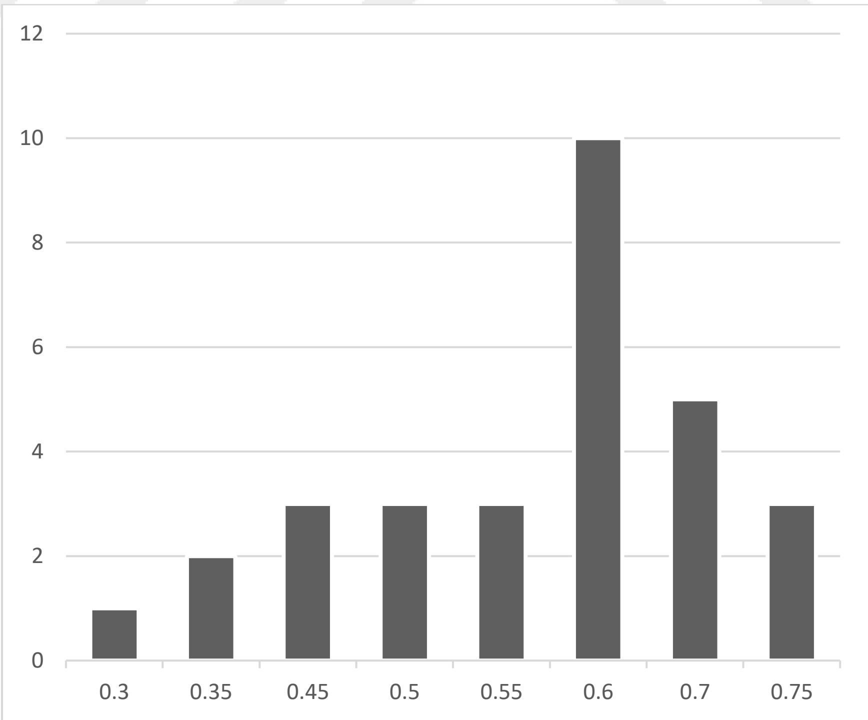


Figure 3.59 : Plot coverage ratios.

3.2.3.5 The parcels

The parcel or the plot is considered as one of the basic morphological units that defines the form of urban fabric (Moudon, 1997). In this context, analyzing the features of parcels in any settlement should be a significant issue. The observations in the neighborhood, show that there are 397 parcels within the study zone. From the number of parcels, we can extract approximate information about population or building number. In addition to that, the surface area of the parcels is also important. The settlement has a wide range of different parcels, but most of them have very close sizes, forming a harmony of fragmentation. The smallest parcel is 35m square and the largest one is 617m square, but these are smallest in number (Figure 3.60). Most of the parcels have sizes between 100m-250m square (Figure 3.61). There are also some parcels in smaller and larger sizes. This type of distribution provides both a homogeneity for coherence in the urban fabric but also provide opportunity for the construction of small houses or larger ones for different types of families.

Figure 3.60 : Parcel number and surface analyses.

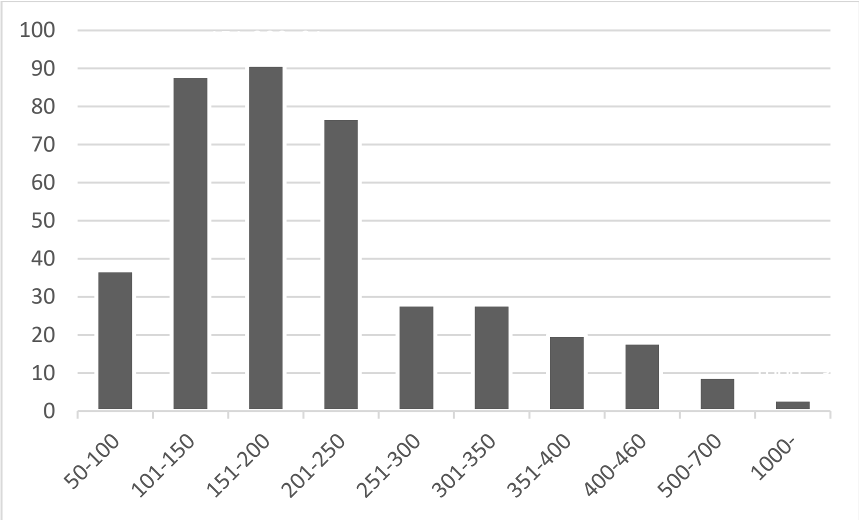


Figure 3.61 : Parcel surface intervals.

Other features of parcel pattern can be understood by analyzing their form typology in relation to the street. In this line, the study makes a categorization of parcels as: narrow, wide and quadrate ones. If the parcel faces the street with its narrow side it means it is a narrow parcel, if the wide side faces the street it is categorized as wide parcel, and if width and depth of the parcel have close dimensions is listed as quadrate parcel (Figure 3.62). Analyses in this issue show that most of the parcels face the street with their narrow side (Figure 3.63).

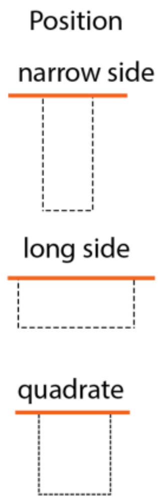


Figure 3.62 : Position of the parcels in relation to the street.

This is a universal principle for any kind of settlement to increase the efficiency of land use and accessibility. Figure 3.63 shows the accurate distribution for each typology of parcels.

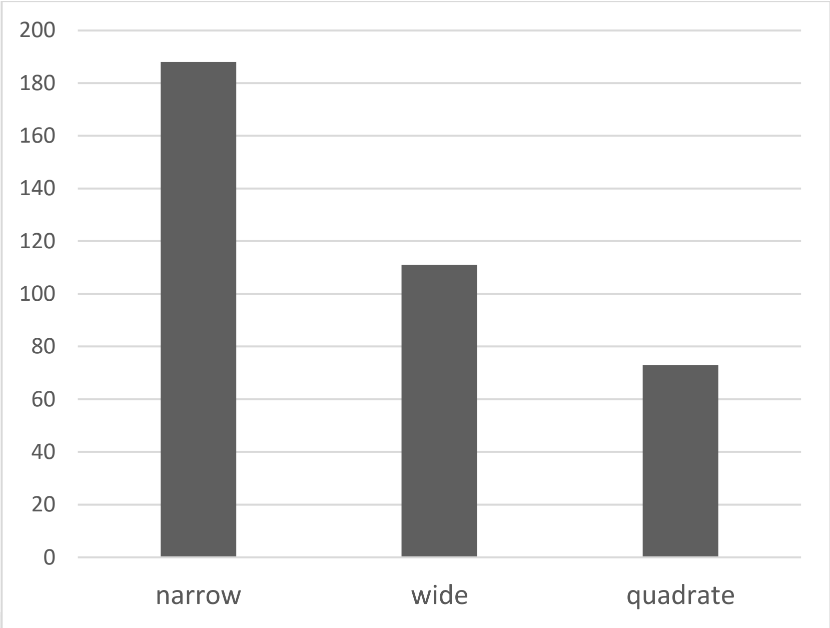


Figure 3.63 : Chart showing the position of the parcels in relation to the street.

Besides the position of the parcel in relation with the street, their dimensions and proportions are also important parameters to be extracted. Based on that, a measurement of parcel width and depth is done for all the parcels (Figure 3.64). The measurements show that there is not any dominant value that represent the trend of parcel width. There is a kind of homogenous distribution of parcel width that varies in the interval between 6m-15m. The highest number is between 12m-15m. Parcel width between 8m-9m and 9m-11m are also in a very high number. Regarding the depth of the parcels, they vary from 10m to 65m. Most common depth varies in interval of 18m-20m, 21m-25m and 16m-17m. The Figure 3.65 the distribution of all the intervals for the parcel depth analyses.

Figure 3.64 : Parcel dimensions analyses.

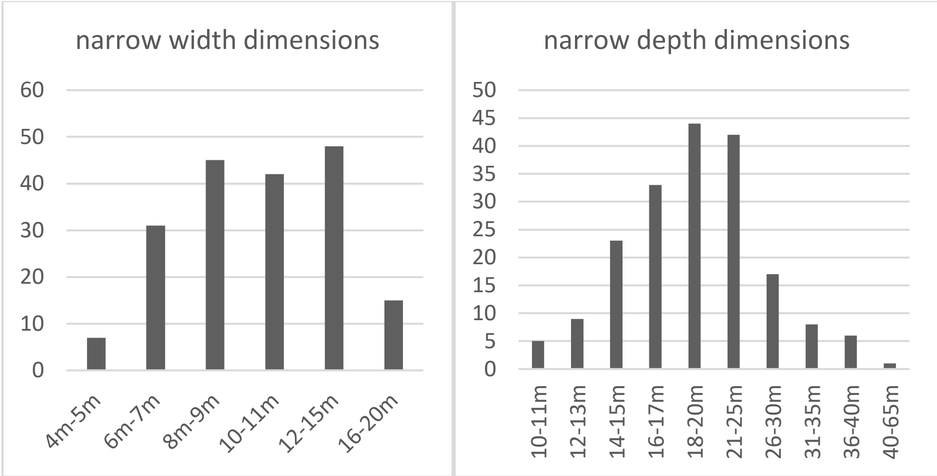


Figure 3.65 : Parcel dimensions analyses.

Only width and depth analyses are not enough to have a comprehensive understanding about parcel typology, their proportions are also very fundamental. The ratios of the width to the depth can be important to establish principles rather than particular dimensions. In this context, further analyses are done to understand the proportions for both narrow and wide parcels (Figure 3.66). Measurements show that there is trend of specific proportions for both types of parcels. The most repeated ratio for both is 1:1.5 (Figure 3.67). This is also similar to the ratio of building height to the street width, representing a kind of rule in the settlement. The second most repeated proportion is 1:2. The values for all extracted proportions are shown in Figure 3.67.

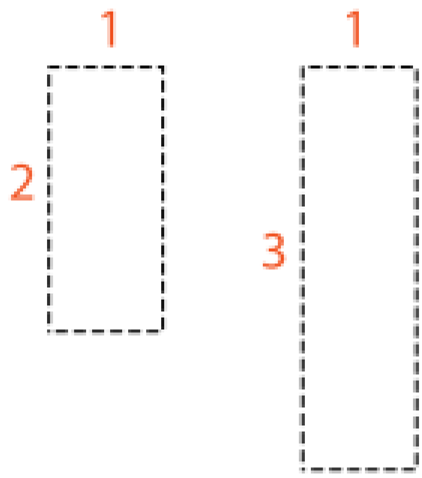


Figure 3.66 : Parcel proportion analyses.

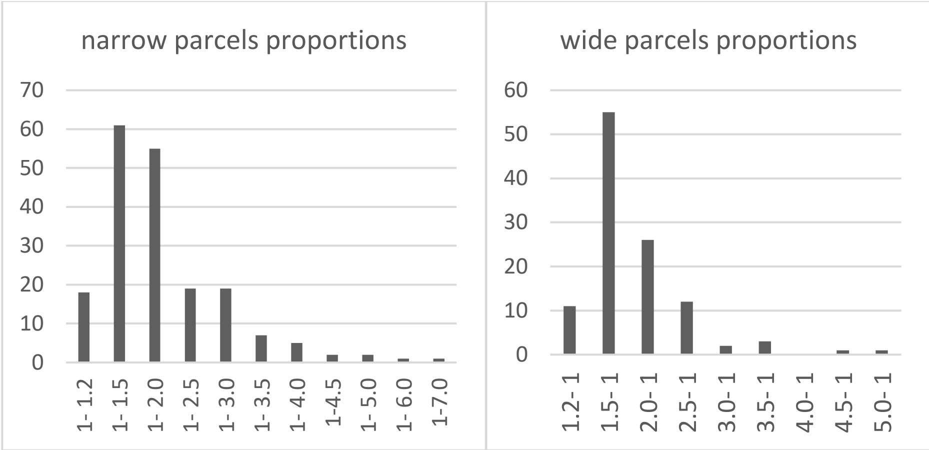


Figure 3.67 : Parcel proportion analyses.

3.2.3.6 The buildings

The final analysis for measuring the attribute of urban morphology in the study area is focused on building fabric and its relationship to the courtyard and the street. The combination of these three components defines importantly the spatial composition of urban spaces. Regarding this, the analyses try to identify the principles related to the location of the building in the parcel, its relation to the street, the orientation of the courtyard, and setback distances between the building perimeter and parcel boundary. Firstly, the location of the building in the parcel is analyzed for different alternatives. As shown in Figure 3.68, there are twelve different alternatives regarding the position of the courtyard in relation to the building and the street: just front courtyard (F), just back courtyard (B), both front and back courtyard (FB), courtyard just in one side (1S), courtyards just in two sides (2S), Front + one side courtyard (F1S), Front+ two side courtyard (F2S), back+ one side courtyard (B1S), back+ two side courtyard (B2S), front+ back+ one side (FB1S), courtyard in all sides (FB2S), and no courtyard (NC). The number of each alternative is identified through a detailed analysis. Figure 3.69 shows the distribution, where the most common pattern is the building with just courtyard in the front, and the less common patterns are the buildings that have both courtyard in front and two sides. Buildings with courtyards in front and back (FB), B1S, 1S and FB1S are also at a considerable number. The analyses show that there is a kind of trend but also there is a high variety of courtyard typology, providing a rich pattern in the neighborhood.

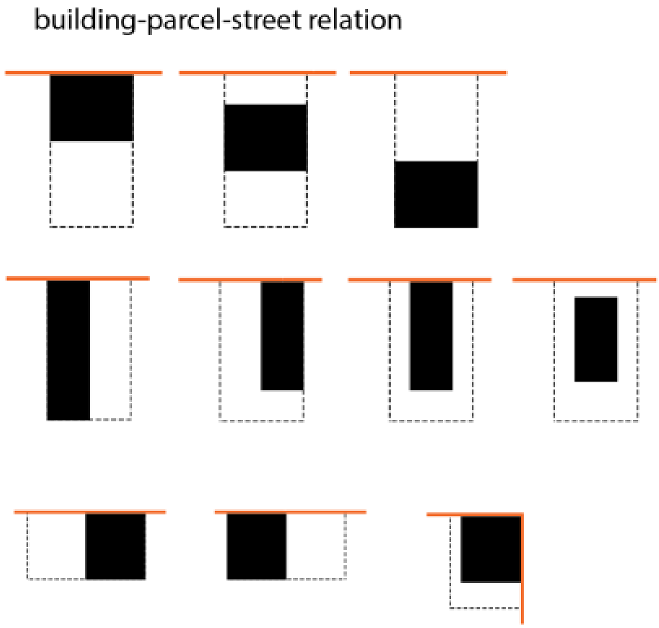


Figure 3.68 : Location of the building in the parcel.

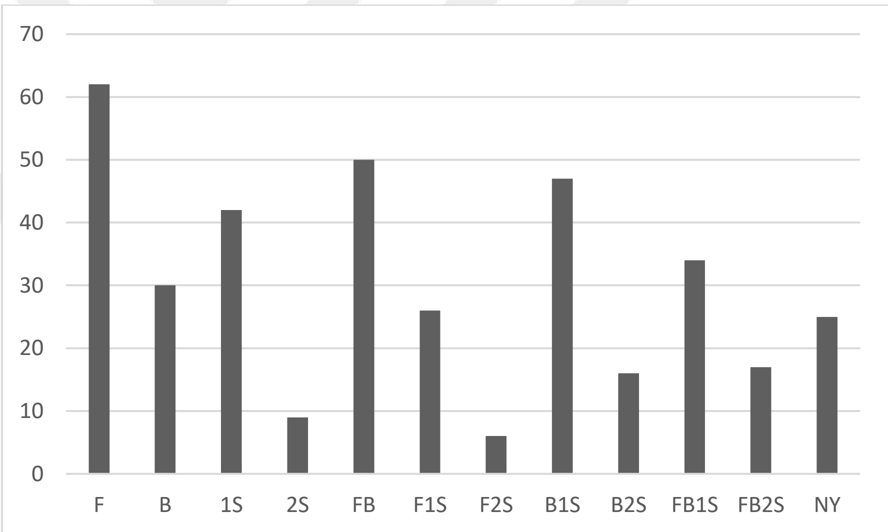


Figure 3.69 : Location of the courtyard inrealtion to the building.

Another basic analysis is done to identify the orientation of the courtyard regarding the position of the sun (Figure 3.70). All the possibilities are identified and represented in the Figure 3.71. In this aspect, related also to the orientation of the street, most of the courtyards are positioned on the southwest direction (SW). This is followed by courtyards positioned in northeast (NE), northwest (NW), and southeast (SE) directions. Other directions (N, S, E, W) are at very low rates.

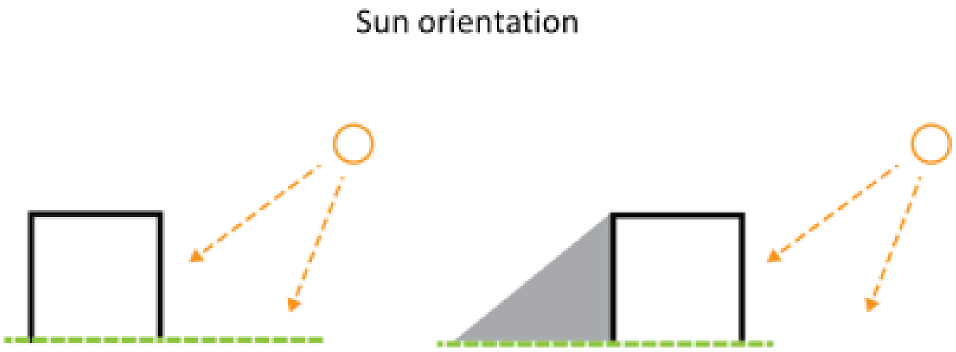


Figure 3.70 : The orientation of courtyards.

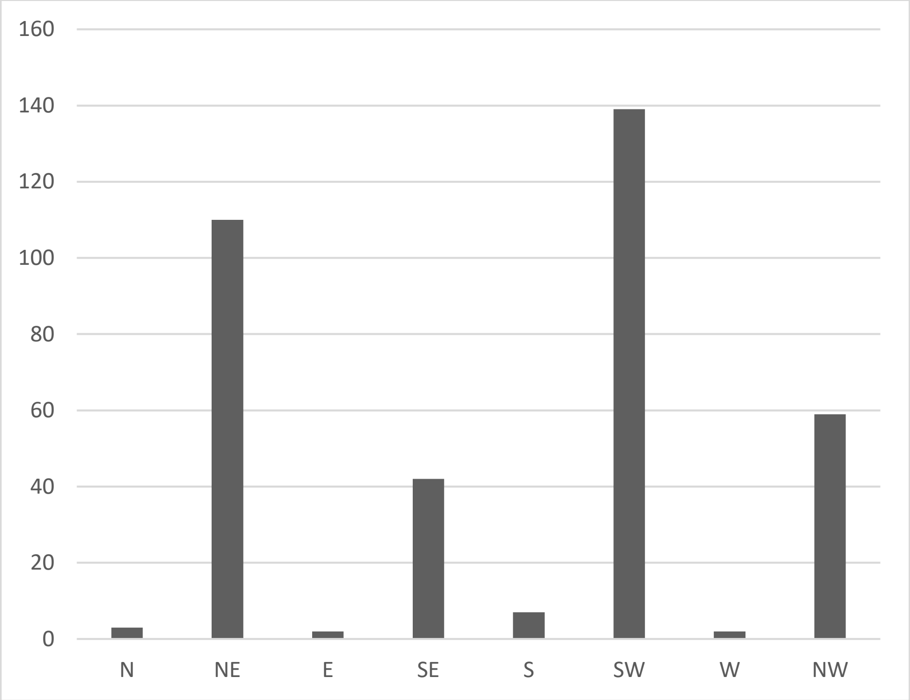


Figure 3.71 : The orientation of courtyards.

The following analysis makes a synthesis of two previous observations by combining the courtyard typology and its orientation. The results are represented in the Table 3.18 and Figure 3.72. Based on this analysis, the most common pattern is the front courtyard located on the southwest and the second one is the front courtyard located on northeast. This is followed by a more homogenous distribution for some other typologies such as: 1S northeast, 1S southwest, FB southwest, FB northeast, B1S northeast, B1S southwest and FB1S southwest. Other alternatives are also present but at lower levels.

Table 3.18 : Matrix showing the type of courtyard and its orientation.

Position/ orientation	N	NE	E	SE	S	SW	W	NW
F	1	20	0	2	2	29	2	6
B	1	10	0	6	1	9	0	3
1S	0	16	2	5	0	12	0	7
2S	0	4	0	0	0	4	0	1
FB	0	16	0	5	0	19	0	10
F1S	0	6	0	5	1	6	0	8
F2S	0	1	0	1	0	3	0	1
B1S	0	15	0	7	2	14	0	9
B2S	0	8	0	1	0	5	0	2
FB1S	1	5	0	4	0	17	0	7
FB2S	0	5	0	4	1	7	0	0
NY	0	4	0	2	0	14	0	5

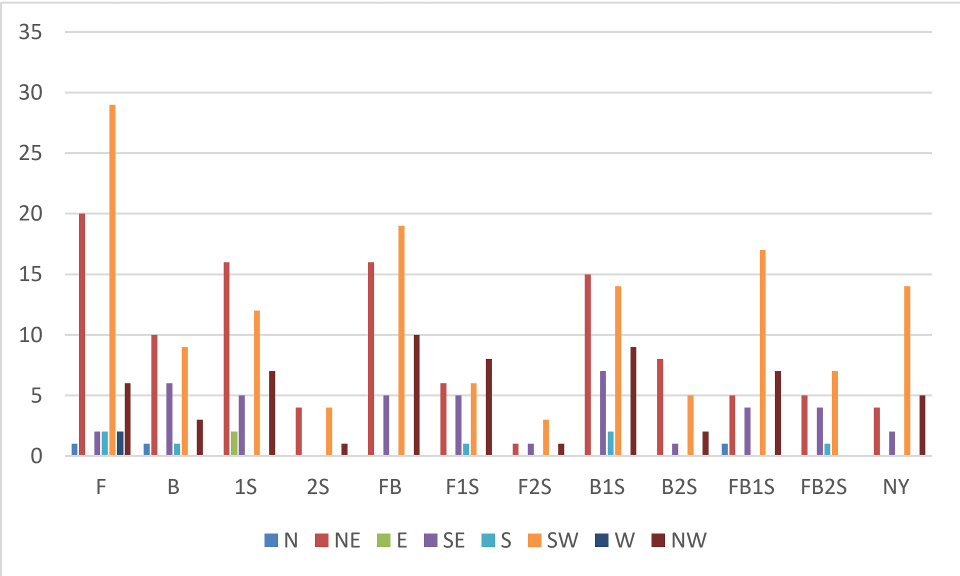


Figure 3.72 : The location and orientation of courtyards.

The final analysis in this section deals with the identification of setback distances between building perimeter and parcel boundary (Figure 3.73). This is important to understand the urban layouts and the compactness of the morphology. The distances are measured for all the buildings and parcels in the study area. So, for the front yards there is a variety of distance that starts at the interval 1m-2m and goes up to distances above 14m. The most common ones are the distances of 3m-4m, 5m-6m, and 7m-8m (Figure 3.74). For the back courtyard the distances between the building and the parcel boundary are little bit lower. The most common ones are: 3m-4m, 5m-6m, and 1m-2m (Figure 3.74). While the side courtyards have a variety between 1m-18m, and the most common ones are 3m, 2m, and 4m (Figure 3.75).

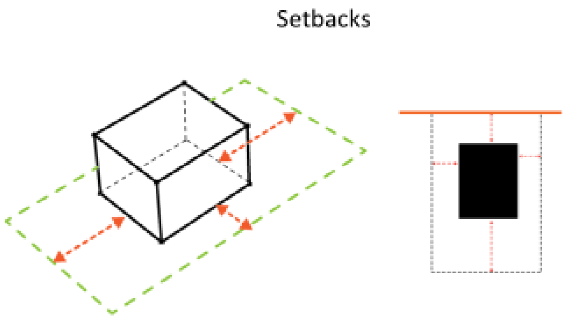


Figure 3.73 : Building setbacks.

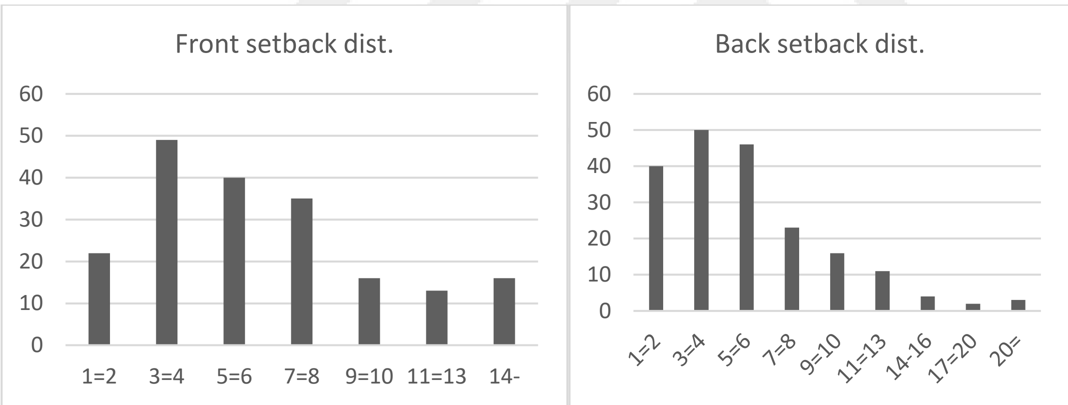


Figure 3.74: Building setbacks.

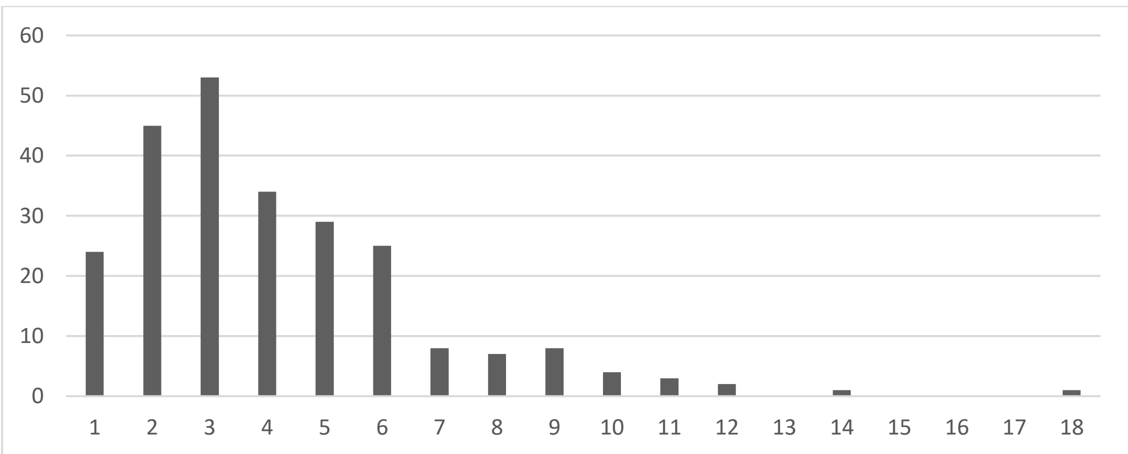


Figure 3.75 : Building side setbacks.

In conclusion, the analyses in this section are focused on understanding the spatial composition of different morphological units by measuring some of their geometrical features. These physical characteristics are a result of a complex process that include many socio-cultural, economic and environmental conditions of the zone. Although the analyses try to make a connection to these factors, it is not in its scope to measure socio-economic or environmental parameters in the study area. The focus is more on measuring the physical attributes of the settlement. These measurements are important to understand some characteristics of the urban fabric but also can be very useful in providing a database and a set of principles that can be integrated in any possible model for urban development. The measurement analyses extract the distribution of frequencies for each calculation and identifies what are the common principles for each morphological unit.

4. CONCLUSIONS AND RECOMMENDATIONS

The modern planning philosophy and its implementation has been widely criticized for establishing a top-down approach which imposes certain masterplans for the organization of the urban space. Moreover, it has produced standard cities that lack the complexity of life, do not consider too much the context, the nature and the human dimension. In this context, there is a broad literature and discourse that suggests that historic cities are more successful in many aspects and there are many lessons that can be learned from these settlements.

The concept of this thesis is based on this approach, trying to identify the ways of learning from vernacular, self-organized settlements. It supports the idea that traditional cities are very successful on embracing a much more comprehensive and complex process that includes many actors, is respectful to local values, and respond to the needs of the communities. This approach claims that vernacular urbanism was capable to establish a complex set of relationships, to produce a coherent, good working system and to create an 'organized complexity', a 'spontaneous order'. In this context, the thesis raises the following hypotheses related to this issue:

Hypothesis 1: The spatial elements that determine the structure of historic settlements have a systematic relationship within themselves and among each-other.

Hypothesis 2: The features of spatial composition in historic settlements can be measured and used as design parameters for possible future urban developments.

Hypothesis 3: Taking references from historic settlements in the planning and design process of new urban areas is very significant to maintain (sustain) the urban memory of a place.

For further elaboration of these three hypotheses, the study uses a hybrid methodology that is implemented in the analyses of a historic neighborhood in the city of Korça, as the case study. This methodology includes three different types of analyses: pattern language analyses, fractal dimension analyses, and geometrical measurements of physical morphology in the study area. Firstly, the study uses some of the pattern language principles, developed by Christopher Alexander. These analyses are helpful to find out if study area possess 'the quality without a name', as defined by Alexander

(1979). This quality is very fundamental to create a living, rich, dynamic, coherent, complex environment which responds to the user needs. The second analysis focuses on a procedure that implements the measurement of the fractal dimension of various morphological units in the study area. The fractal dimension concept is very useful to analyze the organic settlements and understand if there is an order and a coherence in their spatial organization. The final section of analysis deals with geometrical measurements in order to identify some physical features related with spatial organization in the neighborhood. These measurements are important not only to identify some spatial attributes of urban space but also to establish a set of rules that can be integrated in any possible future model for urban development. Some recommendations regarding this issue will be elaborated in this chapter.

The study area, located in the city of Korça, consists of an historic neighborhood near the central zone. The neighborhood is used as a unit for the above-mentioned analyses. This settlement started to develop and consolidate during the ottoman period. It is built in a spontaneous process, as a product of many individual actions that form a complex and coherent whole. Nowadays, although gone through some transformations and adaptations, it maintains many features of the traditional urban fabric. The neighborhood is organized in an organic pattern of streets and plots. It consists mainly of low-rise courtyard houses, forming a compact urban texture. The morphological elements provide a dynamic pattern and a rich spatial experience with narrow curvilinear streets, fragmented by small plazas and surrounded by small compact housing units.

4.1 Discussion of Hypotheses

This section evaluates each of the hypothesis based on results extracted from analyses in the study area.

Hypothesis 1: The spatial elements (features, characteristics) that determine the structure of traditional (or vernacular, historic) settlements have a systematic relationship within themselves and among each-other.

The study makes two different types of analyses to test and evaluate this hypothesis in the study area: pattern language analyses and fractal dimension measurements. The results from both analyses show strong arguments that support the above-mentioned hypothesis. Firstly, analyses related with pattern language include a wide set of parameters that establish a complex, dynamic and living environment which contains authentic elements and at the same time form a coherent, organized complexity. There are around fifty principles extracted from the pattern language which are identified in the study area through analyses and observations and twenty-one of them analyzed in more detail. The degree of presence is not always in its highest level, creating a variety of patterns represented strongly, at a moderate level and in some cases in a lower degree. While patterns such as the identifiable neighborhood, four story limit, small plazas, house cluster, degrees of publicness and many others are present at a strong level, patterns like the access to water, life cycle, household mix, activity nodes are present at lower degree. There are also other patterns that are not directly present in the neighborhood, but they can be identified in very adjacent zones to the study area such as the shopping street, travelers in and promenade. Finally, there are also patterns that are not strongly present in the neighborhood but there is a high potential of the urban fabric to accommodate them. Examples of this include connected play, activity nodes, bike path and some other patterns. However, in overall, the study area has many qualities, defined by Alexander as patterns that create life and sustainability in an urban habitat.

These patterns have the potential to provide an environment that make people feel comfortable in psychological and sociological aspects. They also, form an open system that is dynamic for adaptations and sets complex interrelationship that establish a living ecosystem. Furthermore, these universal parameters that differ based on local context provide a successful and good working environment, effectiveness in spatial compositions, and a variety of beauty.

The second analyses that support the hypothesis of order in the settlement is related to the fractal dimension of its morphological units. Fractal analyses have shown that this organic settlement, that might be considered as unorganized and chaotic by conventional geometric approach, contains a much more complex order formed by multiple relationships. Fractal dimension measurements show clearly that the morphological units have fractal structures and similarities across scales, making them coherent within themselves. Table 4.1 represent the fractal values for each morphological unit and the similarities within itself. As can be seen here, there are many similar values in different scale of each unit, representing a kind of order across scales of a morphological component.

Table 4.1 : Comparing fractal values for each component at different scales.

Streets				Buildings					Plazas		
	20-10	10-5			20-10	10-5	5-2.5				
S1	1.41	1.33		B1	1.83	1.72			P1	1.25	
S2a	1.40	1.33		B2a	1.78	1.72			P2a	1.10	1.45
S2b	1.33	1.34		B2b	1.64	1.73			P2b	1.39	1.63
S2c	1.40			B2c	1.81	1.69			P2c	1.00	1.47
S3a	1.32	1.63		B3a	1.65				P2d	1.18	1.59
S3b	1.34	1.66		B3b		1.66	1.72		P2e	1.28	1.59
S3c	1.32	1.73		B3c			1.66		P2f	1.44	1.66
S3d	1.43	1.78		B3d		1.69	1.71		P2g	1.59	1.62
S3e	1.55	1.77		**B3e**			1.76		P2h	1.49	1.60
S3f		1.62		**B3f**			1.70		P2i	1.42	1.69
S3g	1.60	1.74		**B3g**		1.68	1.62		P2j	1.71	1.49
S3h	1.63	1.74		B3h		1.59	1.61		P2k	1.49	1.63
S3i	1.57	1.79							P2l	1.59	1.68
									P2m		1.65

More importantly, the values of fractal dimensions discover that there are strong similarities among different morphological units and scales, providing a systemic relationship and coherence in the urban fabric (Table 4.2). As shown in Table 4.2, there are three comparisons to identify the similarities between different morphological units: comparison of streets with buildings (S/B), streets with plazas (S/P), and buildings with plazas (B/P). The comparison is shown with similar colors in vertical direction in the Table 4.2. The red color shows the highest number of similarities, the blue shows the second highest, the green is third and purple is the least. So, there is a big similarity of fractal dimension of streets and buildings in different levels. Particularly, there are 42 similarities spread in five intervals. The highest number of similarities is in the interval of values between 1.68-1.74 (red color), with thirteen close fractal values. The second one is in the interval 1.61-1.66 (blue color), eleven close values, and the third one is in the interval 1.77-1.83 (green), six close values.

The same comparison is done for the fractal of street pattern and plazas. As shown in the table above, there are 36 similarities in four intervals. The highest number of similarities between streets and plazas is in the interval of values between 1.59-1.65 (red color), with fifteen close fractal values. The second one is in the interval 1.39-1.45 (blue color), nine close values, and the third one is in the interval 1.00-1.28 (green), seven close values.

Table 4.2 : Comparing fractal values for all components at different scales.

S/B	20-10	10-5	5-2.5	S/P	20-10	10-5	5-2.5	B/P	10-5	5-2.5
S1	1.41			S1	1.41			B1	1.72	
S2a	1.40			S2a	1.40			B2a	1.72	
S2c	1.40			S2c	1.40	1.28		B2b	1.73	
S3a		1.63		S3a		1.63		B2c	1.69	
S3b		1.66		S3b		1.66		B3a	1.65	1.58
S3c		1.73		S3c		1.73		B3b	1.66	1.72
S3d	1.43	1.78		S3d	1.43			B3c	1.57	1.66
S3e	1.55	1.77		S3e				B3d	1.69	1.71
S3f		1.62		S3f	1.18	1.62		B3e		1.76
S3g	1.60	1.74		S3g	1.60	1.74		B3f	1.55	1.70
S3h	1.63	1.74		S3h	1.63	1.74		B3g	1.68	1.62
S3i	1.57	1.79		S3i				B3h	1.59	1.61
B1	1.83	1.72		P1	1.25	1.39		P1		
B2a	1.78	1.72		P2a		1.10	1.45	P2a		
B2b	1.64	1.73		P2b		1.39	1.63	P2b		1.63
B2c	1.81	1.69		P2c		1.00		P2c		
B3a		1.65	1.58	P2d		1.18	1.59	P2d		1.59
B3b		1.66	1.72	P2e		1.28	1.59	P2e		1.59
B3c		1.57	1.66	P2f		1.44	1.66	P2f		1.66
B3d		1.69	1.71	P2g		1.59	1.62	P2g	1.59	1.62
B3e		1.43	1.76	P2h			1.60	P2h		1.60
B3f		1.55	1.70	P2i		1.42	1.69	P2i		1.69
B3g		1.68	1.62	P2j		1.71		P2j	1.71	
B3h		1.59	1.61	P2k			1.63	P2k		1.63
				P2l		1.59	1.68	P2l	1.59	1.68
				P2m			1.65	P2m		1.65

The final comparison is done between building pattern and plazas (B/P). The last two columns in the table represent this comparison, identifying 32 similarities in two intervals. The highest number of similarities between buildings and plazas is in the interval of values between 1.65-1.72 (red color) with eighteen close fractal values, and the second one is in the interval 1.55-1.63 (blue color) with nine close values.

All these analyses showing the big similarities in form for different morphological units are strong evidence that support the hypothesis of an order and a systemic relationship in the organic vernacular settlement studied in this research. Both pattern language analyses and the fractal dimension measurements contribute to idea that there is a coherence and kind of hidden order in the components that form the urban fabric in the case study.

Hypothesis 2: The features of spatial composition in traditional (vernacular, historic) settlements can be measured and used as design parameters for possible future urban developments.

The research makes a very detailed analyses including hundreds of measurements for different morphological units and scales. These measurements consist of geometrical calculations that extract the spatial (physical) features of the urban tissue. Based on Conzenian approach, the urban morphology is divided in four main categories: streets, blocks, plots, and buildings. They include also some calculations that extract information for the overall neighborhood. The categorization is helpful to make the procedure of measurement easier. The calculation gives accurate information about the geometrical features of each unit and identifies the common (the trend) attributes or frequencies of values, proportions, intervals, sizes, distances and ratios. For example, the measurements for street pattern identify parameters such as: the number of streets, their orientation, their surface, street width, directional changes and other physical properties. The analysis show that the urban form not only can be measured but the information can be structured in frequencies that show the most common features, the average values or the less repeated characteristics. This is a crucial to synthesize the information of the large data and extract the common features of the urban morphology. The analyses show the most common street width, the most repeated proportion of street width and building height, the intervals of angles in street directional changes and other important attributes of spatial compositions. The same procedure is followed also for other components that are the plots (parcels) and buildings. Consequently, the analyses show that the features of spatial composition can be measured even in organic vernacular settlements, that might seem irregular in form.

The second part of the hypothesis suggests that these measurements can be very useful as design criteria in any possible urban development model that aims to take references from traditional urban fabric. In this context, here we suggest a framework that shows how this data can be structured for this purpose. However, it is important to notice clearly that this framework can be considered just as a helping tool in the complex process of urban design that includes many other parameters and actors. This framework can be integrated in any computed model that implements the steps and the calculations extracted from the analyses. It is also worthy to mention that the methodology of measurements and the framework can be implemented in any other context, which can produce different results from the one presented in this research. In this section, the study tries to identify the frame and the steps that can be helpful to build a model which uses the parameters extracted from the analyses. It aims to develop a conceptual scenario which can be a guide by defining the steps for a possible computed model in the future. The scenario is built in two different approaches by using the same parameters. The first alternative is developed in an inductive process, starting from smaller units to larger urban fabric. The second is a deductive process, defining firstly the parameters of spatial composition in larger scale and later, step-by-step detailing the structure for smaller units. Both approaches can be useful to be part in any process of building a model. However, the inductive process can be more appropriate since it has a more generative nature, is more flexible for adaptations, and has the capacity to produce more alternatives. The parameters are filtered in order to use the most relevant ones in the process of structuring the urban morphology. In the section below, the study tries to define some steps that can be followed to structure a kind of algorithm for any possible model. Firstly, it elaborates the inductive approach and explains the parameters to be implemented in each step.

4.1.1 The inductive approach

The inductive process starts with defining the smaller units and later adding new components to form the overall structure of the neighborhood (Figure 4.1).

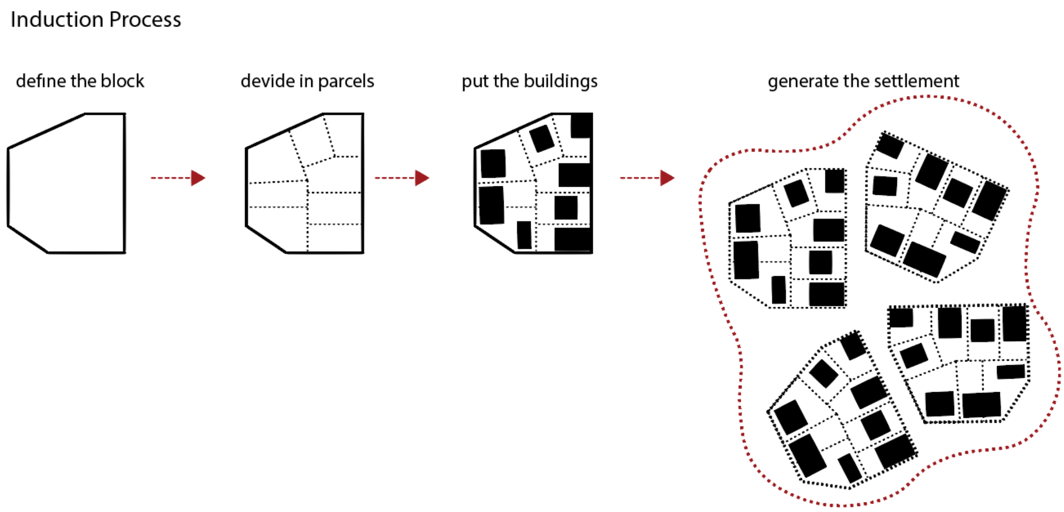


Figure 4.1 : The inductive approach in generating the settlement.

In this context, the first two steps define the boundary and the context where the parameters can be implemented. After that, the procedure starts at a local scale by defining the parameters of the blocks, parcels and buildings. Later, new units are added to generate the overall settlement in the defined boundary. In general the steps for the inductive approach can be summarized as follows: 1-define an area (boundary) for the neighborhood; 2-put the natural and existing infrastructure; 3- draw a block at any location inside the area; 4- Define the features of the block unit; 5- Define the features of the parcel pattern; 6- Define the features of the building fabric; 7- generate a district including some blocks; 8- Add plazas and define their features; 9- Continue to generate the other parts of the settlement using the same procedure; 10- Go back and test the parameters; 11- develop different alternatives for the settlement; 12- choose the most appropriate ones; 13-re-check and test the parameters. Each of the steps is explained in a more detailed way in the flowing section.

Step one: Define an area for the neighborhood

This area should be in an appropriate size for a meaningful neighborhood. It should be in a walking distance, and near a major infrastructure road. Taking reference form the analyses, the area can be between 10-15 ha (Figure 4.2). However, this is not very significant. The parameters can be used also for any other area.

Step two: Update the map by putting the existing natural components and manmade infrastructure

This step is important to identify the existing structure of the selected area. This infrastructure is an orientation and limitation to the implementation of the parameters. The new units should be integrated to the existing infrastructure which includes natural components and manmade infrastructure such as: vegetation, water systems, agricultural lands, forest, roads and buildings.

Step three: Draw a block in any location inside the area

This step is starting point for implementing the inductive approach in the area. It can be in any location within the boundaries. The first three steps are illustrated in Figure 4.2.

Step four: define the features of the block unit

The detailed sub-steps for this phase are as following: 4a-draw a block; 4b-define the minimum and maximum surface area of the block (min:250 m^2, max: 800m^2); 4c-define the maximum/minimum/common length and depth of the block (max length: 70m, min length:25m, max depth:30m, min depth: 15m); 4d- develop alternatives of block shape (quadrate, rectangular, trapezoid, triangular); 4e- develop some alternatives for each shape; 4f- choose one alternative; 4g- re-check and test the parameters. The procedure of the steps is illustrated in Figure 4.3.

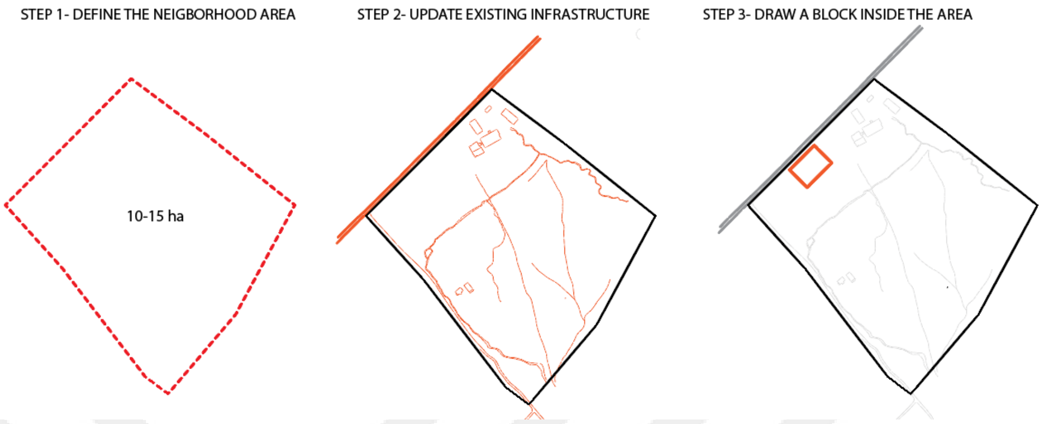


Figure 4.2 : The first three steps of the inductive approach.

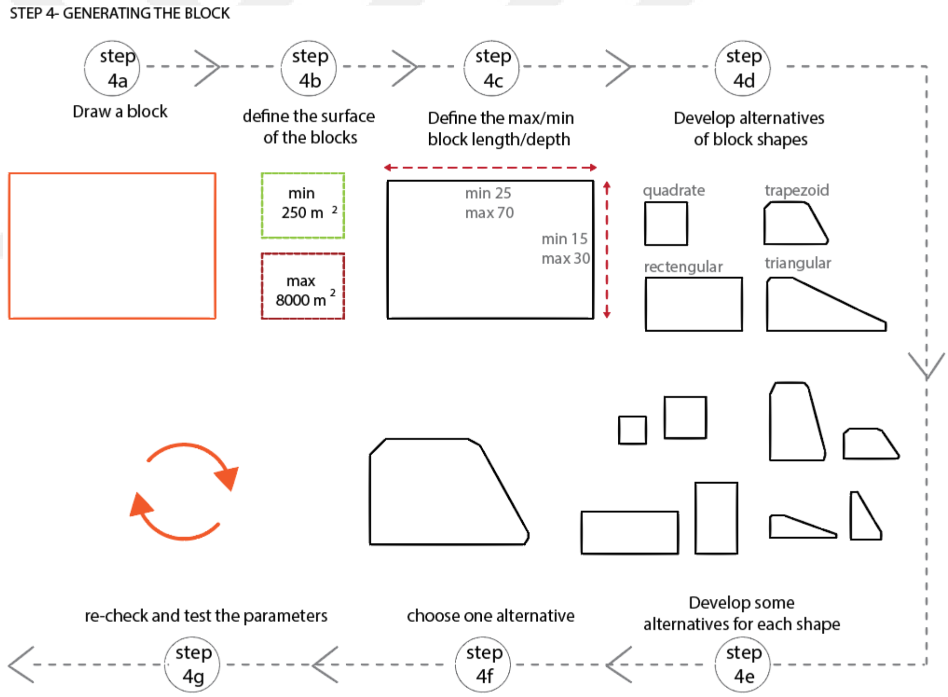


Figure 4.3 : Generating the block.

Step five: define the features of the parcel pattern

Includes the following: 5a- divide the block in parcels (min: 4 parcels, max: 30 parcels); 5b- define the surfaces of parcels (min:60 m^2, max: 500m^2, trend: 150-250m^2); 5c- define the width and depth of parcels (min width: 5m, max width 15m, trend: 8-12m; min depth: 10m, max depth 25m, trend: 15-20m); 5d- arrange the right proportions (min:1x1, max:1x3, trend:1x1.5,1x2); 5e- develop some alternatives of parcel layout; 5f- choose one alternative; 5g- re-check and test the parameters. The steps are illustrated in Figure 4.4.

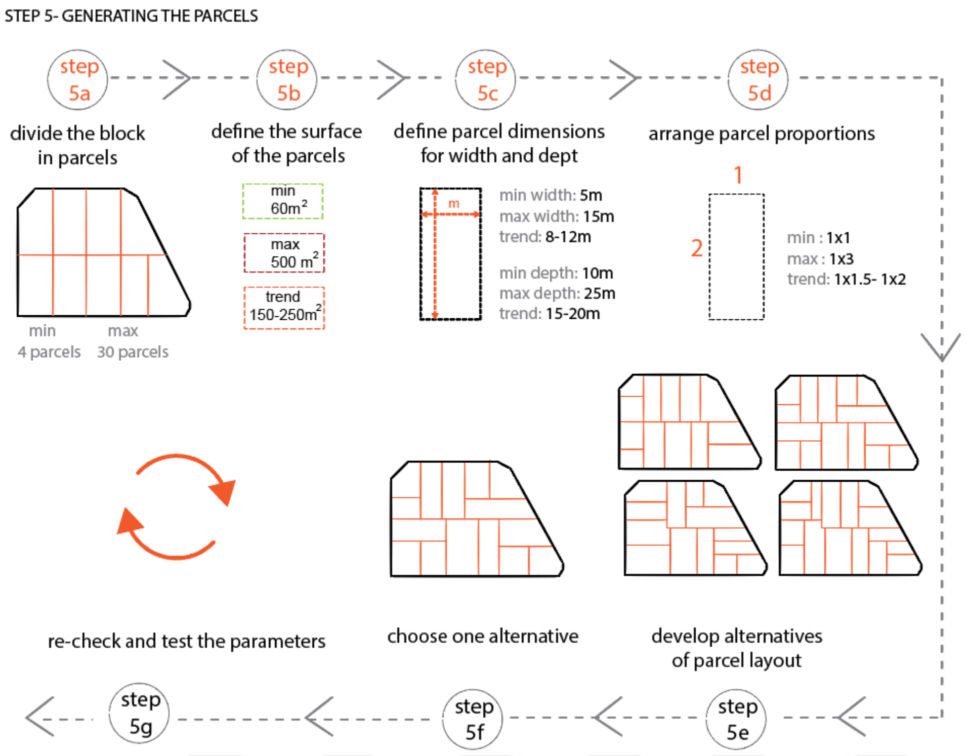


Figure 4.4 : Generating the parcel pattern.

Step six: define the features of the building fabric

Includes the following: 6a- select the blocks; 6b- put the buildings on the parcels (for each parcel one building); 6c- arrange the plot coverage ratio (min:0.4, max:1); 6d- define the base floor surface (min:50 m^2, max: 150m^2, trend: 80-100 m^2); 6e- arrange the location of building in relation to parcel, the street and orientation; 6f-develop some alternatives; 6g- choose one alternative; 6h- re-check and test the parameters. The main steps are illustrated in Figure 4.5.

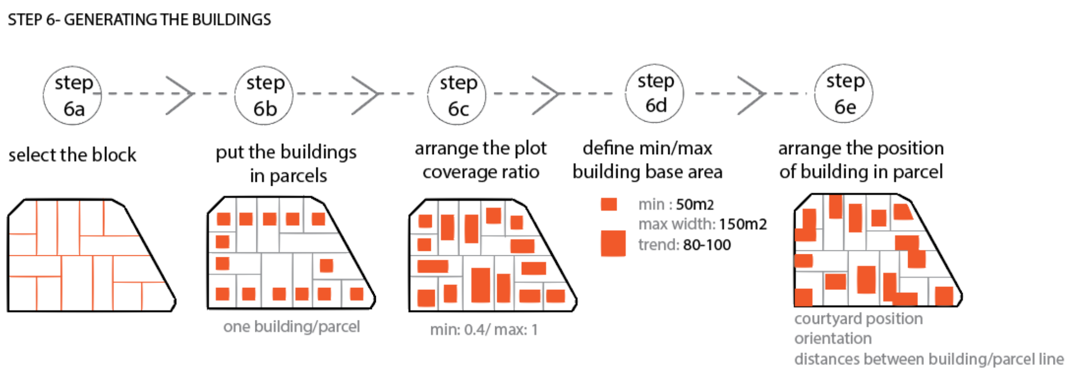


Figure 4.5 : Generating the building fabric.

Step seven: generate a district including some blocks

Includes the following: 7a-add a neighbor block as a new cell and apply the parameters of step 4 for the new block; 7b-separate the two blocks to create the street; 7c- select the adjacent segments of the block perimeters; 7d- shift the segment line to create different street width (min width: 3m, max width:12m); 7e- apply the parameters of step 5 and 6 for the new block; 7f- add a new block and apply step 4, step 5, step 6, step 7b-d; 7g- add other blocks and apply the same procedures; 7i- develop some alternatives; 7j- choose one alternative;7k- re-check and test the parameters. Step seven is illustrated in Figure 4.6.

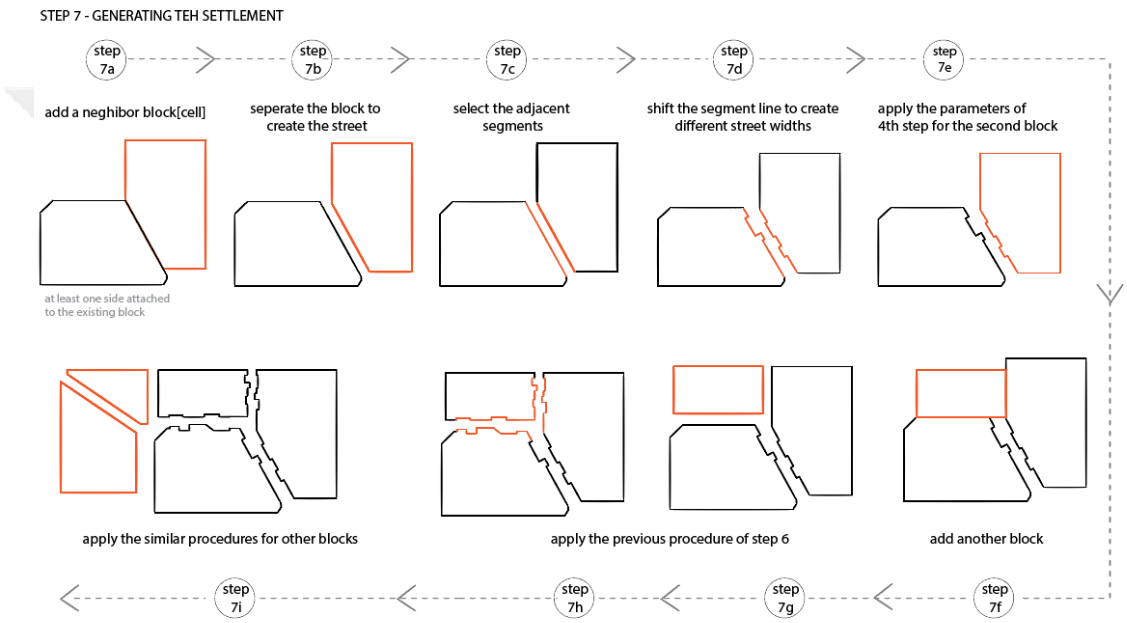


Figure 4.6 : Generating a district.

Step eight: add plazas and define their features

Includes the following: 8a- select the district; 8b-identify the location of plazas; 8c-shift the corner of the blocks to create small plazas in the location were four blocks meet each other; 8d- arrange the size and shape of plazas; 8e- develop alternatives with different plaza sizes and shapes; 8f- choose one alternative; 8g- re-check and test the parameters. Step eight is illustrated in Figure 4.7.

The final steps repeat the previous procedures to generate the other part of the settlement in the defined area. Step 9- Continue to generate the other parts of the settlement using the same procedure; Step 10- Go back and test the parameters; Step 11- develop different alternatives for generating variety of settlements; step 12- choose the most appropriate ones; and step 13-re-check and test the parameters.

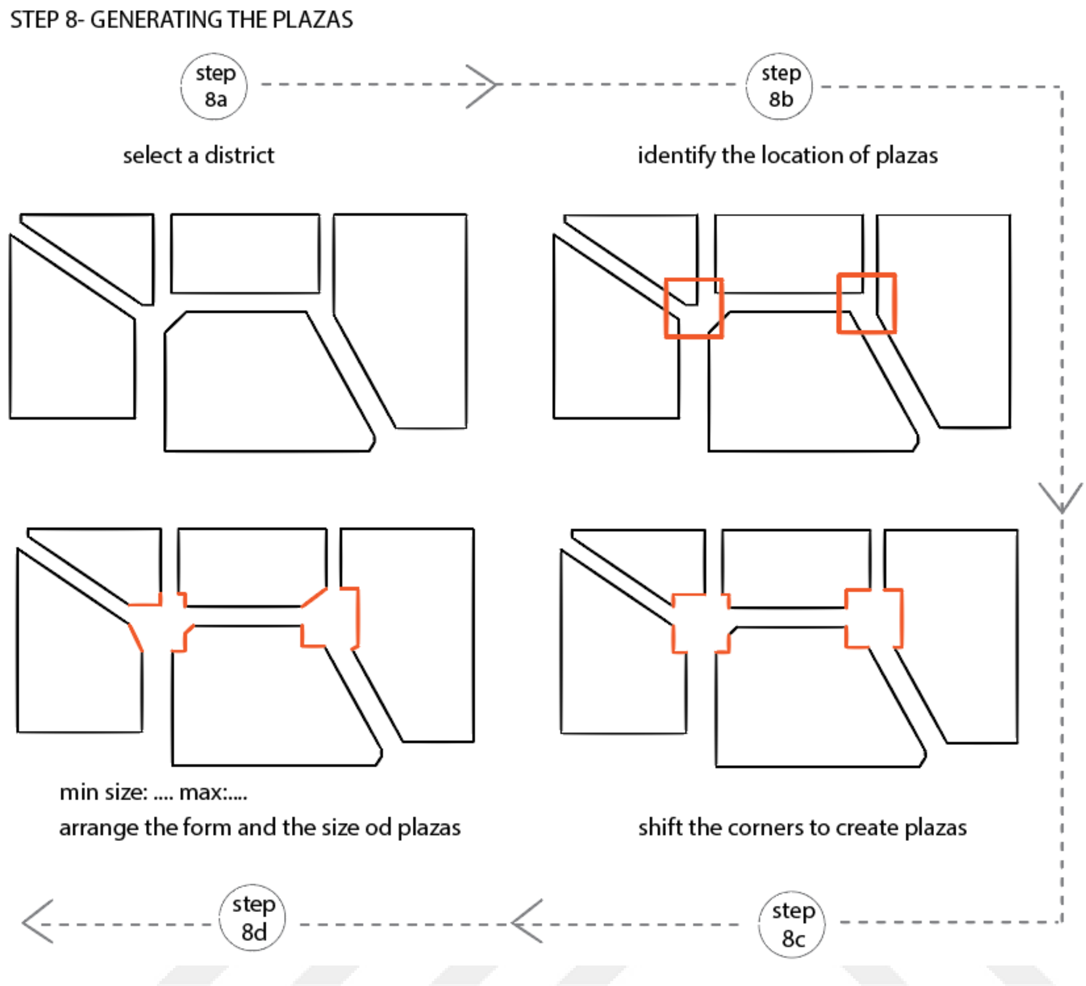


Figure 4.7 : Generating the plazas.

4.1.2 The deductive approach

The other alternative that can be also used for generating the settlement has a deductive approach starting from large scale to the detailed scale. The steps for the deductive approach can be as following: 1-define an area (boundary) for the neighborhood); 2- put the natural and existing infrastructure; 3- divide the area in blocks (min, max, trend); 4- arrange the size and surface of all blocks (min, max, trend); 5- separate the blocks to create the streets; 6- add plazas in-between a cluster of blocks; 7- arrange the size and shape of plazas; 8- add parcels in each block; 9- arrange the sizes, surfaces and proportions of parcels; 10- add buildings in all parcels;11- Define the plot coverage ratio; 12- Arrange the position of building in parcels; 13- develop alternatives using the same parameters; 14- Choose some alternatives; 15-re-check and test the parameters for the overall area. The main steps of deductive approach are illustrated conceptually in Figure 4.8.

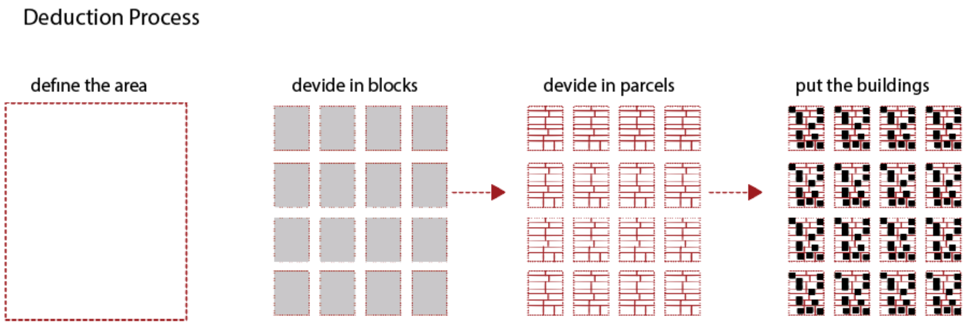


Figure 4.8 : The main steps of deductive approach.

Hypothesis 3: Taking references from traditional (vernacular) settlements in the planning and design process of new urban areas is very significant to maintain (sustain) the urban memory of a place.

The modern planning approach has a big problem with being contextual. Commonly, its objective is to produce new cities in standardized way, in many cases not considering at all the history and the spirit of the place. On the contrary to that approach, this study represents a philosophy which appreciates the importance of local context. It tries to increase the awareness of how important is to take reference from historic vernacular morphology, in the process of designing and building new settlements. Furthermore, the methodology used here, the analyses, the results and the recommendations, show clearly that this is possible and at the same time important. Its importance does not relay on having a nostalgic approach for the past and replicate it, but it is more about building a sustainable city which is able to maintain its urban memory, which is a valuable accumulation of knowledge in a very long process. This knowledge should be maintained and transmitted to the new process urban development, as this thesis suggests.

4.2 Conclusions and Recommendations

- Modern planning philosophy is built on a top-down approach that generally has failed to produce qualities such as: complexity, contextuality, dynamism, participation, flexibility and variety in cities.
- Vernacular settlements generated through a long process of self-regulation, are more successful in aspects of creating a living urban habitat, having an organized complexity, producing richness, variety, flexibility and human scale

in urban space. They are more contextual, respecting the local environmental, social and cultural conditions.

- There are many lessons that we can learn from both approaches on how and how not to build our cities.
- The historic neighborhood in the city of Korca is a typical example of a settlement generated through a long process of self-regulation.
- Like many other vernacular settlements, it possesses many qualities that create a sustainable, working and efficient environment.
- Through pattern analyses the study shows that the neighborhood has 'the quality without a name', as defined by Alexander, which establishes an urban habitat that is generative, living, dynamic, rich, beautiful, authentic, systematic and is close to human and nature.
- The study uses pattern analyses for analytical purpose, but they have also a potential to be used in the design process due to their generative and algorithmic structure
- Fractal analyses in the settlement show clearly that there is a systematic relationship within and among different morphological units. Similar values of fractal dimension extracted from analyses are evidence of this systematic relationship and the strong coherence in the urban fabric.
- The research uses fractal approach for analyses in the study area, but the results and methodology can be used in the process of building new settlements and to reach similar fractal dimensions in order to establish a coherence between historic city and new urban zones.
- Some physical features of the spatial composition in the study area can be measured, although it has an organic pattern.
- These measurements cane be used as parameters in the design process of new urban zones.
- These parameters can act just as a helping tool in the complex and long process of designing and building new settlements which should include many other actors such as: planners, architects, designers, engineers, other professionals, stakeholders, community etc.
- These parameters can be integrated in a computed model that can produce many alternatives with high complexity and systematic relationship among different parameters.

- The study proposes a guideline (framework) by explaining the steps that can be followed for building a possible computational model.
- The measurement analyses and the parameters of the guideline take in consideration just the physical aspects of the urban space in the study area. In this context it has many limitations. In new studies, the methodology can be improved to include also other parameters that deal with environmental sociological, economical, psychological and cultural dimensions.
- The study does not propose a romantic, neo-traditional approach which tries to replicate and mimic the form of historic cities, but it is concerned to understand and extract the principles which produce that urban habitat. It is more a principle-based study rather than a form-based one.
- It is very important that these parameters are adapted to respond to current economic, social and technological conditions in any possible model of urban development.
- It should not be the aim of the model to produce a fixed masterplan for the future but to define the steps and parameters which can be used to generate different alternatives, fitting to the user needs and spread in time.
- The results of analyses and the parameters used in the guideline are contextual to the city of Korca, but the same methodology can be implemented also in other contexts, producing different results.
- This research tries to identify firstly the way of understanding the features of vernacular settlements and then using these parameters as reference for generating new settlements. This is an important issue for being contextual and sustaining the urban memory in a city.

4.3 The Contributions of the Research

This study can have some modest contributions in some aspects of academic research and urban planning/design practice. Firstly, it can help to increase the awareness regarding the qualities of vernacular settlements and identify some of the problems in modern planning approach. It tries to make this through an explanation of these qualities using a clear methodology of analyses. The thesis can have a good input also in pointing the importance of sustaining the urban memory in the processes of building new urban zones, for the purpose of creating more sustainable and local solutions.

A small model of how to connect the past with the current and future. This work can be considered as a small model of how to take references from the traditional urban fabric in the process for urban design and urban planning.

This research contributes to the theory of bottom-up approach, emergent urbanism and generative urban design by bringing a case study that includes many analyses and suggestions of how these theories can be applied. It demonstrates a clear example of using the theory of pattern language and fractal geometry in the processes of understanding the qualities of self-organized settlements.

A fundamental contribution of this study is in developing new hybrid methodologies for analytical purposes in existing settlements and drafting guidelines or frameworks that can be useful in the process of design in new zones. In using the methodology of pattern language analyses, it extracts and classifies the principles related with neighborhood scale and small clusters. It also develops many new abstract diagrams that explain the patterns clearly and relates them with the context. An interesting dimension of the methodology used here, is the combination of conventional Conznian method and fractal geometry for analyzing the urban morphology. In this context, the study uses the categories of morphological units defined by Conzen and apply the analyses of fractal dimension based on this classification. In the process of calculating the fractal dimension, instead of using ready software that can do this, the research develops a technique that uses AutoCAD for elaborating the maps and ArcGIS for counting the boxes. This is a procedure that makes the procedure of calculating easy and still represents the logic of the method very clearly.

Another crucial contribution in methodological aspect, is the procedure of measuring the physical features of organic urban fabric. Here the study uses also the morphological components defined by Conzen as main units for analysis, but it elaborates it further by developing a broad and clear framework of parameters that can be measured and help to understand the features of the organic settlement.

Finally, the research tries to develop a new method of using the principles extracted from analyses in an existing historic settlement, as criteria in the process of building a model for the development of new urban areas. This work is guideline that can be useful in drafting a computed model of urban design.

To conclude, this thesis contributes to the Albanian context where there is a lack of research in overall, and particularly a lack of using innovative methodologies in the issues related with urbanism. The methodologies and the content of this study can be useful in other similar researches in Albania and other contexts. It can be used by other researchers in academic field, but as well as a helping tool in the process of urban design and planning practice.

4.4 The Limitations

There might be many limitations related to this study but two of them are more important. The first one is that, although it tries to elaborate aspects related with environmental and socio-economic issues in the process of analyses, especially in the measurement of urban form, it is focused more on the physical aspect of spatial organization. It does not make an observation and analysis related with environmental, social, economic and psychological aspects. Another limitation of this work is that it uses the methodology of pattern language and fractal geometry only for analytical purposes while they have a potential to be used also as tools in the process of design. The issue of using the patterns as design parameters is not very clear even in the previous studies and literature. Many works that try to use patterns for design purposes have not been successful on creating a coherent and complex system. However, these are issues and challenges that can be addressed also in possible other studies.

4.5 Future Work

The possible future studies related to the topic and content of this research might be in a wide range, but we can mention the ones that can be the most relevant. Firstly, this work establishes a clear methodology that can be used for similar urban studies in other contexts. The methodology can be adapted to the particular case and produce different results.

Another important research, which can be a continuation and a further step of this study, is related to the development of a computed model that uses the parameters and the guideline produced in this work. This research, needs a multidisciplinary working group that includes also software engineers, urban designers, architects etc. The production of a new software or using of existing ones to build a model would be a significant step that puts this study at another level.

Finally, other studies that can improve the methodology used in this research would have a significant contribution. Especially, attempts that can introduce other aspects such environmental, sociological, psychological and economic dimensions to the methodology developed here can be an important added value.

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APPENDICES

APPENDIX A: Tables

APPENDIX A

Table A.1 : Calculations for streets at second scale.

	number of boxes	number of boxes in x	dimension of boxes
S2a	49	8	20
	129	16	10
	324	32	5
S2b	62	11	20
	156	22	10
	397	44	5
S2c	89	14	20
	236	28	10
	572	56	5

Table A.2 : Calculations for streets at third scale.

	Number of boxes	Number of boxes in x	Dimension of boxes
S3a	8	8	20
	20	16	10
	62	32	5
S3b	13	8	20
	33	16	10
	104	32	5
S3c	10	8	20
	25	16	10
	83	32	5
S3d	20	8	20
	54	16	10
	186	32	5
S3e	28	8	20
	82	16	10
	280	32	5
S3f	11	8	20
	25	16	10
	77	32	5
S3g	26	8	20
	79	16	10
	264	32	5
S3h	19	8	20
	59	16	10
	198	32	5
S3i	27	8	20
	80	16	10
	276	32	5

Table A.3 : Calculations for buildings at second scale.

	number of boxes	number of boxes in x	dimension of boxes
B2a	45	8	20
	154	16	10
	507	32	5
B2b	52	11	20
	162	22	10
	537	44	5
B2c	68	14	20
	239	28	10
	769	56	5

Table A.4 : Calculations for buildings at third scale.

	Number of boxes	Number of boxes in x	Dimension of boxes
B3a	54	12	10
	169	24	5
	506	48	2.5
B3b	38	12	10
	120	24	5
	396	48	2.5
B3c	34	12	10
	101	24	5
	319	48	2.5
B3d	40	12	10
	129	24	5
	421	48	2.5
B3e	23	12	10
	62	24	5
	210	48	2.5
B3f	15	12	10
	44	24	5
	143	48	2.5
B3g	24	12	10
	77	24	5
	236	48	2.5
B3h	22	12	10
	66	24	5
	201	48	2.5

Table A.5 : Calculations for plazas at second scale.

	Number of boxes	Number of boxes in x	Dimension of boxes
P2a	7	6	10
	15	12	5
	41	24	2.5
P2b	8	6	10
	21	12	5
	65	24	2.5
P2c	9	6	10
	18	12	5
	50	24	2.5
P2d	11	6	10
	25	12	5
	75	24	2.5
P2e	7	6	10
	17	12	5
	51	24	2.5
P2f	7	6	10
	19	12	5
	60	24	2.5
P2g	14	6	10
	42	12	5
	129	24	2.5
P2h	11	6	10
	31	12	5
	94	24	2.5
P2i	15	6	10
	40	12	5
	129	24	2.5
P2j	11	6	10
	36	12	5
	101	24	2.5
P2k	11	6	10
	31	12	5
	96	24	2.5
P2l	22	6	10
	66	12	5
	211	24	2.5
P2m	18	6	10
	52	12	5
	163	24	2.5

CURRICULUM VITAE

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EDUCATION **:**

- **B.Sc.** : 2009, Istanbul Technical University, Faculty of Architecture, Department of Urban and Regional Planning
- **M.Sc.:** 2012, Istanbul Technical University, FBE, Department of Urban Design

PROFESSIONAL EXPERIENCE AND REWARDS:

- 2nd Price_ International Urban Design Competition_DURANA_ Lot 1, 2014
- 1st Prize, National Design Competition for young Architects: “Tourism into Tradition”, 2018

PUBLICATIONS, PRESENTATIONS AND PATENTS ON THE THESIS:

Zeka, E., & Yüzer, M. A. (2019). A methodology for measuring the form of organic settlements. MethodsX, 6, 368-376.