ALGORITHMIC DESIGN CONTROL FOR PLOT–BASED URBANISM: A MODEL PROPOSAL IN TURKISH SPATIAL PLANNING CONTEXT

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I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

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ABSTRACT

ALGORITHMIC DESIGN CONTROL FOR PLOT–BASED URBANISM: A MODEL PROPOSAL IN TURKISH SPATIAL PLANNING CONTEXT

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Cities intrinsically perform their evolution in a rule–based environment through dynamic processes. Even the cities, which developed without any rational planning process, are built with specific building codes. The rule–based framework that is defined by a set of simple building code provides a basis for the emergence of different urban typologies through the history. Necessity for such codes is crucial in order to maintain the inherent integrity (morphological coherence and functional integration) of collective urban form. In the very context of rapid development and transformation, plans and codes have been the basic apparatuses to shape the modern urban environment over the past century. The uncertainties that faced in city development and the complexity of the processes conditioned by the existence of various actors involved (developer, contractor, designer, user and local governments) required the development control systems to define more flexible and responsive coding techniques rather than solely relying on the masterplans performing as static spatial diagrams. This essentially requires a new approach which addresses more bottom–up and incremental applications by code–based control frameworks. On the basis of the principle of controlling overall urban formation on the scale of plot, the emerging paradigm of ‘plot–based urbanism’, in this context, suggests a fruitful basis to develop an alternative methodological approach to urban design. Computational modelling

tools run by design algorithms, at that point, suggest a very relevant technical basis to apply the new approach in actual urban context. Generating various compositional patterns via certain geometric components and their constitutional parameters, parametric design basically enables designers to gain a serious control over the complex formations. In the context of urban design, that means the possibility of the complex formation of urban fabric on the multiple interaction of plots in the course of time. The current research, in this framework, is to develop a parametric model to integrate computational design to development control in emerging context of plot-based urbanism. Utilized as the already existing codes of Turkish spatial planning system, the actual building rules are taken as the basic parameters of the plot–based generative formation of urban fabric by the algorithmic model proposed. The model basically aims to invest on the urban contexts like Turkey, where the plot has still a significant role in the reproduction of urban model and to provide a responsive control method to come up with coherent unities within reach diversity of urban form.

Keywords: generative urbanism, algorithmic design control, parametric modelling, plot–based urbanism, design control

ÖZ

PARSEL TEMELLİ ŞEHİRCİLİK İÇİN ALGORİTMİK TASARIM DENETİMİ: TÜRKİYE'DEKİ MEKANSAL PLANLAMA BAĞLAMINDA BİR MODEL ÖNERİSİ

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Kentler doğası gereği kural temelli bir gelişim ve dönüşüm süreci içerisinde varlığını evrimsel olarak sürdürmektedir. Herhangi bir rasyonel planlama sürecine tabii olmadan gelişmiş kentler bile belirli yapım kodları ile inşa edilmiştir. Kendi içerisinde bir dizi basit yapı koduyla tanımlanan bu kural çerçevesi tarih içerisinde farklı kentsel tipolojilerin ortaya çıkmasına zemin hazırlamıştır. Belirli bir kural dizinine olan gereksinim kolektif kent formunun kendi içsel bütünselliğinin (morfolojik bağdaşıklığı ve işlevsel bütünleşikliği) sağlanması adına oldukça önemlidir. Kentlerin hızla geliştiği ve dönüştüğü geçtiğimiz yüzyılda, ana plan ve yapı kodu birlikteliği modern kentsel çevrenin şekillenmesinde temel araç olarak kullanılmıştır. Buna ek olarak kentin üretiminde karşı karşıya kalınan belirsizlikler ve çok sayıda yapıcı aktörün (geliştirici, yüklenici, tasarımcı, kullanıcı ve yerel yönetim) sürece katılımı ile ortaya çıkan karmaşıklık durumu, durağan mekânsal şemaya karşılık gelen 'plan'a öncelik veren gelişim denetimini yetersiz kılmakta ve bunun yerine tasarım kodu ağırlıklı daha esnek nitelikte yeni bir yaklaşımı gerekli kılmaktadır. Bu durum, kod temelli bir kontrol çerçevesi sunan ve kentsel formun artırımsal ve aşağıdan yukarı üretilmesini tarifleyen yeni bir yaklaşım gereksinimi ortaya çıkarmaktadır. Bu bağlamda çağdaş şehircilik yazınında öne çıkan paradigmalardan olan 'parsel temelli

şehircilik' yaklaşımı, genel kent formunun parsel ölçeğinde kontrol edilmesi prensibini temel alarak, ihtiyaç duyulan yaklaşıma alternatif bir metodolojik yaklaşım geliştirebilmek adına oldukça verimli bir altlık barındırmaktadır. Bu bağlamda tasarım algoritmaları üzerinden çalışan hesaplamalı modelleme araçları, söz konusu yöntemin güncel planlama pratiğinde uygulanabilir kılınması adına gereken teknik altyapı sağlamaktadır. Belirli geometrik bileşenler ve bunların yapısal parametreleri ile çeşitli kompozisyon biçimleri üreten ve temelde tasarımcıların karmaşık formları üretimine imkân sağlayan parametrik tasarım sahip olduğu algoritmik çerçeve ile form üretim sürecini oldukça kontrollü bir hale getirmektedir. Kentsel tasarım bağlamında ise bu durum, zaman içinde parsellerin çoklu etkileşimi üzerine karmaşık kentsel yapı oluşumunun mümkün kılınabilmesi anlamına gelmektedir. Bu bağlamda bu çalışma, hesaplamalı tasarım yöntemleri ve gelişim kontrolü kavramlarını parsel temelli şehircilik bağlamında ilişkilendirebilmek adına bir parametrik model önerisi getirmektedir. Bu bakış açısıyla araştırma, var olan imar mevzuatı içerisinde yer alan yapı kodlarını dijital modelleme algoritması çerçevesinde ilişkilendirerek parsel temelli üretken bir dönüşüm süreci önermektedir. Böylelikle araştırmanın önermiş olduğu model Türkiye'de olduğu gibi parselin kentsel formun (yeniden) üretiminde önemli bir rolünün olduğu kentsel bağlamlarda, standartlaşmış yapı kompozisyonlarının çoklu seçeneklerini üreterek yeni mekânsal nitelik koşullarının önünü açacak, bağdaşık ve morfolojik çeşitliliğe sahip kentsel dokuları üretecek esnek ve duyarlı tasarım denetimi yöntemini geliştirmeyi hedeflemektedir.

Anahtar Kelimeler: üretken şehircilik, algoritmik tasarım denetimi, parametrik modelleme, parsel temelli şehircilik, tasarım kontrolü

To the legacy of Alan Turing …

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CHAPTER 1

INTRODUCTION

1.1. Context and Problem Definition

The changing needs of developing societies let the cities evolve in time. The evolution process reveals itself in a rule–based framework of building codes and techniques. Such rule–based framework, which plays an active role in the formation of cities throughout the history, has paved the way for cities to develop in a responsive manner for different conditions (Ben-Joseph, 2005). However, the static masterplans based on an understanding of the top–down planning approach have some subtle contradictions with rule–based framework of urban coding. Masterplans, in this context, would fall short to respond to the evolving dynamics of the contemporary urban environment. In this context, control of the design process is inevitable to produce good urban forms and spaces in terms of spatial coherency and diversity. Herein, the basic design control mechanisms, *doctrines, norms and standards, guides and codes* (Çalışkan, 2013, p. 187), provide the fundamental basis to control the formation of urban fabric through different scales. Among them, design codes stand out as the effective tool by providing a flexible and responsive framework to foster the incremental production of urban form. Having capacity to control the overall urban fabric, rule–based structure of design coding aims to morphological coherence within the bottom–up development processes (Alfasi, 2018, p. 13). Therefore, paying attention the potentials of the urban coding to produce better qualities of urban spaces and form, different countries utilize design coding as one of the main control tools for urban development. In the context of the Turkish spatial planning system, the hierarchical framework of different types of spatial plans (i.e. regional plans, master plans and implementation and parcellation plans) prevents the use of design codes in a generative manner. Despite the spatial plans controlling the urban fabric in a top–down and holistic manner, the planned

urban fabric in Turkey is formed by the piecemeal development of individual plots (Ünlü, 2011). In other words, the way of urbanization in is based on either conducting the development through individual plots or in the form of residential estates in large urban blocks without coordinating the basic units of urban form for the sake of spatial coherency and integration. Therefore new methods to overcome the settled deficiencies of the planning systems in Turkey is needed. Taking the multiple–ownership plot pattern as an opportunity to develop a working framework for **plot–based urbanism**, the research aims to suggest an alternative methodology to cope with fragmentation in urban form and pattern.

Plot–based urbanism, as emerging discourse (Barbour, Romice, & Porta, 2016; Porta & Romice, 2010; Romice, Porta, Feliciotti, & Barbour, 2017; Tarbatt, 2012, 2017), promotes the bottom–up development of urban fabric by utilizing the plot as an elementary (generative) unit of urban form to ensure the incremental development of overall urban fabric. In this way, plot–based urbanism proposes new design tactics for the production of adaptable and responsive urban form. Therefore, it also provides a very relevant basis in the context of design control by enabling the usage of design codes on the scale of the plot to develop a coherent framework through **generative design,** which was originally theorized by C.Alexander (1987) as the gradual process of the design of collective urban form. Since the plot is the most dynamically transformed urban context within the evolutionary process of the urban formation (Campbell, 2011, p. 77), plot receives a particular attention as a generative design concept for the notion of *'wholeness'* by supporting diversity within the relational unity (Mehaffy, 2008). In this context, to utilize plot–based urbanism effectively in order to develop a relational and comprehensive framework to establish an alternative design control methods for Turkish spatial planning system, it is necessary to formulate new methodologies (i.e. tools and techniques) as an alternative to the conventional master planning approaches (Tarbatt, 2012, p. 77). Herein, through its algorithmic framework **computational design** methods would enable realization of plot–based urbanism in the context of design control in planning. Unlike conventional

(analog) methods, computational design methods, mainly specialized as **parametric urban design** (Beirão, Nourian, & Mashhoodi, 2011) in urbanism, would be utilized for the control of various (piecemeal) design applications in coordination of urban coherency. In this sense, the parametric modelling in urban design would suggest a controlled framework for the relation formation of incremental urban development. Herein, the immense form production capacity of computational design methods, specifically parametric modelling, suggest real potentiality to promote generative design process in urbanism. As Çalışkan (2017) argued, to reveal the real potential of the parametric urban design, the method should be utilize as a **design control tool**, rather than as a 'design machine'. In this manner, to establish such an integrated framework, **parametric modelling**, the prominent method of computational design, provides an operational basis to relate all the urban components of the urban fabric in an incremental manner (Tedeschi, 2014). Since the algorithmic framework of parametric design is compatible with the parametric nature of the Turkish planning legislation (i.e. coverage, floor space index, setbacks), this provides a relevant basis to (re)define plot–based urbanism in the specific context of Turkish cities. With respect to the theoretical background as abovementioned, the research would focus on the issue of **design control for a kind of generative design urbanism** and **the computational design methods for controlling and guiding the plot–based (trans)formation of urban fabric in the context of design control** which is the current case in Turkey.

1.2. Aim of the Study and Research Questions

In accordance with the theoretical framework that has drawn so far, the main objective of this research is to develop an alternative design control method for the Turkish spatial planning context to generate better quality of urban form. The current urban planning practices in Turkey result with the fragmented urban fabric through identical plots. In this sense, in order to establish such a new design control mechanism the plot would be utilized as the main control element of the urban fabric. To do so, plot–based urbanism as new paradigm in contemporary urbanism, will be re–addressed in the

context of design control to develop an integrated framework to control the development of urban fabric within the nested relationships of different urban components (i.e. urban block, plot, building). In this sense, the inherent form production capacity of the computational design methods would also be utilized to associate the different control parameters of these urban components to ensure the incremental development of urban fabric through the scale of the plot.

In this context, the research would cover the contemporary paradigms of urbanism by associating them with the planning practices in Turkey. By doing so, this research would ensure the binary relations of the theory and the practice within the emerging context of generative urbanism. To that end, the research is carried out by two main research questions. The first research question, on the one hand, is that '**how parametric modelling can be utilized to improve the existing design control system in Turkey by introducing new control parameters within an operational algorithmic framework?'** By investigating the generative capacity of the computational methods in urban context, the first research question would be examined to introduce the use of parametric modelling technique in the control framework of spatial planning in Turkey. The second research question, on the other hand, **how the existing plot-based development patterns can be reproduced by a parametric approach generating rather diverse and coherent urban fabrics?,** would be investigated to (re)discover the historical and contemporary role of plot–based urbanism to ensure the collective character of urban form. In this way, this research aims to establish a theoretical and operational framework to carry out a multi–dimensional discussions on generative urbanism, computational design and plot–based urbanism in the context of design control. Correspondingly, the research would capable of filling the gap between theory and the practice by developing subtle tools and technics to establish a generative framework in the context of emergent paradigms of the contemporary urbanism.

1.3. Methodology of the Research

To fulfill the above–mentioned objectives, the relevant theoretical framework is to be associated with the proposed parametric approach in urbanism. To suggest such an operational and integrative framework, first, the concept of 'design control' is discussed. Following this, plot–based urbanism, as the emerging paradigm in the contemporary literature of urbanism, is to be elaborated by examining the different cities and actual applications. Similarly, computational design as generative method is also examined in the context of design control in a specific context of urbanism.

After establishing a broad theoretical framework, the parametric model for plot–based urbanism is developed by modelling the control parameters of the urban components. Different control parameters are associated with each other by utilizing the generative capacity of the algorithmic framework by the parametric modelling. In this way, the parametric model would be capable of establishing a responsive design framework for the changing spatial demands of the evolving cities through enhancing the adaptation capability of the urban fabric by the scale of plot. Once we have the algorithmic framework, the model would be utilized to generate the morphological alternatives in the actual context produced within implementation plans. To this end, the control parameters one defined to utilize them in a productive way in the search for satisfactory quality of collective urban form in the context of street and block.

By this way, the research aims to come up with an alternative design control technique for the spatial planning system of Turkey while revisiting its plot–base character and improving it from the perspective of generative urbanism.

1.4. Structure of the Research

This research is composed by five consecutive parts. As an introductory part, **Chapter 1**, introduces the general structure of the research covering the contextual framework and problem definition, research questions and methodology of the study. **Chapter 2**, as the following section, provides a comprehensive theoretical framework to investigate design and development control concepts by with a specific focus of design

coding. Design coding is examined with respect to New Urbanism and its corresponding applications like form–based code, SmartCode and pattern books. After, examining the hierarchical conditions of the spatial planning system in Turkey, design control mechanisms are also be examined in the context of the legislative framework by explaining the scope and the objectives of different types of spatial (i.e. environmental plans, master plans, implementation plans). In **Chapter 3,** the emerging concept of the plot–based urbanism is discussed in the context of design control by relying on both historical and contemporary cases. By this way, Chapter 3 tends to present the production of 'diverse' and 'adaptive' urban fabric by utilizing plot as the fundamental unit of urban form through generative design processes. To develop such an efficient framework for the plot–based urbanism in the context of generative design, the new control parameters for urban block, plot, and building is introduced in that chapter, as well. Moreover, the notions of the plot and the plot–based urbanism within the context of the development control systems in the Turkey is also examined in the chapter. To create an operational framework based on the theoretical framework, **Chapter 4**, focuses on parametric urban design and parametric modelling while also introducing parametric model proposal for plot–based urbanism that would utilize as a new design control tool for planning. For this purpose, different examples of the parametric urban design applications from practice and research are also examined in this chapter to constitute an operational framework for the parametric model proposal. Thereafter, the model proposal is introduced with objective to generate the hypothetical alternatives to the actual built environment envisaged by an implementation plan through manipulating its control parameters as introducing new ones. The emerging environmental performance of the alternative form–compositions is simultaneously tested by the model, as well. **Chapter 5** eventually offers the critical evaluations on the potentials of the model to ensure the generative process in the context of design control, in accordance with the theoretical framework. As an epilogue, concluding remarks consist of the critical reflections on the limitations and potentiality of the proposed model.

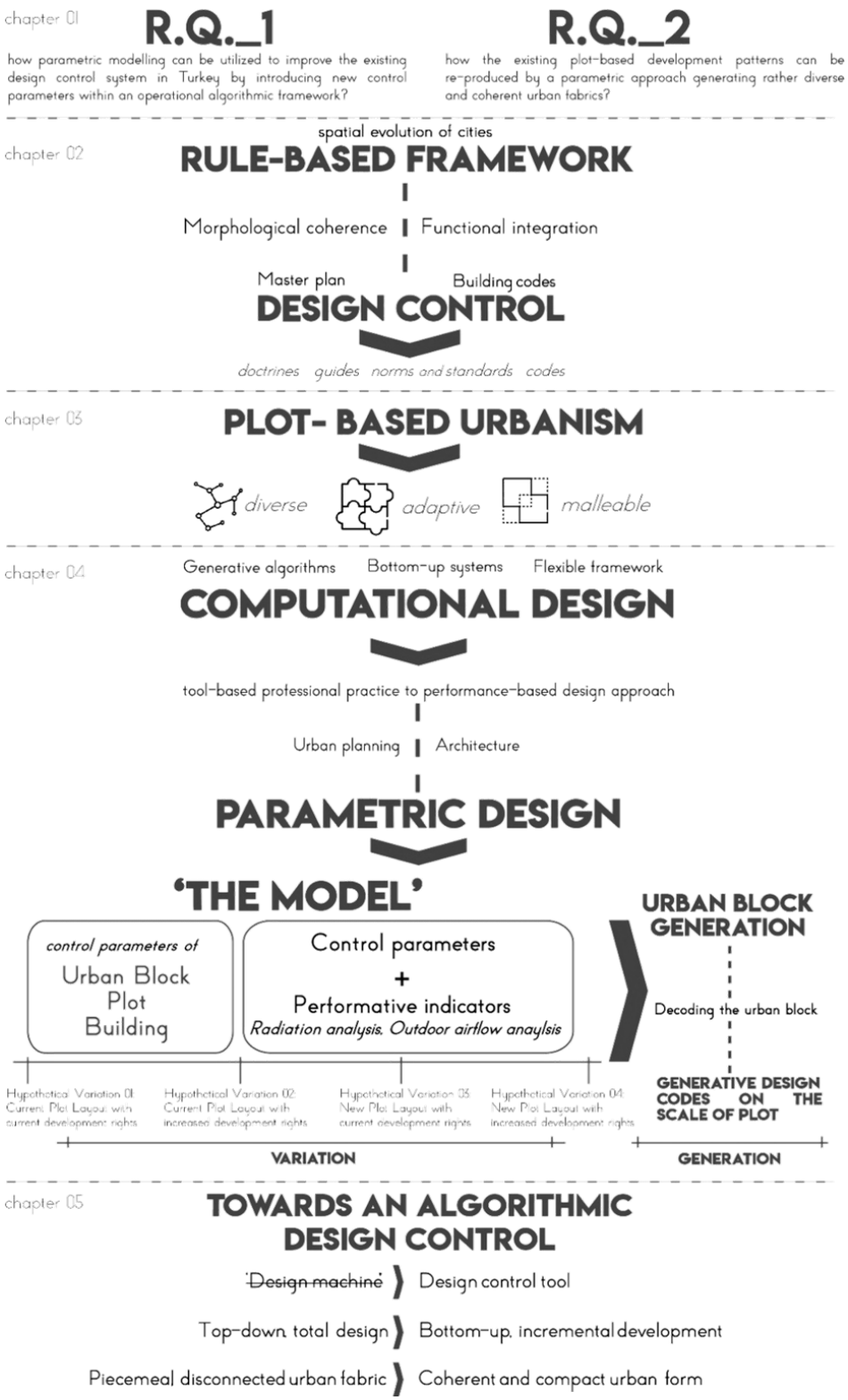

Figure 1.1. Structural and the conceptual flow of the research

CHAPTER 2

REGULATING THE FORM

In this chapter, it is discussed how the production of urban space is regulated in general. In doing so, a general framework has been drawn within the scope of the concepts of design and development control and then the design coding, which is one of the most important tools of design control concept, has been elaborated. Different approaches to how design control is addressed and how design control shapes the built environment are discussed. Finally, the current planning dynamics of Turkey is examined in detail. Within this framework, how the concept of design control is included in different planning processes and how these processes can be improved are discussed as well.

2.1. Design and Development Control: *An Overview*

Basically, control is defined as *'the power to influence or direct people's behavior or the course of events'* (OED, 2019). Here, control implies framing the direct and indirect interactions between the actions that affect the behaviors and choices of people. Since it is related with human relations, the control generally refers to social context in which individuals and institutions are important part of it. In this sense, as Dahl and Lindblom stated (1953, p. 94), control is hidden within functioning of a society in which people take part in permanent, consistent and iterative relationships (Dahl & Lindblom, 1953, p. 94 cited in Ünlü, 2005, p. 2). Within the scope of this research, control is discussed within the specific context of **design** and **development control**.

Control can be conceptualized as link between policy and action (Çalışkan, 2013, p. 185). In urban planning and design, policy can be considered with regards to planning policies on growth, development and transformation, and individual actions of design

and building. In this regard, control operates as a twofold link between planning policies and design implementations in the context of urban planning and design. By definition, development control is a system that has control over land uses and building use (Booth, 1999, p. 282; Thomas, 2013, p. 14). In particular, development control is directly related with general decision making processes of planning (Tewdwr-Jones, 1995, p. 164). It covers systematic control and manage the qualitative dimension of planning that ensure the excellence of urban space and public realm (Ünlü, 2005, p. 3). Within this framework, it deals with different extents of managing the planning decisions which controls the production of the space. Since, development control based on controlling the land use allocation, it is associated with the masterplans which are the plan types that general decisions about the city are taken. That is why *zoning* is the one of the important tools of development control (Kropf, 1996, p. 718). Moreover, as Ben-Joseph (2005) stated *norms and standards* are another control instruments in planning and they determine the general character of urban development by defining the minimum requirements. Therefore, in the context of development control, norms and standards stand out as an important control tools. (see Figure 2.1) Design control, on the other hand, focuses on the qualitative aspects of planning and design actions which enhance the quality of built environment (Çalışkan, 2013, pp. 184-186; Ünlü, 2005, p. 3). Since urban environment is composed of complex organism, it requires a competent methods to control. Design control, in this sense, provides a sophisticated basis to control the city in different scales and degree of interventions (Hall, 1996, pp. 2-6). It controls the planning processes to produce urban spaces with acceptable quality (Punter, 1999, p. 70) and sometimes it can be evaluated according to its capability to create or sustain good urban form (Talen, 2012, p. 1). In the literature, the concept of design control and the concept of aesthetic control are used interchangeably (Booth, 1983; Donovan & Larkham, 1996; Punter, 1994, 1999). However, design control should go beyond this and it should have a scope to include all issues related to the design of the city (Punter, 1999, p. 73). Moreover, design control provides a multi–nodal framework that bridges all professions which concerned with the production of urban spaces (Carmona, 1996, p.

53). Another important feature of design control is that it work as a part of design processes instead of resulting with static end–result (Carmona, 1998, pp. 180-181). It means that design control makes the design processes more controllable and flexible to generate more desirable design products and in doing so design policies and interventions became more operational and effective (Punter & Carmona, 1997, p. 140). Since design control is directly related with the shaping of the urban form, there is a requirement of operational basis to cover design related issues in the context of control. In this context, it has different tools that provide an operational framework for controlling character of urban environment in different extends. As Çalışkan (2013, p. 187) indicated that, there are four different design control tools which can be listed as **doctrines, norms and standards, guides** and **codes** (Figure 2.1) Main classification criteria of these tools are based on the purpose of usages, scale of interventions and level of details. In this sense, *doctrines* described as a range of associated and durable concepts about spatial arrangements, development and framework about the way that they handled (Faludi & van der Valk, 2013, p. 18 ,Çalışkan, 2013, p. 189). In the scope of design control, doctrines can be accepted as normative approach that use for policy making. Furthermore they are addressed as policy decisions that control the design practices in a systematic manner (Çalışkan, 2013, p. 189). *Norms* and *standards* are commonly used to determine the minimum requirements of physical environment in the context of urban planning discipline. The standards as legal instruments are also used by planners to maximize the benefit of the public. This approach revealed in the regulation and control over the design and planning of cities. Such a power that gives opportunity to control the physical development of urban fabric is useful to provide controllable environment during the city building process. As Ben-Joseph (2005) indicates, in the past two centuries, norms and standards are used to create order and safety in the cities but then, especially from beginning of nineteenth century, the scope of the concept of development and design control has changed and they started use to ensure standardization in urban environment. In both ways, norms and standards were starting points that provide a

general understanding of the design process of the communities in cities. They reveal the general framework for development pattern of physical urban environment.

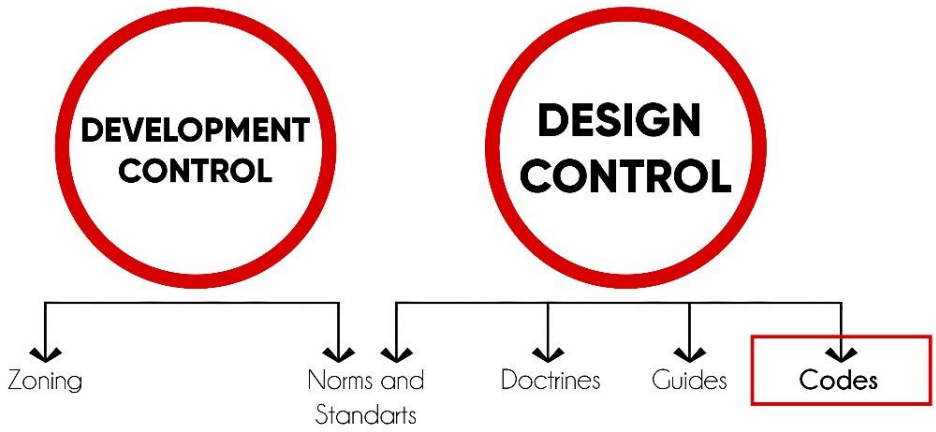

Figure 2.1. Tools of design and development control (After: Çalışkan, 2013, pp. 186-190)

Design guides, on the other hand, come to the forefront with the more generative framework that enable planners to run more flexible processes in the context of design control. They primarily aim at increasing the quality of urban spaces, preserving their character and authentic identity. Furthermore, it covers understandable, descriptive and directive design principles. Unlike norms and standards, design guides provide defined and systematic framework that makes the design processes more productive by which designers can generate different alternatives for specific cases (Çalışkan, 2013, p. 189). *Codes*, as the latest and most important tool of design control, provide the most defined structure to control the formation of urban space and fabric on different levels of scale such as buildings, plots, urban block and street (Carmona, Marshall, & Stevens, 2006, p. 212). According to Cowan (2002) *"a design code is a document (with detailed drawings or diagrams) setting out with some precision how the design and planning principles should be applied to development in a particular place"* (cited in Carmona et al., 2006, p. 224). In this context, codes ensure diversity within unity in urban areas by enhancing harmony. Since design codes are implemented in different contexts by different designers, design processes result with various alternatives. In this sense, although there are many individual

implementations, codes produce highly controlled, diverse and coherent urban fabrics thus codes have great potentials to create high quality urban environment (Carmona et al., 2006, p. 238). Moreover, codes produce a generative framework by assembling different design alternatives in a holistic manner rather than producing a static end-product. Unlike comprehensive planning approaches, codes promote a bottom–up approach that makes the design processes more flexible and adaptable (Alfasi, 2018, p. 13). In addition to this generative framework, codes also have very systematic features that make them more practical and operational in the context of design control. As Russell (2012) indicated, codes should have four basic characteristics which are *clarity, flexibility, ease of use* and *legality.* According to him¸ every design code should be explained in detail with graphics and illustrations to generate foreseeable physical outcomes; it should be flexible enough for different implementations in different contexts; it should be used and understand easily for all and it should be in compliance with legal issues. (Russell, 2012). Creation of such a comprehensive conceptual framework has enabled the usage of codes in design control more effectively. Since design codes have an operational framework that is more suitable than other design tools for different scale of interventions, it is primary design control tool that is considered within the scope of this research. Accordingly, in the following parts of this chapter, codes and rules as the basic tool of design control will be discussed.

2.2. Design by Rule

Several urban spaces that can be accepted as desirable places are results of well–defined and explicit building rules. These rules may appear on different scales, and the physical environment of the city is shaped by applying them from small scale morphologies such as the formation of a plot or even a single building to those of the city and its parts (Talen, 2009, pp. 2-4). As Talen (2012) argues, fundamentally, there are three aspects of urbanism which are ***pattern***, ***use*** and ***form***. (see: Figure 2.2)

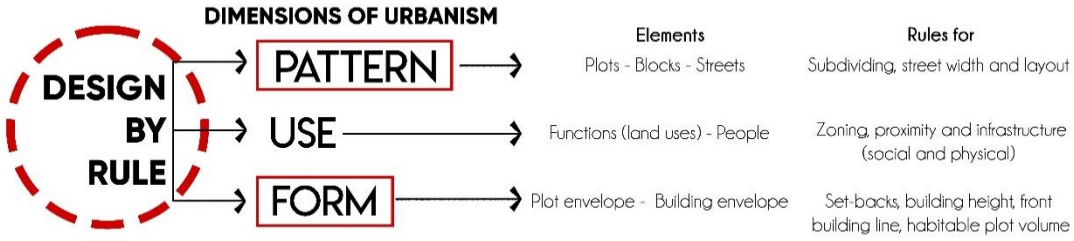

Figure 2.2. Dimensions of urbanism and the prominent rules for each category (After: Talen, 2012, p. 17)

These three dimensions, which are controlled by rules, constitute the main characteristics of the built environment. In this sense, *pattern* as the first component represents the two dimensional structure of urban areas and it contains plots, blocks and streets. Moreover, pattern implies the spatial configuration of the urban environment. Accordingly, *use* connotes to the distributions of land uses within the context of predetermined plan decisions. It can also be associated with social aspects because discussion of use and arrangement of them directly related with social characteristics of the communities mainly in terms of the capacity of mobility. Lastly, form, controls the urban form. In this framework, the notion of *form* in urbanism mainly to controls the three dimensional quality of the built environment (Talen, 2012, p. 17).

Within the scope of the research, the morphological aspects of pattern and form will be specifically discussed in the context of the design control. Since these two elements of urbanism related with subdivision of land and structuring the street network, and three dimensional formation (basic layout and massing) of the built fabric, they provide a relevant basis for the discussion so-called *plot–based urbanism* which will be the major focus of the research.

In this framework, urban *pattern* is under the influence of rules that control subdivision, dimensions and order of the streets and physical and spatial configuration of zoning areas (Talen, 2012, p. 37). The formation of urban pattern and accordingly the formation of the physical form of the city in history has been realized through certain rules which differs in accordance with specific cultures. Rule–based evolution

of cities, in this context, provides a generative framework to create different urban patterns. Necessity for such codes is crucial in order to maintain the inherent integrity (morphological coherence and functional integration) of collective urban form. Whether or not cities have realized a planned development process or not, there are certain evidences that the cities are developed based on certain rules from the time of their first establishment. At that point, understanding and taking lectures from the history is important for putting the contemporary situation in a certain context. In this regard, for instance, there were specific rules about the general layout of the settlement, height and typology of buildings and characteristics of streets about the Indus Valley civilization (Dutt, 2009, cited in Ben-Joseph, 2005). In addition to Indus Valley, there are rules about other civilizations and countries. In China and Japan, for example, there were dominance of grid pattern on cities. Even if there were no specific dimensions for grid sizes, some certain angles for orientation of buildings and usages shape the urban fabric (Ben-Joseph, 2005, p. 10). Roman period, in this sense, was one of the most prominent examples in urban history. Roman city used to be developed on a grid pattern structured by the main axes, *cardo* and *decumanus*. It can be inferenced from the Roman writings is that site conditions were taken into considerations and arrangements about light, wind and soils were important to design better places (Adams, 1935, p. 60; Ben-Joseph, 2005, p. 13). There are also rules that directly shaped the subdivision pattern of cities. As Hoyt (1933) indicates, some analysis about the different subdivision patterns of Chicago shows that there are numerous rules about the subdivision even if they have same in size. As shown in Figure 2.3, five different subdivision patterns were all accommodate the urban blocks that were 40 acres in size. According to analysis, each of the alternatives has specific features. Accordingly, while ‘D’ was practical for commercial usages with its’ wider frontages, ‘C’ indicates the most suitable pattern for residential use (Hoyt, 1933, p. 431; Talen, 2012, p. 42).

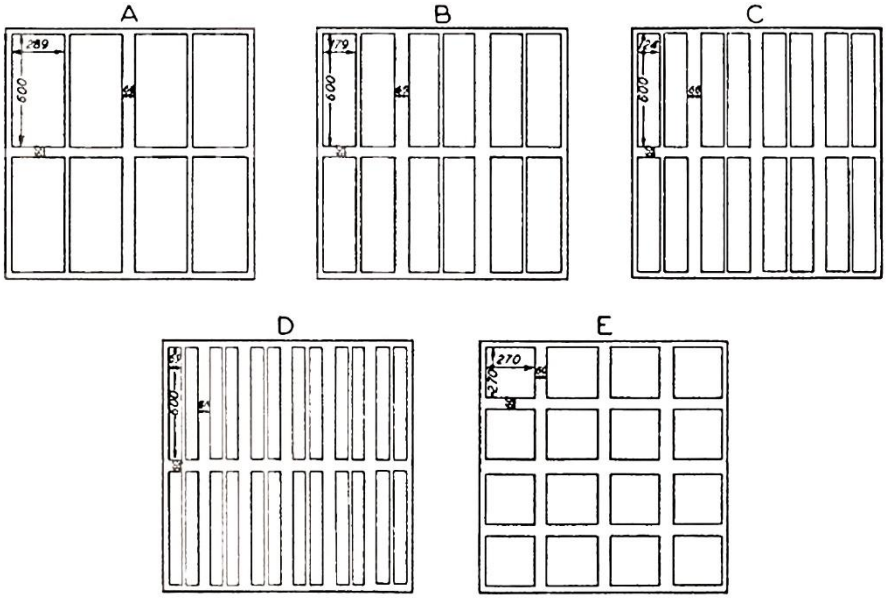

Figure 2.3. Block formations for 40-acres grid cell in Chicago (Hoyt, 1933, p. 431)

As another important component of dimensions of urbanism, *form* controls directly the volumetric (3D) relations within urban environment. In order to develop the rules that reveal or enhance the control capacity of the form, the components of the form should be indicated in detail. In this sense, three dimensional elements of built environment can be listed as plot layout and building setting. In urban morphology, plot generally conceived in two dimensional context but in this study plot layout will be examined as **plot envelope**. Plot envelope represents the buildable volume of plot in third dimension. The boundaries that define the plot are abstract lines and define areas that go to infinity so that they define a buildable space in third dimension according to certain rules and development rights that assigned to the area. As the plot envelope allows to control and shape the urban form in the third dimension, defining the rules on the three dimensional allocation of the plot it is very significant for the development of the city. Thereby, it is also important in the context of design control because it provides an operational framework to enhance and upgrade the spatial relations that experienced in third dimension within the built fabric. On the other hand, the building setting can be examined within the context of **building envelope.** Since building envelope is associated with the overall dimensioning and geometry of the

building, the main aim of determining building envelope is defining the physical limits of the building through its (trans)formation in time. In this way, the three–dimensional relations of the constitutional components of the building can be controlled with reference to neighboring buildings and the street. Building envelope is defined by a number of design parameters which are the front building line, building height, building depth, set–backs and width of the plot (Tarbatt, 2012, p. 156). As it has showed in Figure 2.4, some of these parameters such as building height and set-backs directly related with the three dimensional properties of the building. Thus creation of rules for building envelope is crucial in the context of urban design control of which main concern is the three dimensional quality of cities. The rules regarding the building envelope have also been used throughout history and numerous regulations that have been introduced in many cities. In many Islamic cities, for instance, there were rules related the building heights and arrangements about location of doors and windows (Al-Hathloul, 1981, p. 107). There were also certain rules about the building envelope in Rome. According to these rules, limits of building height were determined and projection of buildings into street were controlled (Ben-Joseph, 2005, p. 13). Within this context, design rules as one of the prominent tools of design control provide a well–defined framework to control the two and three dimensional characteristics of urban form. As indicated above rules control the subdivision, and structure of the street network and physical and spatial configuration of zoning areas in two dimension. In three dimensional context, there are rules to control building envelope and plot envelope which reflects the unique side of this study. Since rules affect urban pattern and form, it has certain potential to create and sustain ‘good urban form’. As Talen (2012) indicates, different kind of rules are essential to design places which exhibits more flexible spatial qualities. The important point here is that connection between rule and physical outcome has to be identified in an explicit way. The ability of the rules to form the city is only possible by using them in a well–structured control framework. Thus there is a requirement of description and explanation of the aims and objectives to use rules effectively in the context of design control.

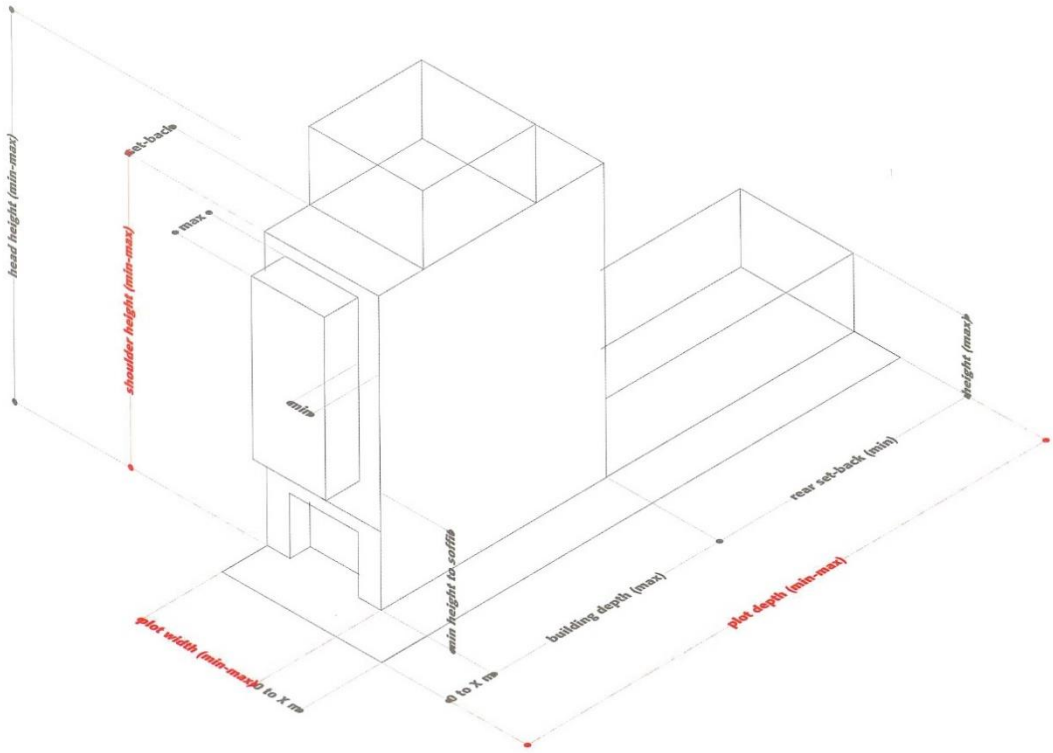

Figure 2.4. Main parameters of building envelope (Source: Tarbatt, 2012, p. 157)

2.3. Design Coding

Codes as a basic tool of design control (Figure 2.1) have characteristic features that differentiate them from other instruments of design control. By definition, design code is "*a system that specifies the attributes of urban components or building components to influence the character or function of the whole urban development"* (Carmona et al., 2006, p. 241). Since the built environment consists of urban elements (i.e. street, block and plot) and building components (i.e. entrances, projections, arcades), design codes have direct influence on shaping the urban fabric. Actually, design coding provides a body of detailed rules that generates urban order according to the predetermined planning decisions. Thus planning and coding, with supplemental differences, are like the two sides of a coin in practice. Planning, on the one hand, involves a more comprehensive comprehension of the city with an inherited tendency to control the overall structure and program of the city. Coding, on the other hand, has

a tendency to control the elementary components that make up the spatial form of the city. However, both of them try to maximize their internal consistency, one emphasizes the importance of the whole (mostly in a top–down approach) while the other focusses on the partial relationships, explicitly, in a bottom–up manner (Marshall, 2012, p. 7). To make it more understandable, it is meaningful to compare the performances of planning and coding. Coding includes all the building rules from the scale of the building to the scale of the city from a multi–scalar perspective. In other words, design codes are flexible in terms of scale, unlike conventional planning methods. It means codes are more suitable to create desirable urban form (Marshall, 2012, p. 4). It therefore has a wide range of practices, including urban regulations, architectural and design decisions that are associated with urban form (Carmona et al., 2006). Conventional planning methods generally result with finite or finished design solutions while coding provides numerous design alternatives by determining features of generic parameters and their relations (Marshall, 2012, p. 5). Codes, indeed, are the recipes to shape the urban environment. Instead of creating a finished project, codes give chance to control the parameters to design every sub–component of urban environment to formulate different design solutions. In this context, binary relations of planning and coding is very crucial to create adaptive and livable urban environment.

Since design coding is directly related to the components of the city, it is necessary to indicate in which extends it is associated with these components. Carmona, Marshall and Stephen compiled (2006) all the major elements of urban components which design codes have effect on them. (see Table 2.1) The index, in fact, signifies a very comprehensive framework about relationships between codes and urban components. Although each component has certain importance to shape the urban environment in the context of design control, only the number of them (i.e. *layout of public space, street types and dimension, street block pattern, plot aggregation, position of buildings, building massing and height of buildings*) will be examined in detail in the scope of the current research within the following chapters.

To be able to control such a comprehensive framework, design codes have some specific features. As stated above, there are four basic features that codes should have (Russell, 2012). These can be listed as *clarity*, *flexibility*, *ease of use* and *legality*. Accordingly, every design code should generate reasonably predictable physical outcomes clearly; it should be flexible enough to create adaptive places in different contexts. Moreover it should be understandable and easy to use for anyone; lastly it should be regulated in accordance with the law (Russell, 2012).

Table 2.1. *Urban components and related elements that controlled by design codes (Carmona et al., 2006, pp. 235-236)*

Components	*Land Uses*	*Streets*	*Blocks*	*Plots*	*Buildings*
	Layout of public space.	Street types and dimensions	Street block pattern	Position of buildings	Building type
	Residential, commercial and mixed land uses	Location of car parking	Plot aggregation	Gardens	Building massing
	Building use	Street furniture, planters, etc.		Boundary treatments	Height of buildings
	Parks and open spaces	Type and placement of trees, etc.			Size and shape of windows, doors, etc.
					Details of eaves/overhangs, gutters, etc.
					Signage

Carmona et al. (2006) classifies codes in accordance with their attributes. In this regard, attributes of the codes are grouped under the three main categories which are *essential*, *typical* and *optional*. (see Table 2.2) This classification indicates the characteristics of the codes from the most general to the most specific. In this sense "essential attributes" are the shared characteristics of all the design codes. In other

words, every design codes have the features that listed in the so-called essential attributes. "Typical attributes", in this framework, are the features which design codes are tend to have. Lastly, "optional attributes" are characteristics that design codes may have. These attributes depend on the context for which the codes are prepared (Carmona et al., 2006, p. 223). From this table, it can be inferred that for different conditions, different design codes can be formulated. In other words, design codes are

Table 2.2. *Attributes of codes (Carmona et al., 2006, p. 225)*

	Essential attributes (E)
E1	Codes are in principle written by one party, with designs carried out to specification by another party or parties. In other words, there is a split between the roles of 'code writer' and 'building designer'
E2	Codes relate to more than one scale—from the built form of individual buildings to neighbourhoods and whole settlements
E3	Codes are proactive in specifying what is 'good' rather than opposing what is'bad'
E4	Codes are specific in terms of three-dimensional forms that may or must be used. In general, they are concerned with form and type rather than use. These are expressed in both written and graphic form
	Typical attributes (T)
T1	Codes tend to be prescriptive, providing a set of definite instructions, rather than providing general guidance or advice. More 'shall' than 'may'
T2	Codes tend to engage a range of 'urban design professions'—typically including architecture, planning, engineering and environmental design, etc.
T3	Codes tend to be specific about architectural features such as walls, roofs, and their materials, etc.
T4	Codes are typically associated with larger development sites—greater than the scale handled by a single architect

T5	Codes are typically intended as a guide to ongoing or long-term management of a development, not just a single act of conception followed through to construction
T6	Codes typically seek to or actually form part of a legally binding agreement
	Optional attributes (O)
O1	Codes may support a wider master plan; may be preceded by a spatial masterplan, development framework or other design work
O2	Codes may be drawn up for application to a specific site
O3	Codes may have public/stakeholder participation built into the process
O4	Codes may be used to generate traditional style urban development—but are capable of generating any other desired style
O5	Codes may be used to create high-quality developments using high-quality materials, etc.—but need not only be for the affluent

flexible enough to compete with different scenarios and basic features of them can be re–arranged according to different contexts. In the context of design control, this feature of codes also stands out because such a responsive control tool make the design processes more efficient.

There are different design codes that control the urban areas in different scales. According to the concept and the context of any specific design application, the type of the codes may vary as well. Although design coding is a comprehensive issue which involves various dimensions to be discussed, there are some prominent design coding approaches in the context of design control. In the following part, these approaches will be discussed.

2.3.1. Coding in the Context of New Urbanism

New Urbanism, as one of the prominent approaches in urban planning and design from the mid–1980s (Hebbert, 2003, pp. 197-205; Marshall, 2003, pp. 188-189; Southworth, 2003, pp. 210-212). In practice, this approach champions the use of design codes in the development of the urban areas (Duany, Sorlien, & Wright, 2009; Duany & Talen, 2001, 2002). From the very perspective on urbanism, there is a tendency to promote the use of codes and coding as a 'generative' alternative to conventional (master) planning approach (Hakim, 2007, 2008, 2014; Mehaffy, 2008). As Carmona et al. (2012) indicates, urban codes, for New Urbanists, "*are not conventional 'words-and-numbers codes' that focus on land uses, road layouts, highways standards, etc. while containing no vision or expectation about the desired urban form. Instead, they illustrate graphically and pictorially the key principles such as street profiles, building volume, and, in particular, the relationship of buildings to streets (i.e. how private property defines public space)"* (Carmona, Heath, Oc, & Tiesdell, 2012). In this context, design tools of conventional methods are inadequate to design desirable urban places. Design codes, in this sense, are qualified to create more controllable and productive frameworks to create better urban areas (Carmona et al., 2006, p. 216). Since design codes provides a systematic perspective to control a wide range of urban components such as plot, block, street etc. they can be accepted as a part of the *"hidden language of place-making"* (Marshall, 2012, p. 1). In this sense, Seaside, Florida is the most well–known example of urban areas designed in line with the New Urbanist approach. Design codes that were developed for the Seaside, provide a set of principles to control the plot size, area and location for open space, porches, outbuildings, parking and building heights (Carmona et al., 2006, pp. 215-216). (Figure 2.5)

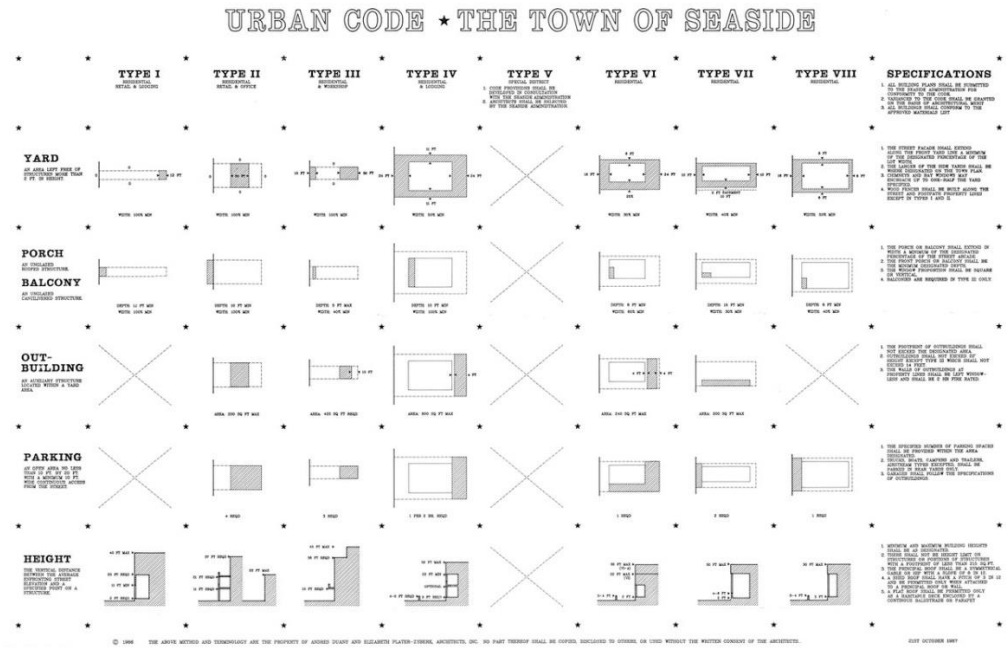

Figure 2.5. 'Urban Code' for the Town of Seaside (Source: Duany, PLATERZYBERK, & Chellman, 1989)

2.3.1.1. Form–Based Codes

According to the definition of Form–Based Codes Institute (2008), "*form–based code is a land development regulation that fosters predictable built results and a high–quality public realm by using physical form (rather than separation of uses) as the organizing principle for the code. A form–based code is a regulation, not a mere guideline, adopted into city, town, or county law. A form–based code offers a powerful alternative to conventional zoning regulation"* (Form Based Code Institute, 2008). From such a comprehensive definition, it can be inferred that instead of focusing the aspects like land–use and density, form-based codes intended to regulate the form of the built environment. By doing so, form–based codes express the connection between building façade and public realm and they define proper form and scale of the built environment (Talen, 2009, p. 144). Since form–based codes produce *"time tested forms of urbanism",*(Form Based Code Institute, 2008) they are supported by simple diagrams and short descriptive texts that explain the codes in detail. (Figure 2.6) Thanks to their comprehensive framework, form–based codes provide a very

manageable framework to control the built environment on different scales from plot to neighbourhood. In the scope of the study, form–based codes are considered to provide a fruitful basis to develop new tactics to control plot in different extends. Such tactics and strategies would be utilized to generate urban fabric from level the plot which is the smallest unit of the urban form.

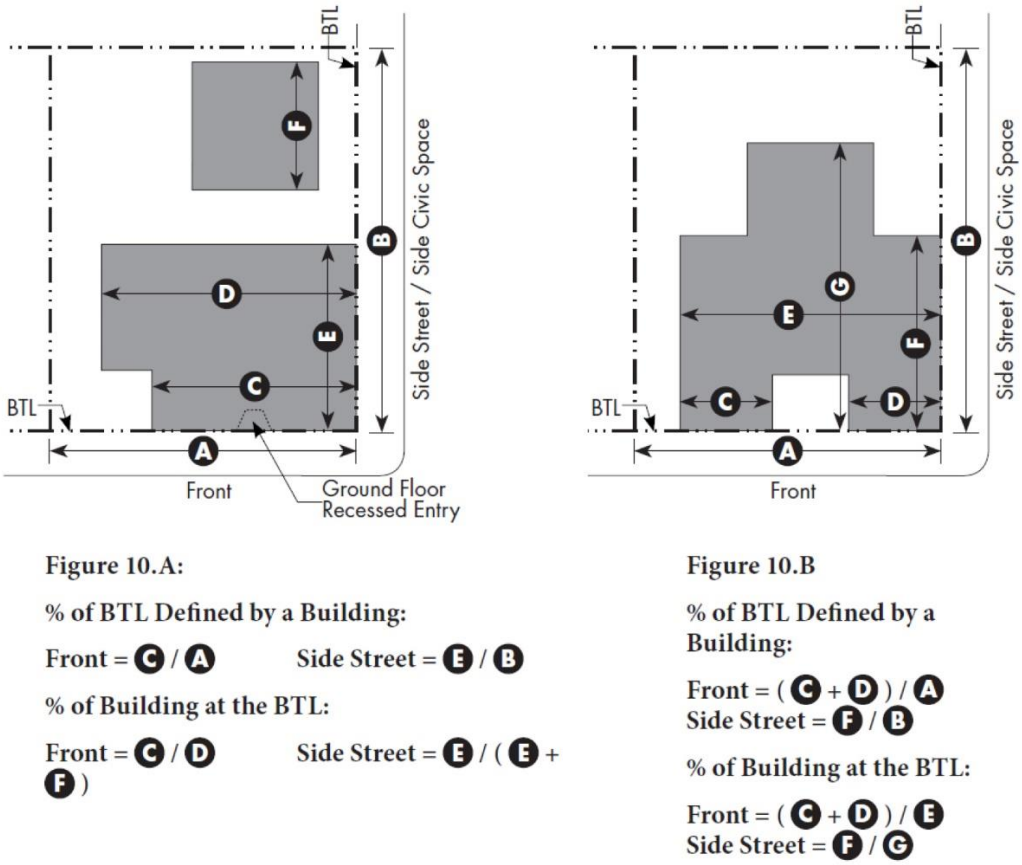

Figure 2.6. Form-based codes for Beaufort County Community Development (Form Based Code Institute, 2015, p. 3)

2.3.1.2. SmartCodes

SmartCode, as a form–based code represents the principles of New Urbanism based on the designed continuity between rural and urban areas by *transect* (Duany et al., 2009; Duany & Talen, 2001, 2002*)*. It is a very comprehensive tool to design all the levels of urban environment in detail. Instead of conventional zoning mechanisms, it focuses on the rural to urban transect. At this point, it is necessary to elaborate the

concept of *transect* so that the SmartCode could be fully understood. With the words of Duany and Talen (2001, 2002) the transect concept is described as, *"a geographical cross-section of a region used to reveal a sequence of environments. For human environments, this cross-section can be used to identify a set of habitats that vary by their level and intensity of urban character, a continuum that ranges from rural to urban."* (Duany & Talen, 2002). (Figure 2.7) In this context, the scope of SmartCode covers a wide range of typologies from urban to the rural. Since the SmartCode is a kind of form–based code, it mainly tends to provide an operational basis to create legible, diverse and coherent built environment. In this framework, it suggests certain rules and regulations on building, plot and block. (Figure 2.8) Moreover, since the SmartCode incorporates the principles of New Urbanism, it is qualified to design compact, walkable, sustainable and mixed–use urban areas. In addition Smart-Codes are handled in a comprehensive framework and this allows for

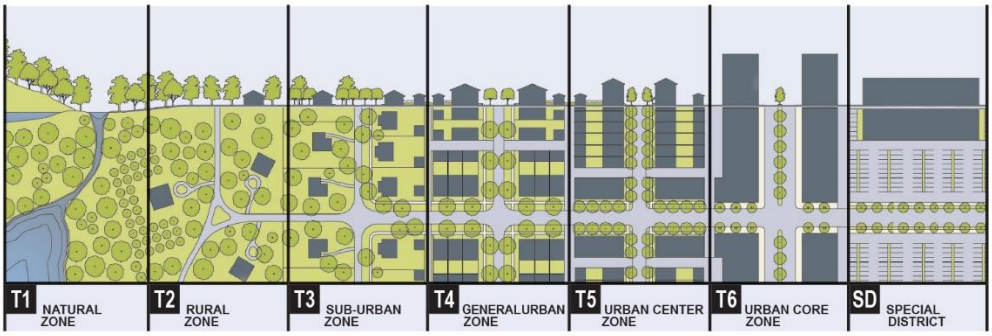

Figure 2.7. A typical Rural – Urban transect with transect zones (Duany et al., 2009, p. 7)

feedbacks within the process, which makes the code parametric (Duany et al., 2009, p. 7). Although it has several common features with other design coding approaches, the context of SmartCode is wider. That is why it is useful for developing plot–based urbanism discussions from an algorithmic thinking perspective. In the chapter 3 and 4, these comprehensive relations would be elaborated in detail.

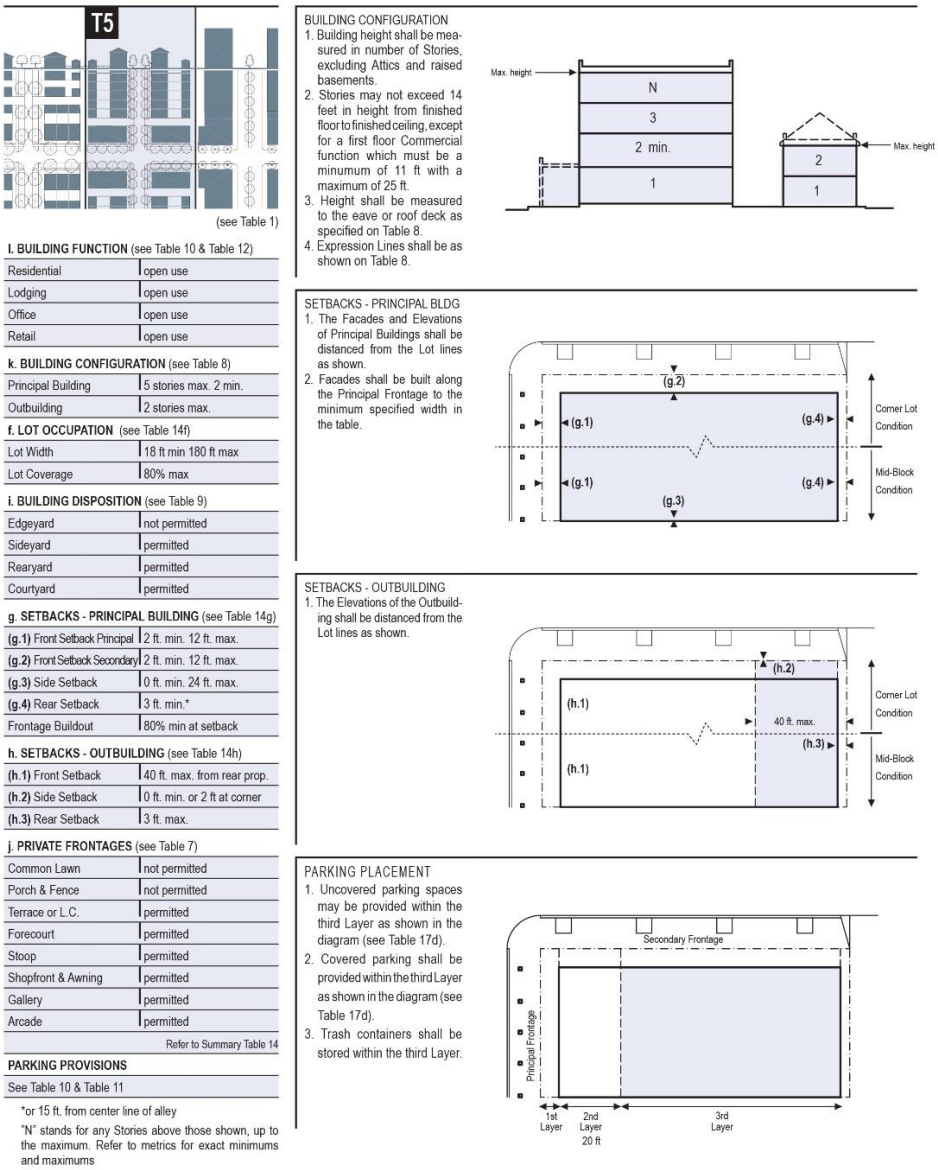

Figure 2.8. A fragment from Smart Code showing the regulation of building configuration, setbacks and organization of parking space (Duany et al., 2009, p. 59)

2.3.1.3. Pattern books

Pattern books, although there are slightly different from other codes, are also directly associated with design coding (Carmona et al., 2006, p. 217). In addition to their detailed content, pattern books have a long history. They were used by the architects of the Roman period to transfer the knowledge of the architects to the builders. Later,

by the end of the 19th century, pattern books became very popular in the real estate sector with the help of the understandable illustrations and detailed diagrams (Urban Design Associates, 2005, p. 70). Also they are more comprehensive than other design coding approaches because of adding architectural details and so on. Nowadays with the increasing popularity of pattern books, most of the stakeholders in housing sectors have consensus to use them to create desirable living environments (Urban Design Associates, 2005, p. 70). At this point, pattern books can be described as the books which supported by colorful, illustrative and explanatory diagrams and they provide a detailed guide for creating individual buildings (Richardson, 1981). (see: Figure 2.9) Thus, it should be noted that the pattern books are tools to guide designing the building

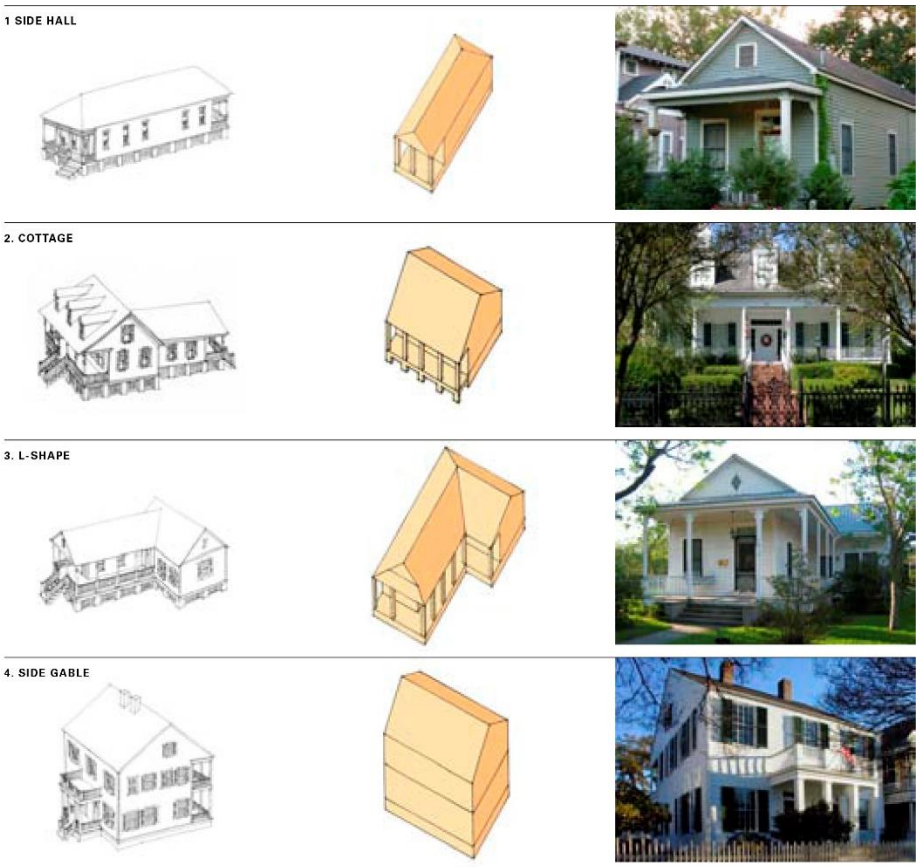

Figure 2.9. Different buildings typologies constructed according to pattern book of Mississippi (Urban Design Associates, 2005, p. 13)

itself rather than performing as a comprehensive design control tool operational on urban scale. In the scope of the research, since plot is the main urban component to be examined by design, pattern books provide a relevant basis to control the major aspects of the formation of the building such as massing and façade articulation. To do so, pattern books have explicitly depicted details about the windows, doors, porches, eaves and massing combinations of buildings. As they have very detailed codes about buildings, the pattern books are an important design control tool on the building scale as stated above and will make an important contribution to the study in this context.

2.4. Design Control Mechanisms in Turkey

Design control is carried out through different plans that shape the physical environment in Turkey. In its legal framework, plan typologies in Turkey are defined in a hierarchical manner. These plans, which are prepared on different scales, provide control of the partial formation of the cities, and have a certain role in design control with different scopes and tools of intervention. At this point, briefly summarizing the historical background of the existing planning system, it would be useful to provide a background information on the design control system in Turkey. In this context, the origins of the Turkish planning system were established in the Ottoman period. The development regulations made in the Ottoman period can be examined in two main periods[1]. Up to Tanzimat edict, regulations were mostly in local context and building scale. For instance, in the beginning of the 1700s, the distance between the buildings was ordered to be at least 8 meters and building heights can be between 6,8 meters and 9 meters (Ergin, 1995, p.997 cited in Ersoy, 2017, p. 13). In the period after the Tanzimat Edict, the effects of modernization were also observed in the planning and many new arrangements were realized. The arrangements made in this period include

[1] The understanding of planning in the Ottoman period shows two different characters in the context of the effectiveness of the central government in the planning process. Up to the Tanzimat Edict, the central government did not provide a comprehensive planning approach and did not interfere with the local affairs. However, after the edict of Tanzimat, centralization was strengthened and a planning approach which was valid for the whole empire was tried to adopted (Ersoy, 2017, p. 4).

more comprehensive interventions. In this sense, it was decided that the streets would be constructed in a hierarchical order and would be 7.5 meters, 6 meters and 4.5 meters. Building heights were determined according to the materials used in the construction and it was decided to be maximum 13.5 meters for wood and maximum 16.5 meters for mudbrick. Moreover projections of buildings were forbidden (Ersoy, 2017, pp. 37-114). These regulations form the basis of the modern planning system in Turkish Republic. Specifically, the regulations related to the streets, buildings, expropriation and land allocation tools such as amalgamation and subdivision have been quite effective in the formation of development regulations(Baş, 2003, p. 52). Afterward, a process of radical changes took place in Turkey with the proclamation of the Republic. In this period, legal and administrative reforms were made with a new understanding in the field of zoning and municipality. This situation was reflected in the planning system and there have been major changes in the planning studies. Accordingly, master plans were prepared in many cities such as Ankara, Istabul, Izmir and Antep (Ersoy, 2017, pp. 115-128). With the declaration of Municipality Law in 1930, all municipalities had to prepare maps and plans in compliance with the main development control elements specified by the law (Baş, 2003, pp. 53-54; Bilgen & Özcan, 1989, pp. 5-9). Moreover, it ensured the legal infrastructure to provide health and hygiene in urban areas (Ersoy, 2017, p. 124). Although it was effective in shaping the cities until the World War II, in the face of the rapid urbanization process that came with the World War II, the existing planning legislation of the period remained insufficient (Çalışkan, 2013, p. 200). Therefore, in order to eliminate the problems brought about by rapid urbanization, in 1956, Law No. 6785 was issued. With the new law, the planning system became more comprehensive. Accordingly, the concept of development is controlled with master plans and detailed control of the sub-components of the city has been carried out in accordance with the enduring idea of zoning (Baş, 2003, p. 55; Çalışkan, 2013, pp. 199-200). In this context, the new legal framework provided an actual basis for spatial planning to control urban areas at all levels of scale. Since master plans promotes integrity, they became able to control the general structure of the city and legislations specified the basic standards for detailed

implementations on building, plot and block (Duyguluer, 1989, p. 38, cited in Baş, 2003, p.56). The current law on spatial planning in Turkey is the Development Law, no.3194 which was enacted in 1985.

The law, which is still valid, basically outlines the planning hierarchy, the definition and scope of the plans, and the plan making processes in detail. Although the development law does not specify the exact codes of the plans, there are a number of control parameters for different components of urban areas. Accordingly, building configuration (i.e. attached, detached, row, block), floor area ratio (FAR), coverage, maximum building height, setbacks, plot width and plot depth can be listed as parameters that controlled by law. In this context, in the scope of this research, the development law also provides a sufficiently defined framework for controlling the plot because every cases that defines the construction conditions of the plot is considered.

In Turkish planning system, spatial plans, in terms of their scope and objectives, are classified as ‘environmental plans’ and ‘development plans’. Development plans are divided into two: ‘master plans’ and ‘implementation plans’. In this sense, environmental plans have certain role to suggest guiding characteristics of the city to be ideally further elaborated by the development plans. Master plans, in this framework, represent the stage in which land–use decisions are taken, distribution of the density surface are made accordingly, and the basic principles that will guide the implementation plans are determined. Implementation plan draws attention as the plan in which the built environment is determined in the city and the decisions are taken in this context. As mentioned above, all of these plans take place in a hierarchical system and each plan is prepared in accordance with the plan in the upper level.

2.4.1. Environmental Plans

By definition, the Environmental Plan represents a kind of spatial planning *"which sets out the principles and criteria within the framework of general land-use decisions that direct the sub-plans of the settlement, development areas and sectors in accordance with the objectives and strategies of the spatial strategy plans, is a whole prepared with the plan provisions and report prepared in the region, basin or province"* (Bayındırlık ve Iskan Bakanlığı, 2009). In this sense, the environmental plans strike a subtle balance between conservation and utilization of urban land through the developmental sectors such as housing, industry, agriculture, tourism, and transportation in consideration of natural and cultural assets while determining the principles of coordination between administrations for functional integration and spatial coherence (Ersoy, 2006, p. 6). Although environmental plans provide a comprehensive and integrated basis for large–scale plan decisions, it is the least effective plan type in the context of design control. Therefore they do not suggest a direct influence on design control through the parts of the whole urban fabrics.

2.4.2. Development Plans

Along with the specific set of codes, development plans that directly shape the built environment in Turkey. They are divided into two groups as: masterplans and implementation plans. This classification is made according to the scope of the plans, the levels of intervention in scales, and the control tools that the plans have. Although both plan typologies differ at the points indicated, they basically control the various components of the city through small–scale implementations. In this sense, the levels of scale determined to shape the built environment are 1/5000 for master plans and 1/1000 for implementation plans. Moreover, as Çalışkan (2013) states, "*however, the ever-changing legislative regulations on the authorization of plan making, control and approval have not changed the conventional plan typology for the production of intermediate-scale urban form. Within the overall (legal) framework, the physical (trans)formation of Turkish cities is mainly controlled by master plans and local*

implementation plans" (Çalışkan, 2013, pp. 200-201). Thus, in the context of design control, development plans are considered as the major plan typology for the spatial planning mechanism in Turkey.

2.4.2.1. Master Plans

According to current development law, master plan is prepared depending on the general principles set in the regional plans and the environmental plans. Moreover, it specifies the general decisions for land use, the direction and the size of the urban areas, the population densities and thresholds, the transportation systems envisioned for future (Çevre ve Şehircilik Bakanlığı, 2014). (Figure 2.10) In this sense, master plans are operate as integrated structure and provide the control of urban form through

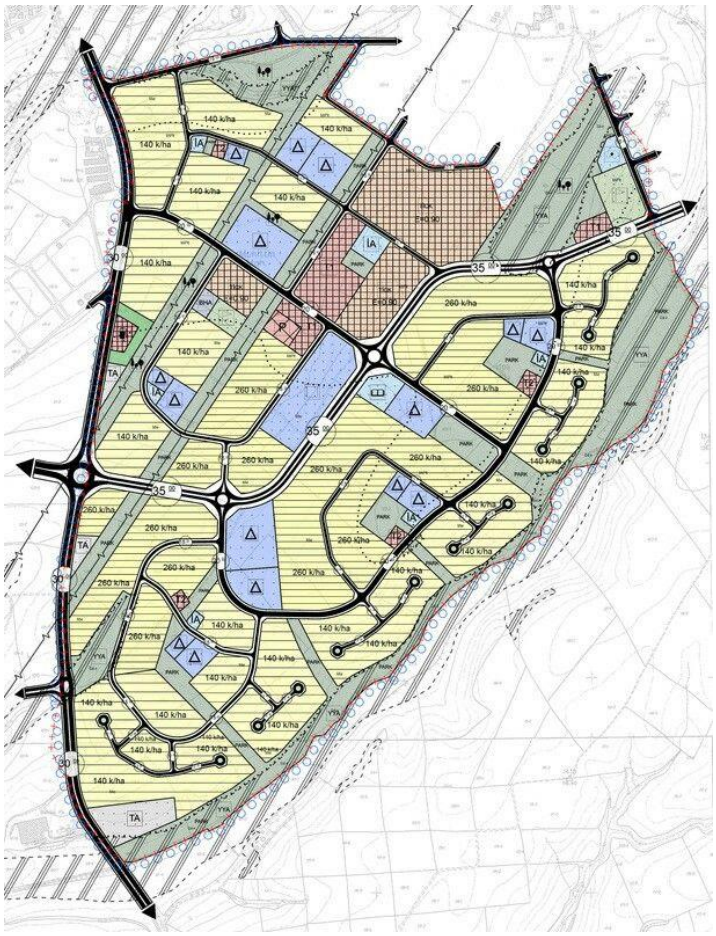

Figure 2.10. Master Plan for Çorlu, Tekirdağ (Source: Tural Planning Office, 2015)

macro scale relationships. The main issues of control in master plans are zoning, and technical and social infrastructure. These tools mostly define the general structure of city by controlling settlement boundaries, transportation network (both for vehicles and pedestrians), population and land use distributions and formation of urban blocks (Baş, 2003, pp. 65-66; Çalışkan, 2013, p. 201). In the scope of the research, the most important urban component that master plans control is considered as urban block because it is one of the main elements to produce built environment.

2.4.2.2. Implementation Plans

As specified in the current development law, implementation plans are prepared on cadastral maps in accordance with the macro–decisions of the master plans, and they designate the future characteristics of urban blocks, basic indicators of building configuration such as building heights, setbacks, coverage (*TAKS*) and floor area ratio (*KAKS*). (Figure 2.11) The main objective of implementation plan is determining the formation of urban areas by considering the mass–space relations, organization of public private spaces, building configurations in terms of orientation, landscape and technical infrastructure (Baş, 2003, p. 68). In this context, the concept of design control, at the lower scale, could be associated with the control tools of the implementation plan. Development rights and land regulation are two important control issues of implementation plan in order to shape the urban form in mezzo scale spatial frameworks. Although an implementation plan has a certain scope to shape the built environment, there is no elaborated set of control tools for shaping the three dimensional characteristics of urban form (Çalışkan, 2013, p. 202). In other words, though implementation plans in Turkey tend to control the basic layout of urban form, they do characterize the compositional quality of the fabric. Therefore, although there are some indicators that reflect some basic building rules such as FAR, coverage and maximum height, control tools of the implementation plan are not elaborated and flexible enough to generate urban block with rich set of configurations. In this context,

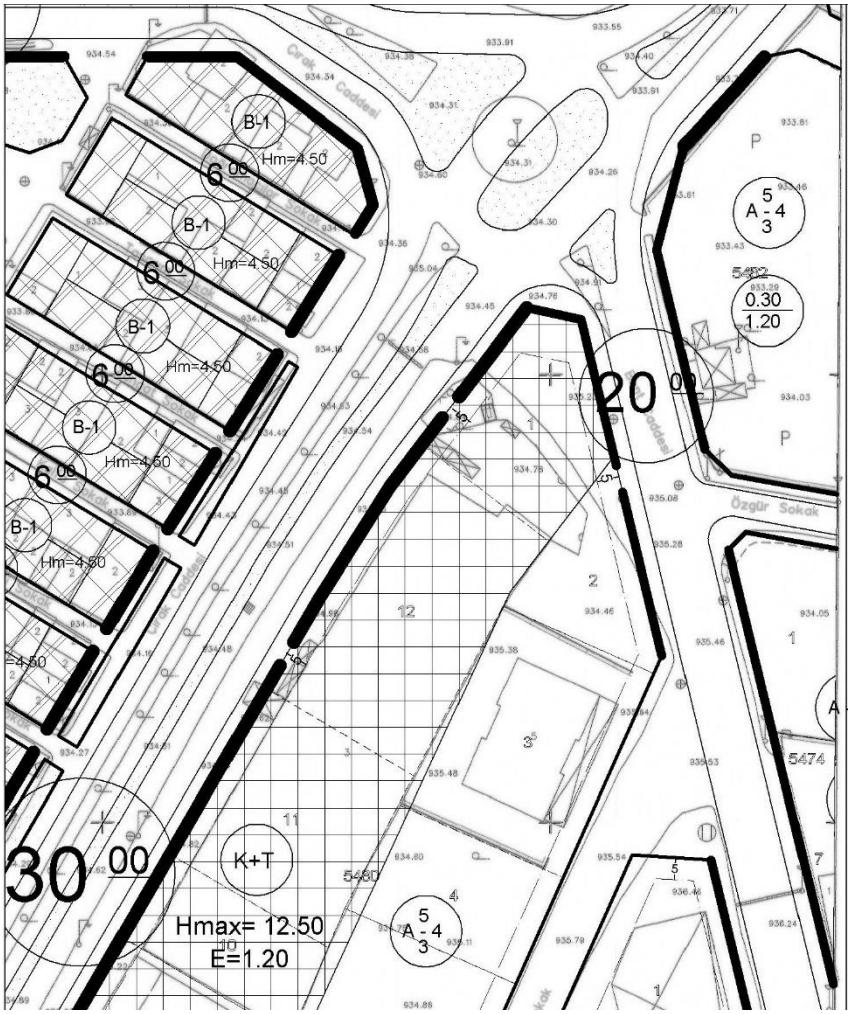

Figure 2.11. A fragment from a typical implementation plan along with basic codes indicated on each street segment and the block (Gaziantep Municipality, 2018)

although implementation plans are the main mechanism that provides direct control of the formation of the urban space in Turkey, they fall insufficient to control the three–dimensional formation of the urban fabric. At this point, in addition to suggest some supplementary control parameters for three–dimensional urban form, the study aims to reveal the hidden potential of the basic building parameters within the development law which are not utilized by the current application of the implementation plans in Turkey.

2.4.2.2.1. Allotment Plans

Production of urban lands in Turkey is eventually provided by allotment plans which are prepared in accordance with the spatial decision of implementation plans. Accordingly, an allotment plan is prepared after the implementation plan and it represents the final subdivision pattern of an urban area. Since the urban areas of Turkey are mostly composed by piecemeal individual plots, the allotment plan became more important in the context of design control. In this sense, an allotment plan stands as the planning phase in which the property rights are distributed. In this framework, allotment plans controls the several elements of urban form such as plot size, plot shape and its location (Baş, 2003, pp. 71-72; Çalışkan, 2013, p. 201; Ünlü, 1999, pp. 89-90). To that aim, allotment plans are equipped with certain regulation tools such as expropriation, subdivision and unification and land re–adjustment (Ersoy, 2005, p. 1). Since the plot is the main unit of the production of urban form and all the parameters involved in the allotment plans directly control the property relations, they are very important in the context of design control. Although allotment plan provides an operational framework for the controlling the plot, such potential is not fully realized because it is mostly prepared by cartographers without any systemic outlook on the spatial quality of urban from a designerly perspective. Therefore, land subdivision cannot go beyond a technical process and a creative scope for the formation of the plot layout cannot be revealed.

Within overall context briefly discussed above, hierarchical mechanism of Turkish planning system brings many problems in practice. It results with a system that different plans which control the urban areas in different scales cannot work in a holistic way. In this sense, the top–down control mechanisms that directly shape the built environment restricts the generative nature of urban formation as the basis of diversity and coherence. Moreover, all the components of urban form have to be framed into pre–determined (block) layout and it results in a disjointed urban setting. As Ünlü (2011, p. 447) stated, with the static understanding of development plans in Turkey, the shaping of the urban spaces restricted with the piecemeal production of

similar plots in terms of size and shape. This process generates urban fabric which emerges as collocation of identical plots and ordinary buildings. That is why development practices are still unqualified to create desirable urban spaces. Despite all, development of urban areas which emerging from multiple ownership plot pattern has potential to be reconsidered and developed in the context of *plot–based urbanism* which is one of the prominent paradigms of contemporary urbanism and discussed in following chapter.

CHAPTER 3

PLOT–BASED URBANISM IN THE CONTEXT OF DESIGN CONTROL

Throughout the history, planning practices have been changed in order to meet the social and economic needs of evolving societies. Accordingly, the types and scales of planning and design interventions have been changed, as well. Since masterplans, as 'blue-print', come up with static end-product, they have limited capacity to respond to the complex planning and design processes. In order to cope with the deficiencies of the conventional planning approaches, new points of view are needed. In this sense, 'generative urbanism' which was originally introduced in "A New Theory of Urban Design" by Alexander et al. (1987), provides an responsive framework in the context of design control. It exists as an approach that allows all urban components to be defined in a systematic/parametric manner and to be associated with an operational integrity as providing a flexible and efficient framework by creating alternatives to the built environment. The new approach differs from the conventional design methods by focusing the evolutionary (trans)formation of urban fabric instead of solely dealing with the end-product, the final form of the plan itself (Mehaffy, 2008). By doing so, design started to be perceived as dynamic and non-linear processes which enable the designers to produce alternatives instead of a single design solutions (Campbell, 2011, p. 69). What generative urbanism puts forward in its' essence is the notion of *wholeness* (Alexander et al., 1987). In order to realize the approach in practice, the planning process works in a bottom–up approach which controls the choices with logical constraints but still allows numerous design alternatives (Campbell, 2011, p. 61). In this sense, to create such a coherent approach, it is necessary to determine the basic morphological units of design control with responsive tools and mechanisms. The concept of *'plot'* and *'plot based urbanism'*, in this context, provides a very

relevant framework to develop generative urbanism in the context of design control in planning.

3.1. Plot as the Elementary Unit of Urban Form

The notion of plot has been addressed by different authors in the literature of planning and design. Campbell (2011, p. 77) defined the plot as *the smallest, and therefore, the most achievable unit of delivery*. For Porta and Romice (2010, p. 14), plot is the *ultimate unit of urban form*. Panerai (2004), on the other hand, describes it as the *minimum unit of developable land* (Romice & Porta, 2015). From wider perspective, Conzen (2004, p.75) describes the plot as *the smallest expression of undivided ownership* (cited in Barbour, Romice, & Porta, 2016). Kropf (1997, 2014, 2018) emphasized the physical feature of plot and defined it as the *physical entity reinforced by identifying a primitive entity of control, an area of ground and the things on it over which some person or group has control of access and control of activities within the area.* Lastly, Tarbatt (2012, p. 2) describes it in a more comprehensive manner and identifies it as *a substrate for generating diversity of building form which, in turn, can support other forms of diversity in the built environment: variety in the design and age of buildings, mixed housing types, sizes and tenures and a mix and intensity of different land uses*. With reference to all these explanations, plot, in the scope of this research, is defined as the key component of urban fabric that ensures the bottom–up development of built environment by enabling individuals to create different design solutions and alternatives for specific unit of land. Herein, bottom–up development associated with generative planning and design processes. In this sense, plot is the most proper urban component to create conditions for evolutionary development of urban areas. For generative processes it is inevitable to use the plot as a basic unit of development because *"it provides an opportunity for independent timelines and introduces the possibility for individual responses – the preconditions for richness, variety and uniqueness"* (Campbell, 2011, p. 77). Thus it is a reliable component for greater wholes because it ensures diversity within unity by providing an operational basis to make urban environment more coherent and complex (Romice & Porta, 2015).

In a historical context, the dynamics of the formation of the plot and the role of the plot in development of the city follows an evolutionary process. During the medieval ages *burgage plots* – rental properties of king or lord – were mostly allowed to use for production and rent. There was a general tendency for burgages to subdivide them into smaller plots to obtain more rental income (Tarbatt, 2012, pp. 35–36, 2017, p. 22). These plots, especially the subdivided ones, followed irregular street patterns and topography. They owned by different artisans such as millers and bakers, tanners, weavers etc. That is why plots were occupied up to their street frontage in order to maximize interactions of buildings with street which, in turn, made the streets more vivid and attractive (Tarbatt, 2012, p. 37). In the 18th century, estate owners started to create new streets and plots with respect to medieval core. Unlike medieval period, they amalgamated the smaller plots to get bigger plots for commercial usages such as bank. Moreover, also for this period, the relationship between streets and buildings was very important for the vitality of the city as well. Thus, development of plots were individually or in small groups to make the fabric more fine–grain (Tarbatt, 2012, p. 37). In the late 19th and the early 20th century, Garden City Movement had a strong influence on shaping urban areas. Since Garden City Movement puts forward the advantages of rural life, new suburbs were emerged with open–rows of semi–detached houses with larger plots which encourage people to make agriculture in their backyards. In the following period, planning regulations were made to produce larger and identical plots to meets the need of society (Ibid, 37). In this sense, the conditions emerged today is quite different from what laid out at history. It is obvious that there is a historical tendency to subdivide large urban areas into smaller plots (Tarbatt, 2017, p. 22). But, contemporary urban planning and design approaches ignore the place-making potential of 'art of subdivision' (Campbell, 2011, p. 26) which reveals the *characteristic-full patchwork* of urban form in cities. Since top–down planning mechanisms of emerging trends develop the cities through larger pieces of land, they cause decay of *rich tapestry* in urban places which results in fragmented urban fabrics. (Figure 3.1) Correspondingly, in the context of design control it would be possible to argue that the control capacity of plot which is the essential urban component to create

more fine–grained urban places is quite disregarded within the current design practices. Moreover, plot is the most functioning spatial scale to follow incrementalist way of development because "*small scale strategies and initiatives, if there are enough of them, can become a very big idea indeed"* (Campbell, 2011, p. 26; Tarbatt, 2012). Therefore, 'plot' in the contemporary theory of urbanism is considered the key and the critical element of urban form to develop generative processes which make the design stages more efficient based on more dynamic processes. In the scope the research, plot also provides an efficient framework for coding as a method of design control because it enables individual design implementations to create more adaptive and coherent urban environments.

Figure 3.1. Formation of the coarse-grain fabric out of the fine grain subdivision in London (Source: Tarbatt, 2012, p. 13)

From the perspective of generative design theories, subdividing larger pieces of lands into smaller plots is useful to ensure scalability, flexibility, and variety in urban areas as well as provoking the designers to produce different design solutions for specific area (Campbell, 2011, p. 80). As Conzen(1985) states, plot frames the *other elements of townscape*[2] that is why controlling of plot with different dimensions is important to control the form of the city (cited in Tarbatt, 2012, p. 23). In this sense, it is quite clear that there is a requirement for the control mechanism to re–discover the potentiality of plot in the context of generative design and design control. In this context, the 'Plot–based Urbanism' comes forward as a new paradigm in the contemporary planning and design agenda which aims to strengthen the collective character of urban form by proposing new design tactics to consolidate the role of plot in the direction of sustainable urban form. Although the notion of 'plot–based urbanism' has been used for many years to reveal the positive characteristics of the settlements, especially for historical sites,(Tarbatt, 2012) very few definitions have been developed for it. As Porto and Romice (2010, p. 14) defined, plot-based urbanism *is the set of spatial principles conducive to urban spaces that are adaptable over time.* Urban form is composed by embedded morphological relations of *plot, lot* and *block.* (Figure 3.2) Within in the evolutionary development of cities, plot is the most important urban element since it triggers the generative processes. In this sense, new strategies and design tactics that introduced by plot–based urbanism is important to design cities in a bottom–up manner. By doing so the deterministic design approaches of the contemporary planning (Çalışkan, 2017, p. 1) approaches can be (re)formed by incremental design processes.

Another definition for plot–based urbanism is provided by Jonathan Tarbatt in his book, '*The Plot'.* According to him, plot–based urbanism is as an approach that "*aim to foster the characteristics of close-grain places that we value – diversity, variety,*

[2] Conzen (1985) explained the urban form as "townscape" and according to him there are three elements of townscape which are the pattern of streets and plots, the building fabric and the pattern of building and land uses.

adaptability – while also putting in place the frameworks necessary to achieve all other objectives of urban design; character, continuity, enclosure, legibility and ease of movement" (Tarbatt, 2012, p. 54). In this context, plot–based urbanism draws attention as a new breath for planning and design to make the urban fabric ***diverse, adaptive*** and ***malleable.*** Plot–based urbanism proposes a development pattern through individual plots. Thus, it promotes the subdivision of bigger lands into smaller plots

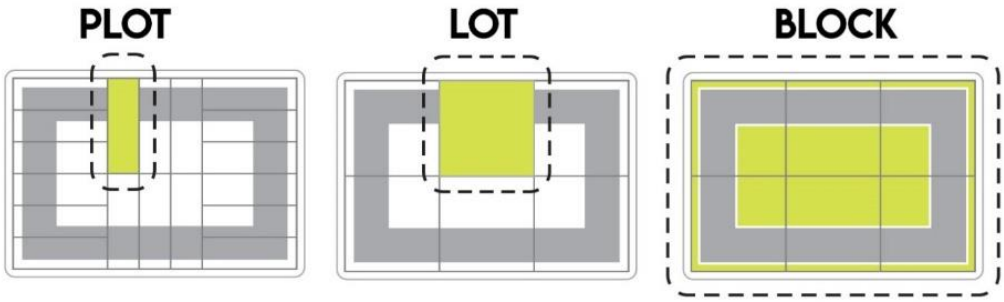

Figure 3.2. Embedded structure of plot, lot and block (Adapted from Campbell, 2011, p. 76)

which enables different developers to take action instead of leaving the stage to the single agency. Moreover, the plot-based urbanism essentially promotes the 'fine-grain' urban development (Barbour et al., 2016; Romice & Porta, 2015; Tarbatt, 2012, 2017) with the relatively small element of the urban fabric. The term of 'grain' addresses the density of subdivision in the context of planning and design (Tarbatt, 2012, p. 28). In this sense, fine–grained urban fabrics is composed by the dense plot pattern fostering the place–making capacity of the city. As Tarbatt (2017, p. 26) argued, fine–grain plot subdivisions *"produce inherently robust building forms that are adaptable to changes in use"* and they are capable of being transformed in different times. In this way, it revitalizes ***diversity*** in urban fabric by "*offering an innovative approach to development, based on the creation and maintenance of a structure made up of integrated elements, in the form of plots, capable of incremental development, by a range of agencies"* (Barbour et al., 2016). Plot–based urbanism differentiates from conventional planning approaches because it alters the static morphology of masterplans. Instead of creating predictable final forms, plot–based

urbanism embraces the change in urban fabric by ensuring incremental (re)development of urban fabric. Such a development pattern is the starting point for making cities more ***adaptive***. Moreover, plot–based urbanism *enhance the adaptive capacity of urban spaces to respond change over time and help us to re-discover the knowledge of 'urban adaptability'* (Tümtürk, 2018, p. 157). In this sense, in order to provide *more time-conscious and adaptive development processes for urban environment, it should be suggested that the structure of urban form has to be conducive to small-scale intervention* (Thwaites, Mathers, & Simkins, 2013, pp. 76–77). Here, plot–based urbanism provides an effective framework to shape the built environment through small scale and incremental changes (Campbell, 2011, p. 72). By doing so, it turns the urban development into a processes rather than the product that essentially would make the practice more gradual and therefore generative (Mehaffy, 2008). Plot exists as an urban component which is open to change. As stated by Conzen(1969), the plot has tendency to change faster when compared to the other elements of urban form (i.e. street, blocks). Thus, fine–grain characteristic of the fabric which consists a dozens of piecemeal plot operations steers the change of urban fabric in a coherent way. Moreover, since plot has many dimensions which shape the built form both in the two and three dimensional context, it is the most operable unit of the city in the context of design control. In this sense, plot–based urbanism provides a very relevant base for controlling form and formation of the urban fabric. This situation reveals itself as ***malleable*** urban form in the built environment which is capable of to ensure *urban adaptation to occur and continue in gradual manner* (Tümtürk, 2018, p. 136).

Briefly, plot–based urbanism provides an effective framework to develop urban fabric in an incrementalist manner which triggers the generative processes and providing a configurable scale of intervention to shape built environment in a bottom–up manner. In this context, in order to sustain such a comprehensive framework to control the main components of urban form it is needed to define the main control parameters.

3.2. Design Control Parameters for the Plot–Based Urbanism

In the scope of this research, several parameters on the urban block and the building are defined in relation to the plot. Accordingly, for the urban block, there are two different parameters which are block size and number of subdivisions. For the building, there are three control parameters which are building height, front building line and building setbacks. For the plot itself, there are five control parameters which can be listed as plot size, coverage, floor area ratio (FAR), plot setbacks, and buildable volume ratio.

3.2.1. Urban block size

In order to control the formation of the plot, dimensions of urban block are the main parameters which characterizes the subdivision of the urban lands into plots. In this framework, block size is controlled by the *depth* (a) and *width* (b) of the urban block. (Figure 3.3) According to Urban Design Compendium (2000), size of the block is diversified with respect to configuration of streets, preferred orientation and topography, plot subdivisions and building types (cited in Tarbatt, 2012, p. 23). Despite the fact that size of the block is affected by several other factors, controlling the depth and width of block would be effective in the scope of the plot–based urbanism since the urban block has nested spatial relations with the plot and building.

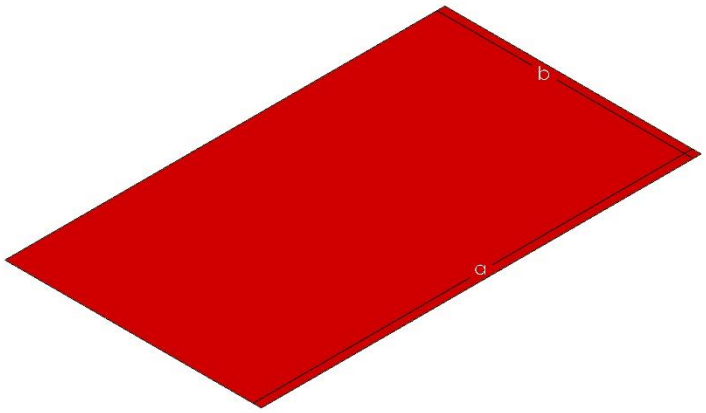

Figure 3.3. Depth and width of the urban block

3.2.2. Number of Subdivisions

Urban block consists of a number of plots which have different sizes and shapes. (Figure 3.4) As stated above there is an interwoven relation between block, plot and building. As stated by Campbell(2011), *efficient dimensioning and design of the block derives from a strong understanding of building typologies and their complex interrelationship with the plot* (p. 78). In this sense, number of subdivision points out as important parameter to shape urban block in the context of design control. Since subdivision pattern directly form the built environment, relationship between number of subdivision and block is crucial to promote the plot–led development of urban areas.

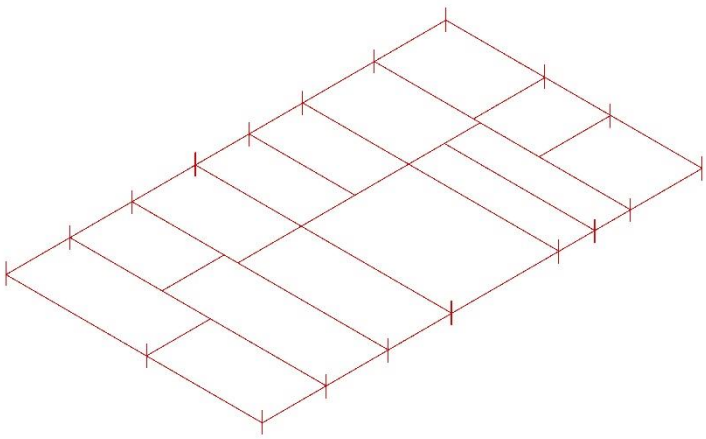

Figure 3.4. Number of subdivisions

3.2.3. Plot size

Like block size, plot size is defined by *depth* (b) and *width* (a) of the plot. (Figure 3.5) Since the plot is the elementary unit for controlling the urban environment, controlling the dimensions of plot is inevitable to conditions the urban block and building morphologically. Plot–based urbanism fosters the fine–grain urban environment by controlling the depth and the width of the plot to ensure diverse and adaptive urban fabric.

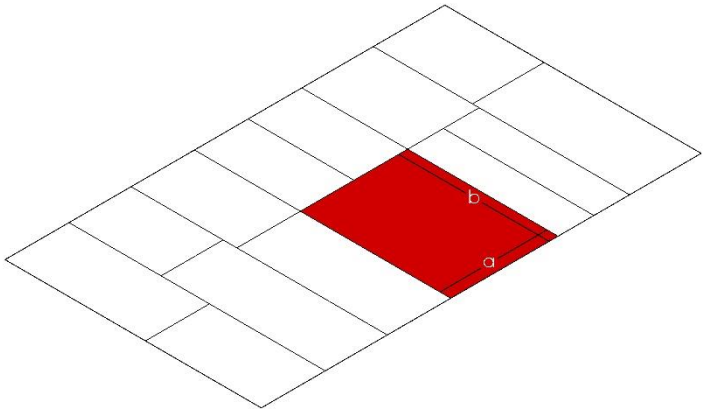

Figure 3.5. Depth and width of the plot

3.2.4. Coverage

Coverage, as one of the most common control parameter of development in planning, implies the ratio between buildable area of the plot and the total area of the plot surface. It basically demonstrates the extent to which plot can be covered by the building. (Figure 3.6) It is useful to control desired relations between plot and building by conditioning the figure–ground relations within the collective urban form.

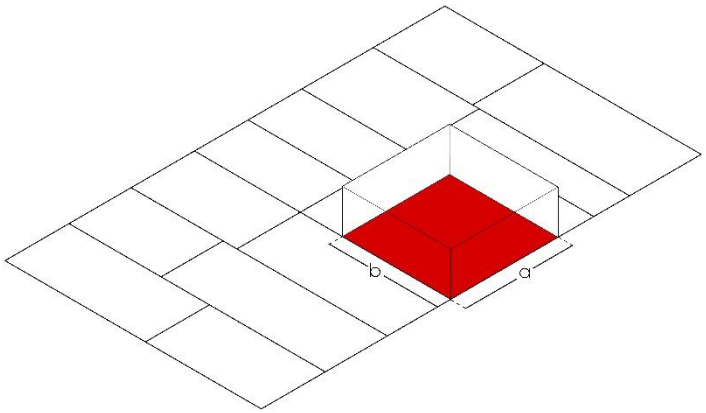

Figure 3.6. Coverage

3.2.5. Floor area ratio (FAR)

Floor area ratio indicates the building density in a plot. It is calculated by the ratio between total floor space of the building and the surface area of the plot. (Figure 3.7)

FAR is used to be utilized as a complementary indicator with *coverage*. By division of FAR by coverage gives the number of floors as one of the major control parameters in planning.

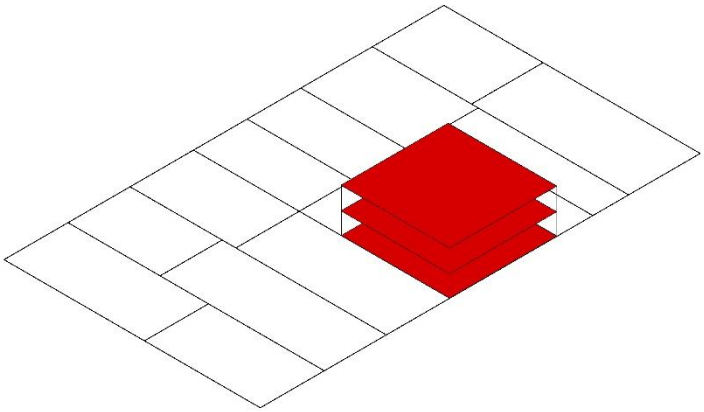

Figure 3.7. Floor area ratio

3.2.6. Plot setbacks – Footprint

Setbacks basically determines the distances between building and the edge of the plot. In this sense, setback is a tool to ensure the desired distance between the buildings on a street or in an urban block. Setbacks, in our framework, are used to condition the footprint of a building in the plot. In this context, it limits the coverage of the building on ground. (Figure 3.8) There are three different setbacks of the plot: front, rear and side setback.

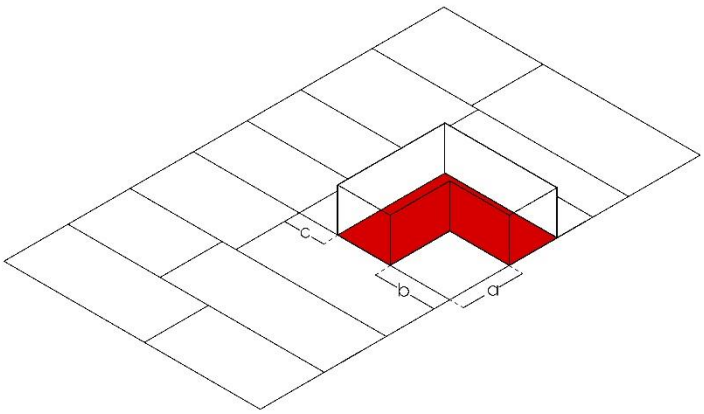

Figure 3.8. Different types of setback of the plot *(a=side-setback, b=front-setback, c=rear-setback)*

3.2.7. Buildable volume ratio (BVR)

Plot is usually described as a two–dimensional with in the relation to the other elements (i.e. building, street and block) of urban form. Nevertheless considered as a unit which accommodates building in itself, plot could be described as a three–dimensional entity, as well. The concept of *plot envelope*, in this sense, has great potentials to control the plot in three–dimensional context. Instead of defining *an area* for the building setting, plot envelope provides *a volumetric* definition for the control of the building mass. In this way, plot acts as an abstract three dimensional frame in which building could be configured within the pre–determined constraints (i.e. maximum height, setbacks, coverage). Such a comprehension of plot provides flexibility for building to be composed in close relation to the adjacent buildings to ensure adaptable urban fabric. Therefore, plot envelope would perform as an interface between building and block. By doing so, it defines new three–dimensional conditions within nested relations of the major components of the urban fabric. Conditioning the building mass in a volumetric manner, plot envelope provides a generative basis by ensuring different alternatives for building within the volumetric context. Buildable volume ratio, in this context, is calculated by dividing of the building volume to the total volume of the plot envelope.

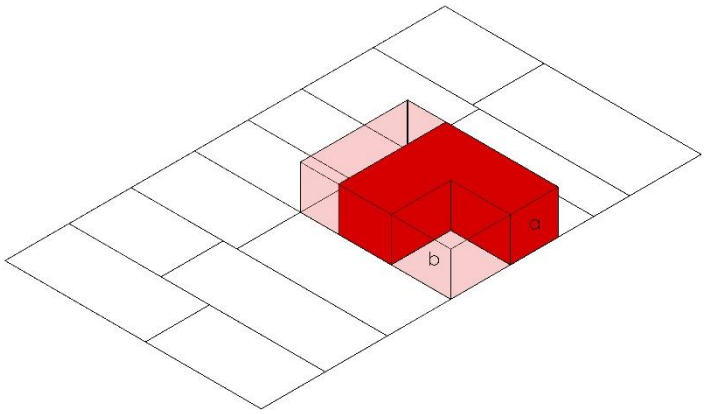

Figure 3.9. Buildable Volume Ratio (a: volume of the building, b: total volume of the plot envelope)

3.2.8. Building envelope

While the plot envelope tends to control the development in a volumetric manner, building envelope aims to guide the articulation of the building within the three–dimensional framework. Building envelope, in this context, connotes the spatial limits of the habitable volume in three–dimension (Çalışkan, 2013, p. 130; Tarbatt, 2012, p. 156). In other words, it is a three–dimensional volume in which the building can be configured in accordance with pre–determined rules. It indirectly conditions the relationship between building and street with the adjacent buildings, as well. The basic parameters of the building envelope are height, building setbacks and front–line.

3.2.8.1. Building height

Building height is determined by the number of storey and the height of each storey. That means the parameter has two sub–parameters embedded: height of the storey (i.e. ground levels' and the upper levels' height) and the range of height within the building envelope. It has a very important role in the spatial perception of people as it directly shapes the built environment. (Figure 3.10) Building height is one the major elements of building envelope because it is a major factor on the construction and management cost of the vertical access to the dwelling units (Çalışkan, 2013, pp. 119–120).

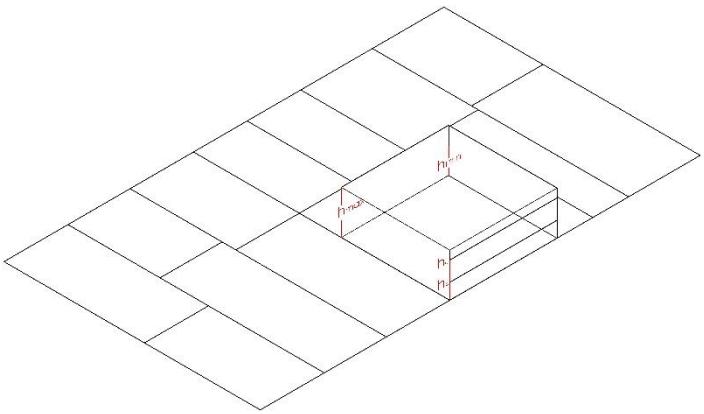

Figure 3.10. Building height (hb: height of the basement, hu: height of the upper storey, hmax: maximum height of the building, hmin: minimum height level of differentiation if desired)

3.2.8.2. Building front–line

Front–line is simply the line which conditions the open active façades of the building that have faces to street. (Figure 3.11) It is suggested to establish a relationship between building and the streets, performing as an interface between the inner and outer space of the plot at the ground–floor level. Front–line is controlled by the length of the line (meter) in relation to the building footprint.

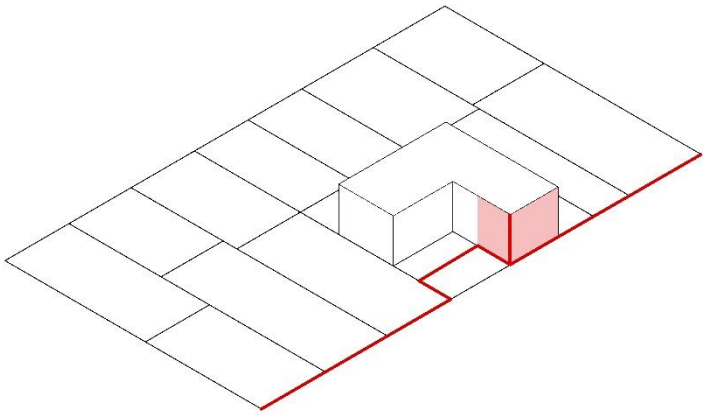

Figure 3.11. Building front line

3.2.8.3. Building setbacks

In order to describe the building envelope in three–dimensional context, setbacks on the building façades would be useful in the control of urban form. Like plot envelope, building envelope has three different types of setbacks: front, side and rear–setbacks. (Figure 3.12) These setbacks directly related with the building height and front–line, as well. Setbacks in three–dimension provide fruitful design alternatives and morphological diversity for urban fabric by guiding the articulation of the building in relation to the other buildings within the same urban block and the street as well. Recession and protrusion, in this framework, are the basic operations to control the parameter.

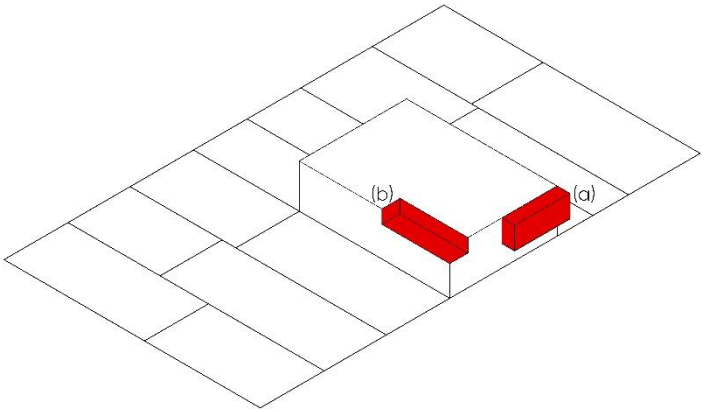

Figure 3.12. Different types of setbacks on the building envelope: protrusion (a) and recession (b)

Herein, to be able to draw an operational framework to reveal the potentiality of 'plot–based urbanism' to strengthen the collective structure of urban form and to promote the incremental development fostering generative design processes, it would be useful to look out the historical and contemporary examples in practice. Re–evaluating the several examples of plot-based urbanism, relevance and the particularity of the approach would be revealed on actual basis. Accordingly, international examples will be examined with respect to two categories. In this context *historical background* will cover the cases, *Eixample – Barcelona* and *New Town – Edinburgh*. Then *current state of the art* will included the contemporary examples such as *Borneo Sporenburg – Amsterdam, Bo01 – Malmö* and *Homeruskwartier – Amsterdam.*

3.3. Historical Background of Plot–based Urbanism

3.3.1. Eixample – Barcelona

In the mid–1800s, Barcelona was an active port city with its' industry–based economy. With the industrial revolution, rapid population growth brought negative conditions in the city and population density increased, considerably (850 people per hectare). Parallel to this, infrastructure problems have started in the city and an unhealthy urban areas has been emerged. In this sense, new living spaces with more livable conditions were needed (Pallares-Barbera, Badia, & Duch, 2011, p. 124). To this end, the

Barcelona City Council organized an urban design competition in 1859 to find the best solution to expand the Barcelona beyond the city walls. Ildefons Cerda won the competition with his influential proposal. There was a systematic theory behind the Cerda's plan which constitutes an operational solutions to problems of the city. The theory was composed of three fundamental components; *hygenism*, *circulation* and *future city* (Busquets, 2014, pp. 125–129). In order to form the urban space through these objectives, the plan suggested the superposition of different layers which would provide different levels of intervention. (Figure 3.13) The basic layout of the plan is shaped by unlimited geometrical urban blocks (113.3 by 113.3 meters), with 20 meters, chamfers on each sides (Sardà, 2018, p. 25). Cerda proposed three types of urban block to ensure the diversity within the urban fabric. General layout of the block

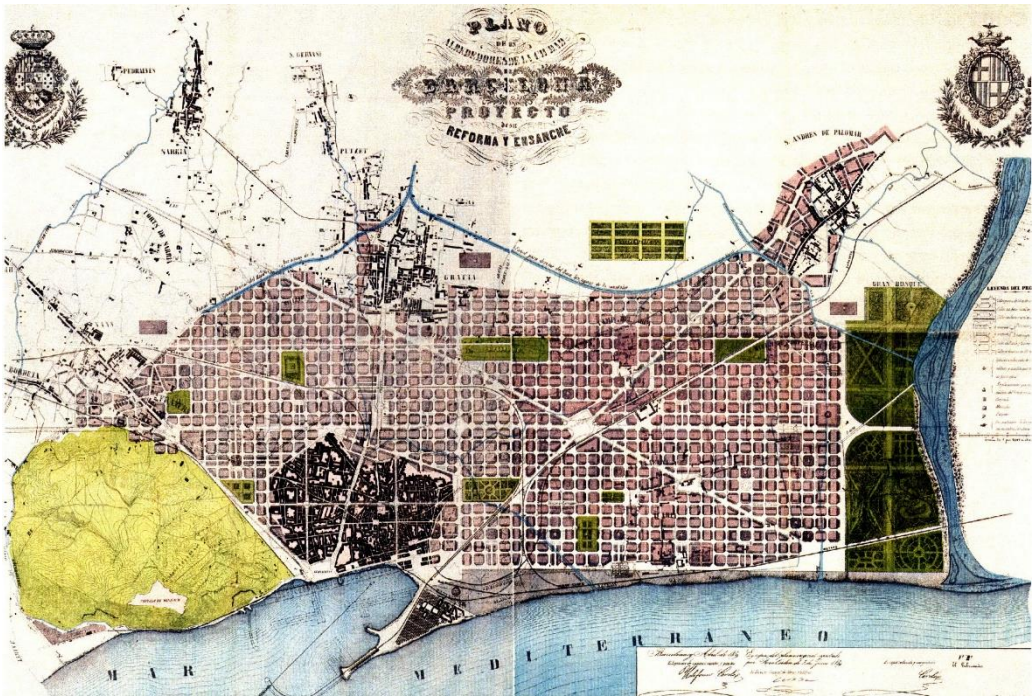

Figure 3.13. The Plan by Ildefons Cerda for Barcelona's Eixample, 1860 (Source: Busquets, 2014, p. 127)

were forming as two parallel lines, u shaped block and l shaped block (Fernández, 2008, p. 65). (Figure 3.2) These blocks were suitable to enable different configurations which make the plan more flexible. Correspondingly, I.Cerda used the different

combinations of these block types to shape the general layout of the Eixample. Indeed, I.Cerda's initial control unit when designing the Eixample was the urban block. However, urban blocks, do not represent the end point of the design process. In the way to develop the urban blocks, he used various combinations of individual plots and housing units that were organized within the blocks in the overall urban grid (Neuman, 2011, p. 127). (Figure 3.15) As stated by Sola-Morales (1997), the production of urban fabric in Eixample followed three interconnected stages: *parceling, urbanization and construction* (cited in Leote, 2015, p. 3). Correspondingly, development process of the

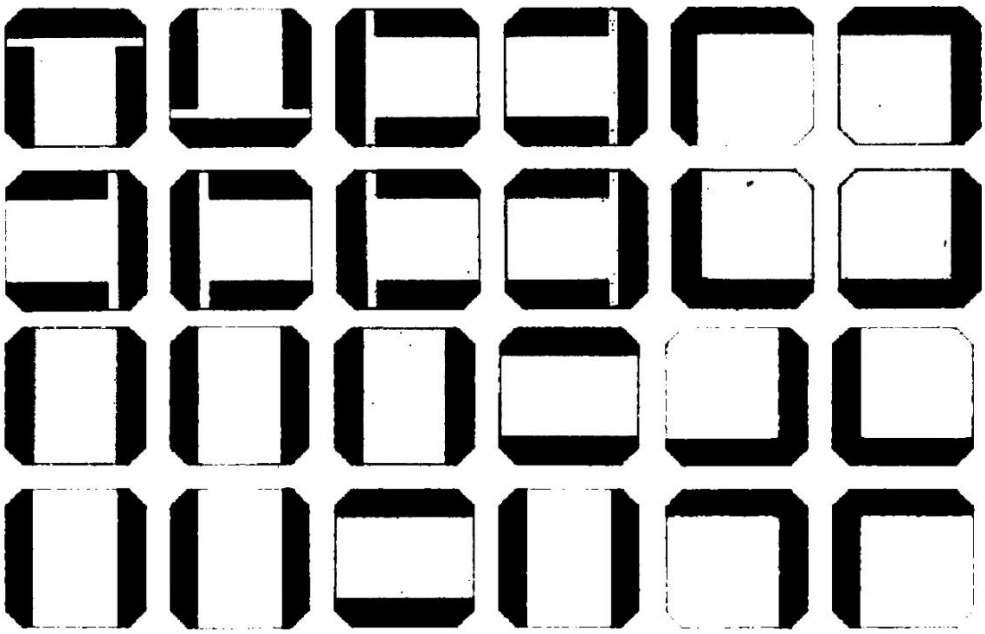

Figure 3.14. Different block formations initially envisioned by Ildefons Cerda, for Barcelona Plan, 1860 (After Fernández, 2008, p. 66)

city continued with the progress of these three stages and the form of the Eixample was emerged accordingly. In this sense, Cerda began to his work by parceling the agricultural lands in order to generate fine–grain plot pattern in the city (Habitat, 2015, p. 14); then the urban fabric was articulated within the envisaged blocks in time (Leote, 2015, p. 3).

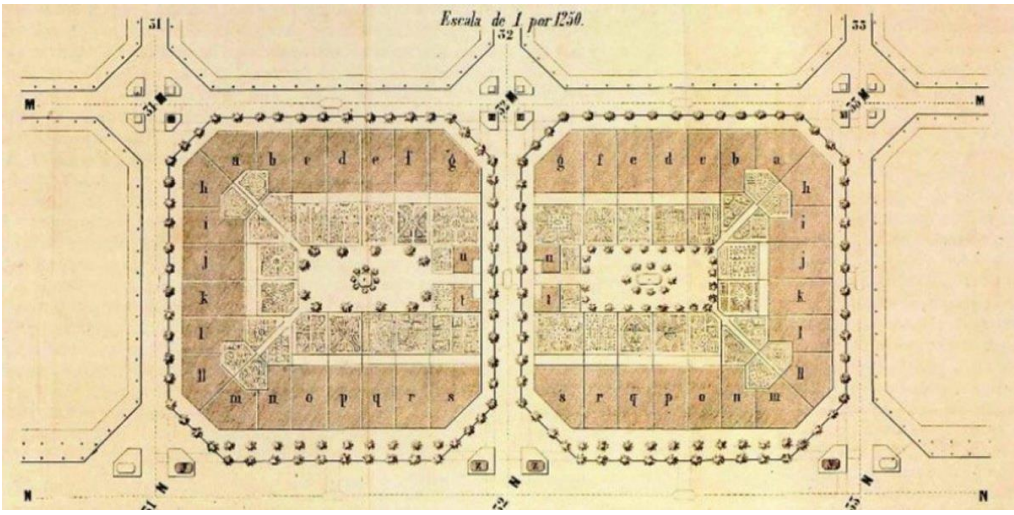

Figure 3.15. Plot configuration of u shaped urban block designed by Cerda, 1860 (Source: Busquets, 2014, p. 139)

Before I.Cerda's plan the area of Eixample were occupied by farmlands made up by small plots. In order to sustain the character of the area, I.Cerda subdivided and amalgamated farmlands to obtain fine–grain plot configuration. In accordance with this purpose, he suggested different drafts for different urban blocks (Busquets, 2014, pp. 136–137). (see Figure 3.15) Actually he *carefully designed the plot division according to the overall layout, breaking the area down into 325 plots that were quickly developed* (Ibid, 138). With the fine–grain plot configuration, I.Cerda were aimed to create flexible and adaptable urban fabric which can change overtime according to changing demands of the society. That is why he did not put the idea of finished definitive project. Instead of creating a static end scheme for the Eixample, he tried to understand and regulate the process of formation of the urban fabric that affect the topographical, technical, legal and economic principles of city building processes. In this way, he created an approach of urban design with a certain capacity to adapt to the changing historical circumstances depending on the legislative regulations (Guarida & Fava, 2010, p. 2). At the beginning of the construction process

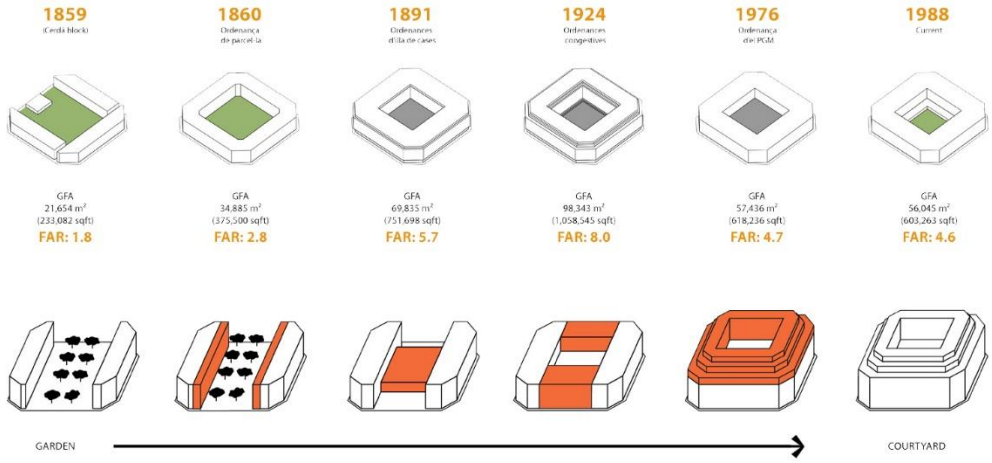

Figure 3.16. Evolution of urban blocks of Eixample over time (Projective Cities – AA School of Architecture Website: Yuwei Wang, 2012)

I.Cerda defined a rule for coverage of the urban blocks. In addition to the regulations for the general land coverage, building height, plot gardens; plot coverage was limited to the 50 percent (Aibar & Bijker, 1997, p. 17). Since the coverage of the first urban blocks was at that level, the city was open to change gradually thanks to its' fine–grained subdivision pattern. Accordingly, the block formation of the Eixample has changed over the years. (Figure 3.16) In this manner, the plot sizes, plot coverages, building widths and heights evolved in time and it fostered the diversity within the urban fabric through different scales. (i.e. buildings, blocks and streets)

By relying on all these transformations, it would be possible to argue to that the evolution of the Eixample followed an emergent way of development through carefully designed individual plots. The fine–grain subdivision character of the plots allowed incremental development of the city which shaped the overall urban form of the todays' Eixample in a strong urban coherency. Herein, the operational design understanding and the layout of the Eixample has formed a quite flexible design framework that was competent to adapting the urban form to a historical evolution that was *hard to foresee, and capable of absorbing modifications* (Guarida & Fava, 2010, p. 8). In this context, fine–grain plot configuration and plot–based development of Eixample, provided a well–controlled design process that makes the urban fabric

more adaptive, flexible and open to change within the emergent development processes over time.

3.3.2. New Town – Edinburgh

By the end of the–1700s the city of Edinburgh had an overcrowded and unhealthy urban areas through migration from rural areas to the cities as a result of the transition from an agricultural to the industry–based economy. Moreover, the presence of public spaces in the Old Town to meet the social needs of the population became insufficient and the poor health due to overcrowded city space (Fry, 2001, p. 2). Under these circumstances, there was an actual requirement for new residential areas in the Edinburgh. In accordance with this purpose, an architectural design competition was held in 1766. James Craig, a young architect, won the competition with his proposal. The layout of the plan was dominated by rectangular blocks with strict grid formation and main street that links the two garden squares located at the east and the west side of the area (Carley, Dalziel, Dargan, & Laird, 2015, p. 8). (Figure 3.17) The plan for the Newtown was prominently geometric and it was ensuring the regularity and order within the urban fabric. Although the plan of James Craig is highly rigid and monotonous it has a *systematic approach to planning and a desire to try to forecast a*

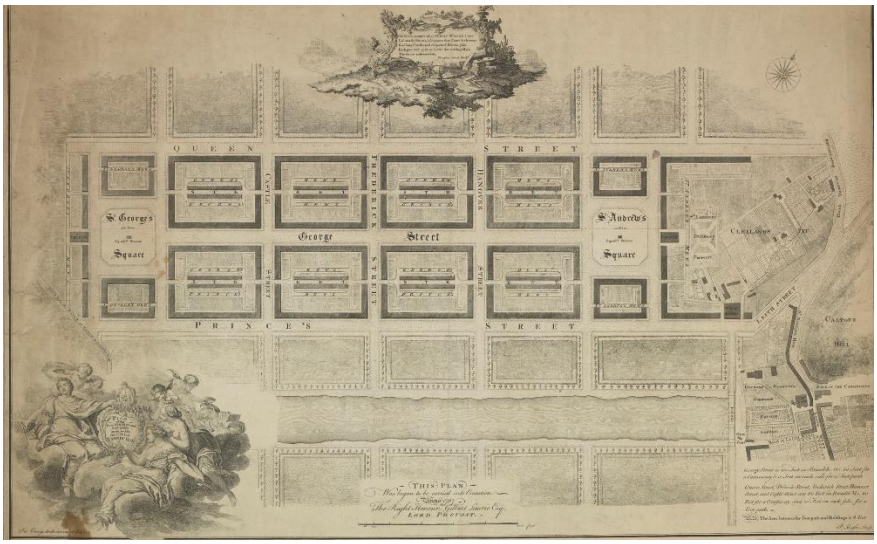

Figure 3.17. The plan for the New Town – Edinburgh by James Craig, 1768 (Retrieved from Scotland National Galleries - Plan of the New Town, Edinburgh, 2019)

future and then build a structure to represent the or enable such a future(Carley et al., 2015, p. 16). To this end, the New Town has evolved over time and has become a district with an adaptable urban fabric (Ibid, p.30). In this sense, the important point is to develop a systematic framework to determine the catalyzer behind the evolving process of the New Town when the original parameters of the plan were so rigid[3]. Although the plan of the New Town composed of urban blocks coming from a very geometrical and rigid layout, has a fine–grained plot pattern, which allows residents to design their buildings individually (Kondo, 1998, p. 253). In this sense, it would be possible to argue that close-grain plot configuration of the plan *demonstrate both a flexibility and a capacity for architectural sophistication far beyond anything envisaged by Craig* (Carley et al., 2015, p. 46). Herein, the main objective of the plan was to create an urban fabric which capable of fostering the greater variety of residential and commercial usages relying on plot–based development. By ensuring such a development model, an urban form can be achieved that *fixed by design at the same time embrace change is an unusual and valuable one* (Carley et al., 2015, p. 221). Correspondingly, the plan of the New Town with its' fine–grain plot subdivision enabled the evolution of the city in time. (see Figure 3.18) Gradual development of the New Town, in this way, gave opportunity to different designers, developers, building professionals and individuals to take part in the design of the city since the relatively small, individual plots provided individual buildings with greater variety of expression and influential flexibility (Carley et al., 2015, p. 228). Accordingly, after the design of the New Town, the project started to be implemented. In this manner, in the first phase of the project, the static and homogeneous urban blocks that proposed by the Craig's plan is divided into smaller plots to create new plot configuration. Afterwards, a fine–grain subdivision pattern was designed in order to ensure diversity in depth and width of the plot and building (Tümtürk, 2018, p. 138). (see Figure 3.18)

[3] According to Carley et.al. (2015), there were eight different parameters which shaped and supported the change in New Town while maintaining the essence of its' original orderly framework. There were *geometry, density, height, grain, hierarchy, spatial planning elements, building design* and *control* (p.31).

Plot-by-plot development process of New Town in accordance with simple design rules introduced after Craig provided an incremental transformation process for the overall urban fabric. Involvement of different actors in this transformation process ensures diversity and longevity of the urban fabric by a bottom–up manner.

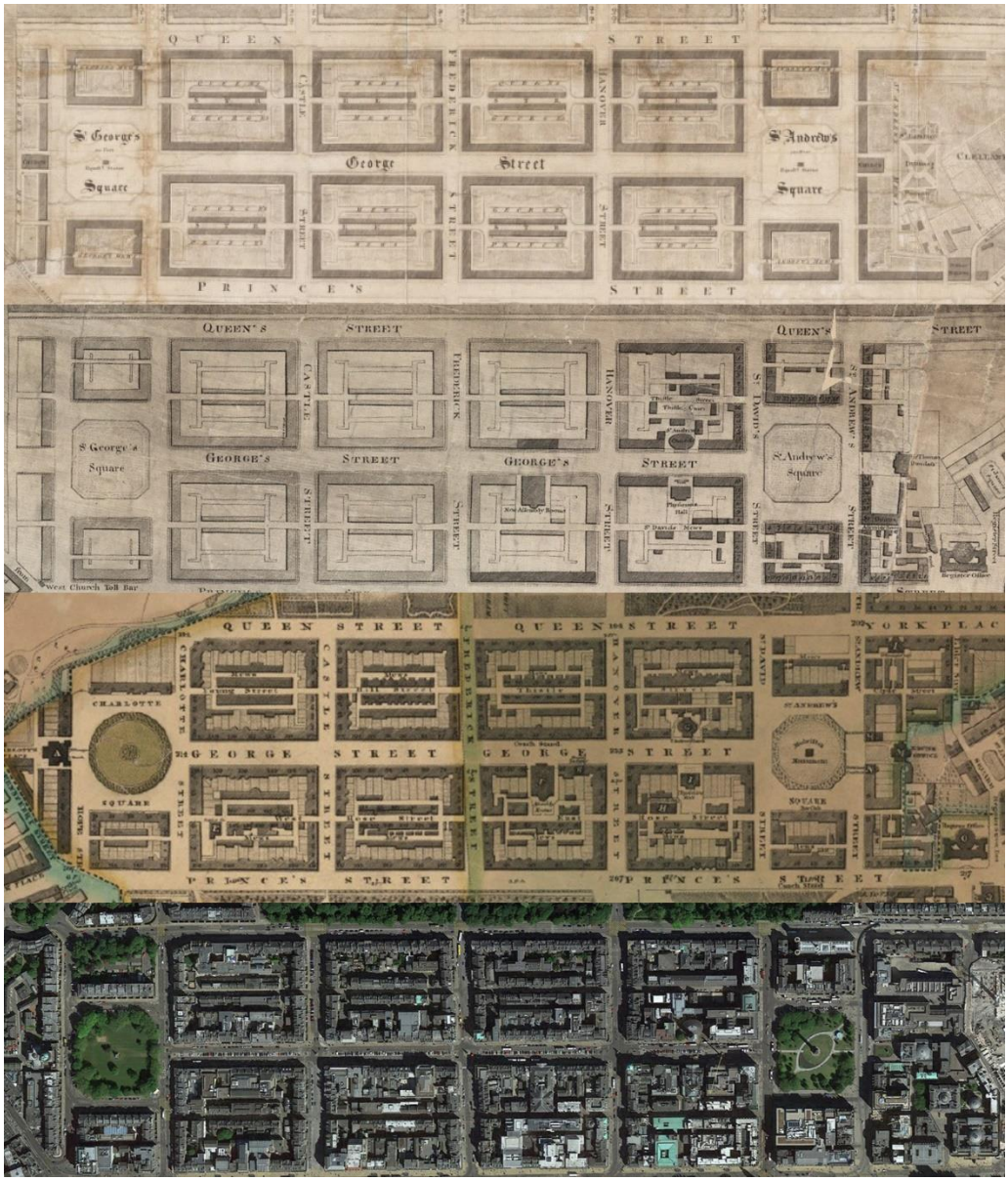

Figure 3.18. Transformation of plot configuration over time in New Town – from James Craig's' original plan of the New Town,1768 (above) to plan of Alexander Kincaid,1784 (middle) to Kirkwood's new plan of the City of Edinburgh, 1821 (middle) and current plot configuration of the New Town (Retrieved from National Library of Scotland, Town Plans/Views 1580-1919; Google Earth, 2019)

Therefore, like Barcelona, New Town exemplifies a successful applications of plot–based urbanism in history. The evolutionary formation of the city through different processes was realized through the plot as major unit of transformation. (see Figure 3.19) In this manner, fine–grained plot configuration and plot–based urbanism provide a highly efficient framework for creating an adaptive, diverse and flexible urban fabric over time.

Figure 3.19. An aerial view of the New Town – Edinburgh (Source: Carley et al., 2015, p. 48)

3.4. Current State of Art

3.4.1. Borneo Sporenburg – Amsterdam

Borneo Sporenburg is located in the eastern part of Amsterdam, the Netherlands. It was built as the third extension of Amsterdam Eastern Docklands with the aim of industrial port activities (Pacheco, 2004, p. 10). As it was built–up for commercial services, it was densely used for import and export facilities in relation to the Dutch colonies. Until World War–II, Borneo Sporenburg preserved its' harbor character both spatially and functionally. (see Figure 3.20) After the war, industrial facilities were moved to the western part of Amsterdam and accordingly in the following years

docklands were also moved to the western part of the city. As a result of this transformation process, Borneo Sporenburg lost its industrial, then port function and it became a place occupied by squatters (Höger, 2011, p. 39). By the end of 1980s redevelopment processes were started in the area. Accordingly most of the squatters

Figure 3.20. Harbor of Borneo Sporenburg (Source: Pacheco, 2004, p. 10)

were relocated (Ibid, pp.39-40). At the beginning of the–1990s, Borneo Sporenburg was included in a master plan program of development of the eastern harbor area of Amsterdam (Pacheco, 2004, p. 10). As a result of this planning decision, a design competition was held for the renewal of the Borneo Sporenburg. The West8, a group of Dutch architects, won the competition with their proposal which provided plot-based development through 2500 dwelling units with a density of 100 units per hectare. (Figure 3.21) As the first brownfield redevelopment project in the Netherlands, the planning process was finished in 1996 and construction completed between 1996 and 2000 (Gray, Novacevski, & Auld, 2016, p. 11). The design concept focused on the series of dynamic plots as the main catalyst for production of the urban form. Accordingly, the main objective of the plan was creation of a unique structure within a diversified whole. In order to provide a coherent urban fabric, the plan was defined certain design codes that would control the access and parking facilities,

private open space, number of storey and building heights, plot widths and building materials (Gray et al., 2016, p. 13).The design project mainly composed by three main component which are *series of dynamic plots, large scale – landmark – buildings and the three bridges* (Kömez, 2009, pp. 88–91). In the context of the plot–based urbanism

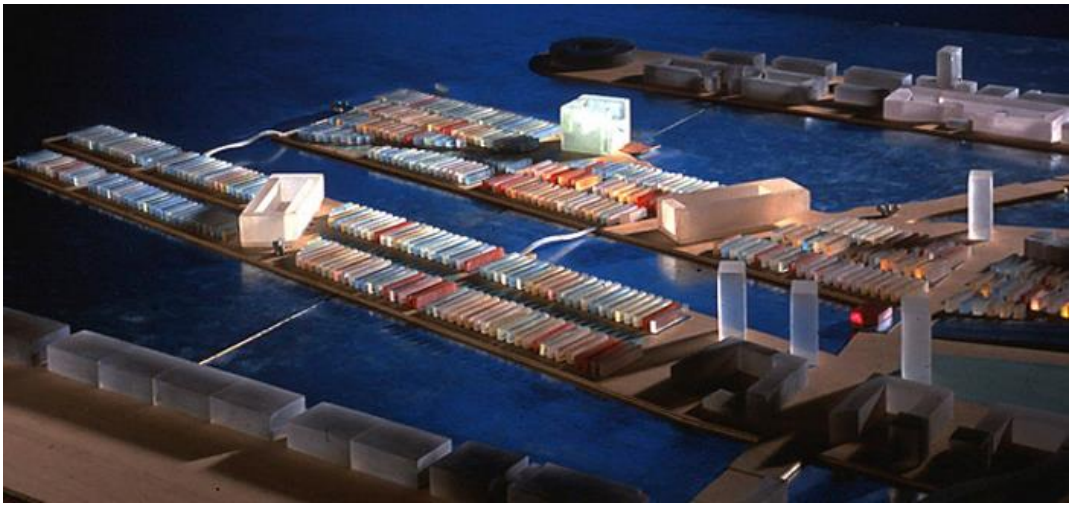

Figure 3.21. The model of the proposal of West8 for Borneo Sporenburg (Source: West8, 2002)

a series of diversed plot configuration came to the front as they ensured the fine–grain morphology of urban fabric. Fine–grain configurations of the plot trigger the incremental way of development by enabling different designers to take place in the development process. Although the plan proposed a limited land–use activity for the area, it provides a significant degree of formal variety since it follows plot–based development character (Pacheco, 2004, pp. 11–12). (Figure 3.23) Supporting the plot–based design with the design codes provided a very efficient framework for the project in terms of design control, as well.

Correspondingly, the plan came up with a new idea called ‘free parcels’ which supports the variety by providing a spatial basis for plot–based urbanism. The ‘free parcels’ allowed individuals to design their own buildings in accordance with the specific design codes. Accordingly, over 100 architects including OMA, Enric Miralles, Claus en Kaan, Van Gameren, Mastenbroek, Koen van Velsen and Inbo Architecten involved in further development process in the generation of the urban

fabric which has a rich variety of architectural typologies (Goody, Chandler, Clancy, Dixon, & Wooding, 2010, pp. 81–82). (Figure 3.22) In time, each plot was interpreted

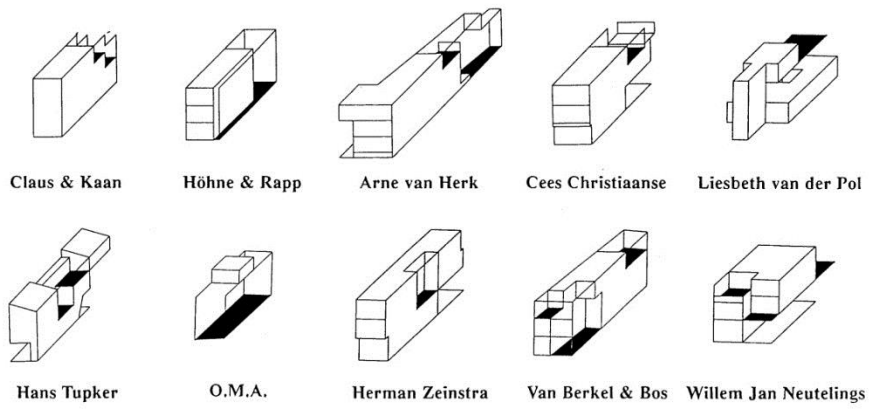

Figure 3.22. Several architectural suggested by the master–planners of the project, in Borneo Sporenburg (Source: West8, 2002)

by different architects with respect to the pre–determined design codes and it results with variety, richness and uniqueness which enhance the responsive character of urban fabric to become more adaptive for changing conditions. Strong repetition of individual plots in Borneo Sporenburg which promotes the plot-by-plot development also provokes the bottom-up design processes in the area since the plot is the reliable scale to design coherent a wholes in a bottom–up process (Romice & Porta, 2015).

By incorporating design codes with the master plan, the project developed a design approach at the intersection of urbanism and architecture, thus provided a highly balanced scheme in terms of spatial configuration. Furthermore, with the concept of 'free parcel', a generative design process was provided by producing highly diverse, responsive and adaptable urban fabric instead of reaching a static and total designed scheme. Fine–grain urban fabric with a *preset spatial relations ensured by design codes assigned a certain coherence and unity to the whole, at the same time as its general parameters allow for multiple variations to a predetermined conceptual model* (Höger, 2011, p. 64).

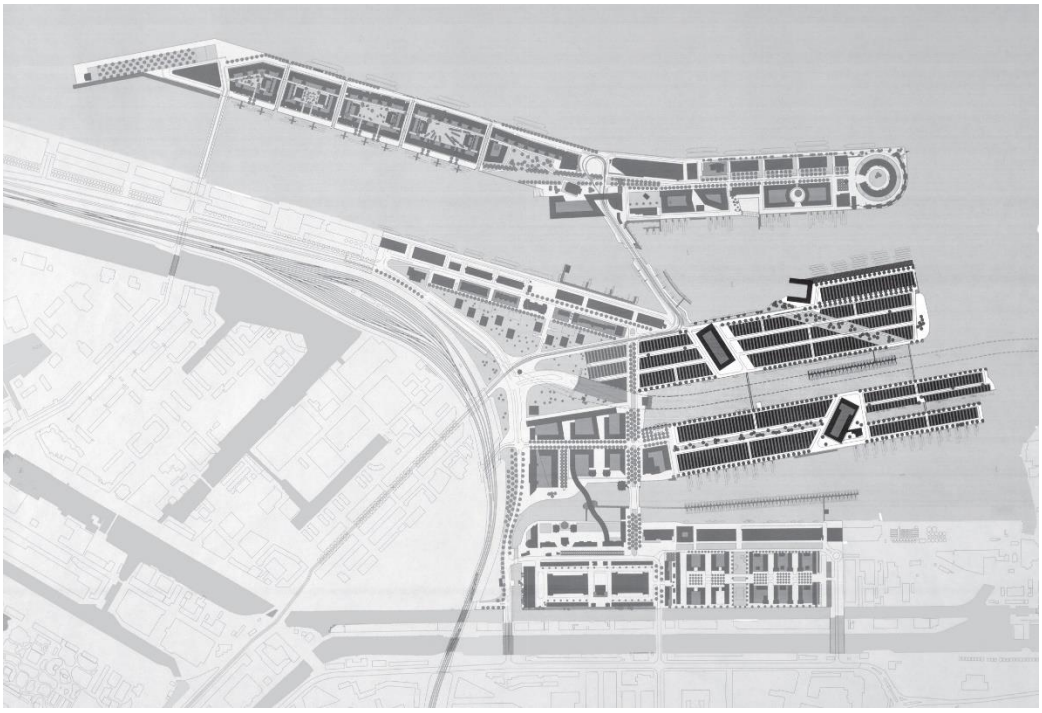

Figure 3.23. The master-plan proposal of West8 for Borneo Sporenburg (Source: West8, 2002)

3.4.2. Bo01 City of Tomorrow – Malmö

The economic changes that caused the decline in the heavy industrial activities in time in Europe caused the ports used for these activities in urban areas to lose their importance over time and these areas were abandoned. In Malmö, Sweden, the west coasts have attracted attention as the areas where the heavy industry activities were carried out and the ports where the shipyards were located. In parallel with the economic changes in Europe, the ports on the west coast called "Västra Hamnen" have not been used for many years and these areas have existed as problematic areas in the Malmö (Ginot, 2010, p. 34). In the mid–1990s, important steps were taken for the transformation of these areas and planning activities were initiated in line with sustainable urban development criteria for the area (Anderson, 2014, p. 15). The planning processes gained momentum in 1996 when Malmö was selected to arrange the EXPO-European Millennium Housing Exhibition in 2001. Accordingly, in 1997, the planning processes for the expo officially started and the first phase of the plan was named as the Bo01-*The City of Tomorrow* (Anderberg, 2015, p. 216). The main

motivations behind the plan was to create a compact and lively district to increase the quality of life in the area to achieve sustainable urban environment. In this sense, providing an urban structure to meet the needs of future; ensuring the gradual development by provoking diversity in urban fabric through the small–scale (plot-based) subdivision pattern; enhancing the conditions of urban areas to become pedestrian friendly and offering the wide range of vegetation to encourage people for individual gardens can be stated as the basic motivations of the plan (Lewis, 2012, p. 92). The street pattern of the urban fabric that proposed by plan is distorted grid. (Figure 3.24) The main reason behind is the weather conditions of the site. Since the western harbor of the Malmö is very windy, plan proposed a diversed structure as response to the extensively changing wind conditions of the area. Unlike Borneo Sporenburg, there were no specific design codes for the Bo01. In spite of the fact that

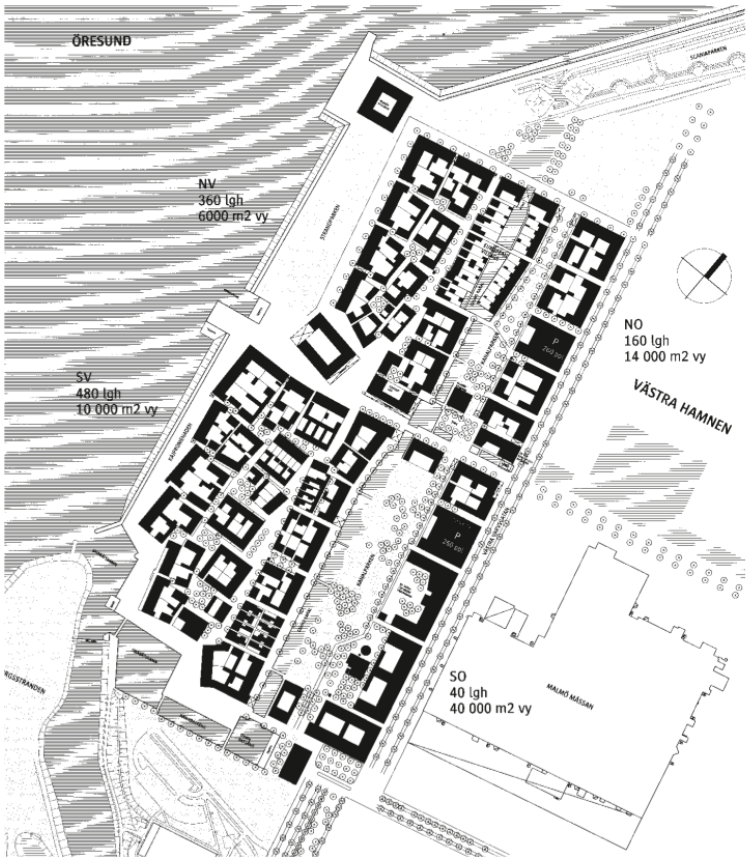

Figure 3.24. The built fabric suggested by the masterplan of the Bo01: the dynamic grid structure is accompanied by the diversity in plot layout and building configuration (Source: Höger, 2011, p. 72)

there was no pre–defined codes for the overall area, there was a consensus provided only on building height and color palette. Diversity was the most important design principle for the plan. The masterplan was composed of a series of plots that would enable the different actors to take place in the development process. (TEN Group, 2010, p. 20). Correspondingly, 18 property developer and 22 architecture firms were involved in the planning and design process to foster the diversity within the urban fabric. Not surprisingly, 550 different architectural typologies and a non–repetitive architectural character emerged within the 18–hectare project area (Höger, 2011, p. 143). (see Figure 3.25) Plot–based characteristic of the plan promotes the development of the urban fabric gradually as well as it works as a key element to steer the diversity through different scales. In this sense, evolution of the Bo01 through the individual plots reveals abundance of expression both in architectural typologies and urban spaces. Although there were no detailed design codes to make the area diverse and flexible, the collaboration of the plot pattern and various designers acts as stimulator for the urban fabric to make it more adaptive. Moreover the masterplan that designed by the K. Tham shows *what can be achieved where strong basic principles are rigorously adhered to and well executed with the small, dispersed development plots* (Höger, 2011, p. 152).

Figure 3.25. Great variety of types of buildings and designs in Bo01 (Source: Anderberg, 2015, p. 221)

All in all, Bo01 – *the city of tomorrow* – designed with an original approach is meaningful in the context of plot–based urbanism. In the plan, the plot proposed as the main urban component which form the built environment. Accordingly, plot performs as the basic unit of urban fabric which initialize morphological diversity. Such development pattern promotes the spatial relations between plot and building since binary relations of them *has always been interdependent so it is needed to rediscover subdivision alongside the development of new building typologies* (Campbell, 2011, p. 77). In this context, fine–grain subdivision pattern of the Bo01 provided an operational basis for ensuring freedom of expression which resulted in greater diversity in architectural typologies. Hereby, the plot–based development proposed by the plan provided an incremental development of a living quarter while stimulating a pleasurable urban environment.

3.4.3. Homeruskwartier – Amsterdam

The concept of 'self–build housing' has been involved in planning processes in Europe, especially in the UK, and led some critical transformation in the housing sector (Caputo, de Oliveira, & Blott, 2019; Lloyd, Peel, & Janssen-Jansen, 2014). In parallel with these developments, in the late–1990s, the "self–build" program was initiated in the Netherlands and included into the planning process. The main motivation behind this policy was made the self–build concept long lasting to revitalize the housing sector in the Netherlands. Correspondingly, in 2001, the Dutch National Housing Report stated that by 2040, a third of the total housing production in the Netherlands should be self–build (Lloyd et al., 2014, p. 24). With this declaration, the concept of self–build in the Netherlands started to show its effects in the housing sector and people started to produce their own houses. Almere, in this context, is the well–known residential area as an example of the self-build experiment in the Netherlands. The masterplan to initiate self–build program for Almere was prepared by Office of Metropolitan Architecture (OMA) in 2006. The plan is composed of 3400 housing units which 1000 of them is aimed to be constructed self–build by individuals. Homeruskwartier was one of the neighborhoods in Almere that

Figure 3.26. The master-plan of the Homeruskwartier (Source: Municipality of Almere, 2014, p. 3)

was planned to be the largest residential area in the Netherlands which developed by owners of plot (Municipality of Almere, 2019). The Development Plan of the site was adopted in June 2007. The plan for Homeruskwartier consisted of 720 plots spread over 100 hectares (Caputo et al., 2019, p. 9). With the plan, the city council has given the starting signal for the development of a unique neighborhood, which is built entirely by residents themselves. In the Homeruskwartier, people are given the opportunity to realize their own house, individually, collectively or - in co-commissioning - together with a project developer (Municipality of Almere, 2009, p. 85). The development plan has a spatial structure that, both in terms of content and design, offers a good starting point for the development of the Homeruskwartier in the stated objective. There are three different areas within the plan; residential areas for

co–missioning in the outer ring, residential areas for (collective) private commissioning in east and west, and the central area, the heart of the neighborhood. (Figure 3.26) An urban park, the De Green, is also being built in the middle of the neighborhood. According to the plan, a great number of small (minimum 86 m^2 in size) and affordable plots were provided to the future residents to build their own houses. This was the key decision of the plan to ensure rich variety of buildings and the street scape.

Plot–based development of the Homeruskwartier would be controlled by design codes which basically conditions the distances from the borders of each plot and the height of the buildings. According to the masterplan, there are 15 different enclaves, some of them named as *I Build, I Build Sustainable, I Build Town Centre and I Build Free*, in the Homeruskwartier and these rules differentiates in each neighborhood. For instance, in the I build free, there are four different rules that form the neighborhood; *the dwelling must be self-build; must be built within the plot and on the street line; it must not exceed 14 m in height; the dweller's vehicles must be parked within the plot* (Caputo et al., 2019, pp. 9–10). These design codes ensure the certain standards for built environment while at the same time providing a highly diverse urban fabric with the generative framework it has. In this sense, Homeruskwartier is *an attempt to design a code that allows enhanced individual choices to form the character of the place and regulate growth* (Ibid). The flexible design environment created by the collaboration of design codes and individual plots contributed to the emergence of different housing typologies. Correspondingly, rural houses, canal houses, residential work villas, bungalows, garden houses and residential towers constructed in the Homeruskwartier in semi-detached and detached building configurations (Municipality of Almere, 2009, p. 85). (Figure 3.27) Moreover, as it provided in Borneo-Sporenburg, design codes and plot-based character of the neighborhood generated the diversity in the Homeruskwartier by including all individuals to the design process as well as gave chance to them to make cooperation with architects and other individuals to build their houses as they want.

Figure 3.27. An aerial view of the plot-based developed housing typologies in Homeruskwartier (Municipality of Almere, 2019)

Eventually, Homeruskwartier exists as one of the well–practiced examples of self-build housing through plot–based urbanism. From the beginning, the main logic that forms the neighborhood was diversity of buildings and controlled freedom of the individuals within the private plots. The large variety of buildings and their quality show the great commitment of the owners and made the Homeruskwartier not only a charming neighborhood but also a significant step in the search for the alternative model of incremental urban development.

3.5. Plot in the development control system of Turkey

The design and development control mechanisms in Turkey are carried out by Development Plans which performing in a strict legal framework. As mentioned in Chapter 2, the development plans that directly control the production of urban space are master plans and implementation plans. Differing according to the scales of the intervention and the scope, the implementation plans consist of the codes of the control that directly shape the built environment. Within the legal framework, implementation plans produce a static spatial framework which is highly restricted by the building rules. (Figure 3.28) In this sense, implementation plans shape the built fabric with a

series of parameters building density (in terms of coverage and FAR), building height, setbacks, plot width and plot depth. By relying on the legal structure of planning legislation and operational framework of the planning processes, it would be possible

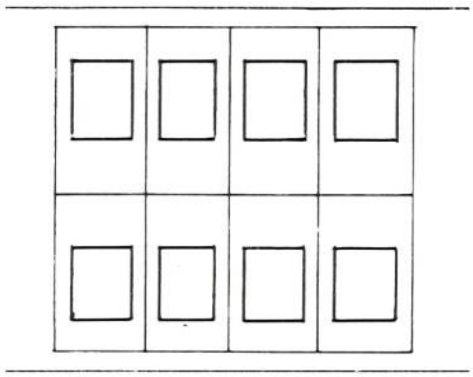

Figure 3.28. The typical urban block formation that produced by the implementations plan in Turkey (After Özbay, 1989, p. 48)

to indicate that the plot is the fundamental element prominently controlled by the spatial planning system in Turkey. The priority of the implementation plan is given to the issue of the distribution of property rights on individual plots. In practice, implementation plans regulating the development forms in plots result in a disjointed pieces of urban fabric lacking with necessary control on the coherency relation between the plots. Moreover, due to the legal regulations which focus on the allocation on development rights rather than creating a collective urban fabric, a strong parametric approach cannot be practiced in the planning and design processes in Turkey. As criticized by Ünlü (2011), the plot–based development process in Turkey, in the way of continuous (gradual) increase in densities. According to him, *the shaping of the built environment is reduced to the piecemeal production of identical plots of similar size and shape, and freestanding buildings as a settled typology* (Ünlü, 2011, p. 447). (Figure 3.29) The lack of strategic control mechanism of the planning system and the absence of the design codes that would guide the design process for a more coherent planned and diverse built fabric essentially result in fragmented and poor–quality fabric of the cities in Turkey.

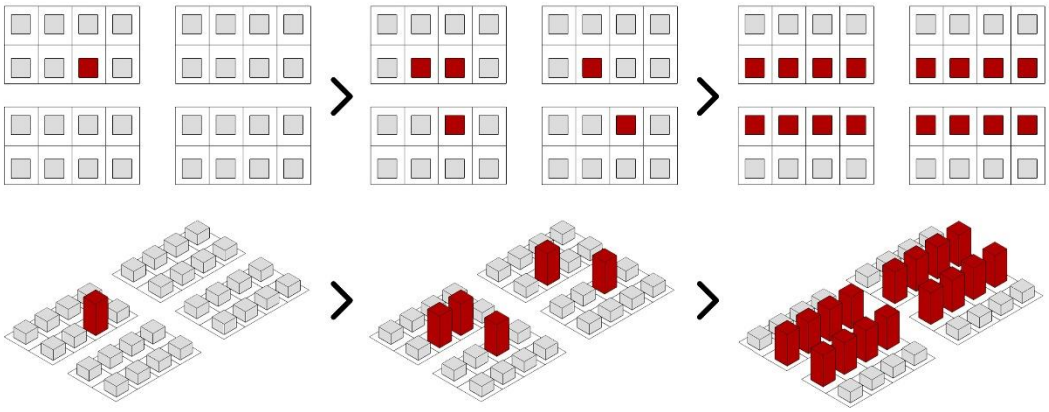

Figure 3.29. Transformation of urban fabric through plot–based changes in Mersin, from the 1970s (left) to 2008(right) (Adapted from Ünlü, 2011, p. 455)

Although the implementation plans in Turkey has an operational limitations to produce the successful urban places, there are few attempts to reveal the real potential of the control parameters of the plans to create desirable urban spaces. As argued by Özbay (1989), different alternatives of the built environment that envisaged by the implementation plan are possible to be generated, for the same urban block by utilizing the parameters of the implementation plan in creative way. In this sense, he put forward the possible alternatives, each has same buildable area, of the typical urban block formation that produced in accordance with zoning regulations. (see Figure 3.30) Similarly, Baş (2003) emphasized the richness of the legislative framework to create the alternative urban environments. Herein, he examined five different components of the urban fabric which are cluster housing, courtyard apartment, cul-de-sac, passage and arcade. Using the tools of the implementation plan as a main control parameters (i.e. setback, coverage, FSI), he produced the possibilities of the built environment. (see Figure 3.31) In parallel with this purpose, it could one argue that the main focus of the research is reveal the flexibility of the implementation plan in the context of the design control. In this context, although the current practices of the Turkish zoning regulation produce unqualified urban fabric in terms of morphological coherence and there are limited attempts to prove the inherent richness of the legislative framework, in the scope of this research, it is believed that the plot–based urbanism which is one of the prominent approaches in the contemporary

urbanism has great potentials to turn the above–mentioned conditions into positive factors by the necessary tools and techniques.

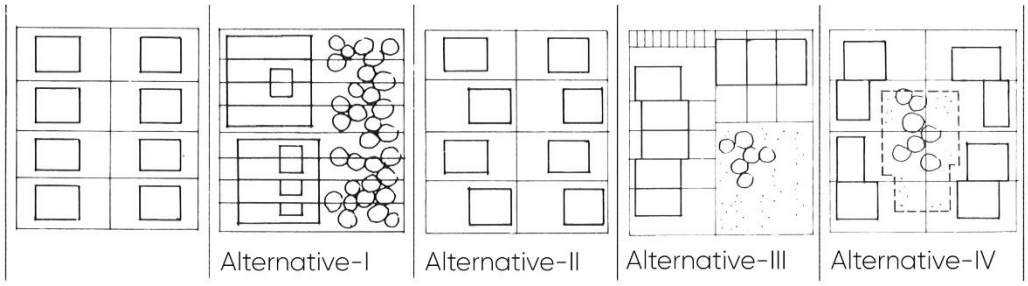

Figure 3.30. Morphological variations of the typical urban block (After Özbay, 1989, p. 48)

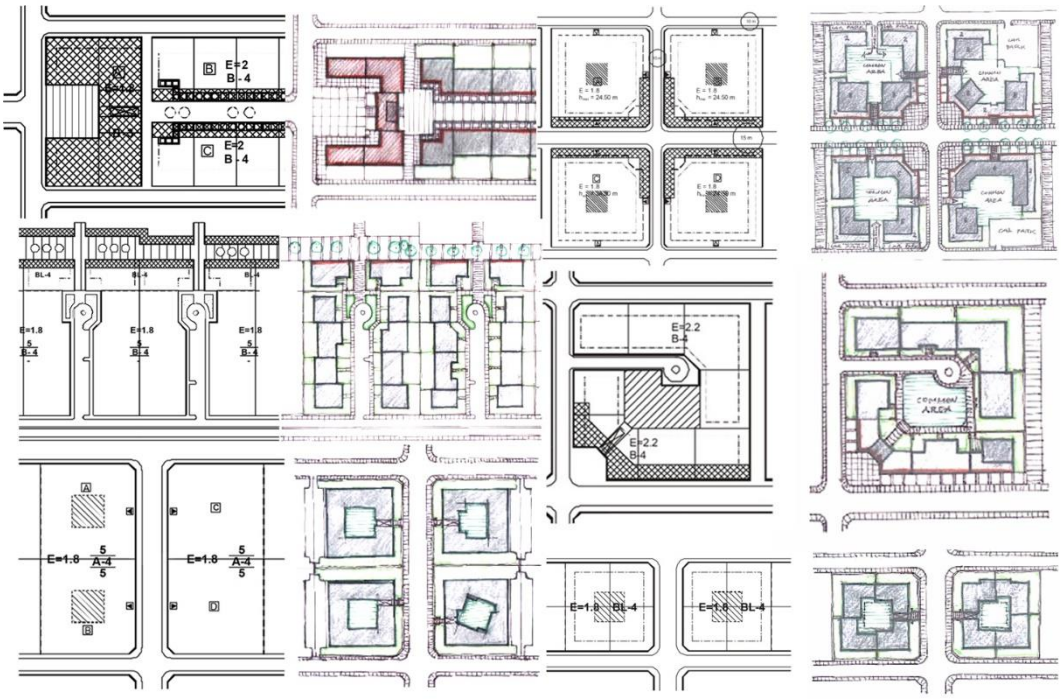

Figure 3.31. The possible spatial organizations of different urban components designed with the re-handling of the existing design codes (After Baş, 2003, p. 101;103;109;111;115;117;122)

As stated in this chapter, plot–based urbanism approach which aims to strengthen the pluralistic structure of the city, proposes new a design approach to produce sustainable urban fabrics. Herein, the study aims to provide a new design control method to open a way to provide harmonious morphological diversity by a robust control perspective

as an alternative to the strict zoning regulation techniques. Plot–based urbanism, which considers the plot as the basic control unit in the production of urban fabric, shapes the urban fabric in a bottom–up way by providing diversity and compatible densities for urban environment. In this sense, even though what Ünlü (2005, 2011) argued for plot–based development has an actual validity in the current conditions of Turkey, the operational framework of plot–based urbanism as an emerging discourse (Barbour et al., 2016; Porta & Romice, 2010; Romice, Porta, Feliciotti, & Barbour, 2017; Tarbatt, 2012, 2017) is believed to suggest a relevant basis for enhancing the current planning practices of Turkey.

Moreover, since plot–based urbanism controls the nested relations of the urban block, the plot and the building, it also provides an operational basis in the scope of design control in planning. In order to establish such a relational framework to create alternative design control methods for current design control mechanisms in Turkey, new spatial relations should be envisaged parametrically to be able to control the urban fabric in the third dimension as well. To this end, the key control parameters are defined in the context of the research, as follows: *block size, number of subdivisions, plot size, coverage, plot setbacks, buildable volume ratio, building height, building frontline, building setbacks*. As indicated in the previous part, these parameters would be beneficial to establish new morphological relations by controlling the urban fabric within the scale of the plot. As Tarbatt (2012) argued, *in order for plot–based urbanism work, however, it needs to reconcile the divergent agendas of conventional master-planning with more incremental approaches* (p. 77). In this context, this research also argues that re–examining the plot–based urbanism approach within the scope of the computational design would provide a highly productive and efficient framework for design control especially for the urban contexts like in Turkey.

Computational design methods work in an algorithmic framework basically allows the generation of complex form patterns parametric. In urban planning and design discipline, computational design methods are mainly specialized as parametric urban design (Beiaro, Nourian, & Mashhoodi, 2011) which highly corresponds to the

parametric nature of design control in spatial planning. Unlike conventional design methods, parametric design methods allow control of the design process instead of producing a static blue–print plans while enabling the simulation of a generative (based on complex relationships between parts and whole) design process. As stated by Çalışkan (2017), *in urbanism, the real challenge and potentiality of parametric design does not lie in the playful exploration of complex form-compositions via the algorithmic models, but in the intrinsic capacity to control collective urban formation in a relational structural framework* (p.21). From this critical point of view, considering the actual generative capacity of parametric modeling (in terms of urban pattern formation) one could argue the effective use of computational / parametric design tools in the context of urban design control is crucial to formulate a new design understanding. Relying on this perspective, the research proposes a parametric model for design control based on the algorithmic framework involving a series of codes defined by the key parameters of the plot. By this way, it is aimed to provide an alternative methodical computational perspective to the emerging approach of plot–based urbanism, as well.

CHAPTER 4

PARAMETRIC DESIGN CONTROL FOR PLOT–BASED URBANISM

The development of technology in the last two decades has made the revolutionary changes possible in different fields. Digital methods and new techniques that arise with the increasing use of computers affect the professional practices, as well. The use of the computer allows difficult operations to be made faster and makes the solution of the complex problems in an easier manner. In the context of architecture and urban design, the most noticeable change in recent years has been in the use of computational design technologies within design processes. With the help of the computer, the design paradigm has been changed from manually driven tool–based professional practice to a computer–driven performance-based design approach (Terzidis, 2006, p. 40). Herein, the conceptual ambiguity between '*computation'* and *'computerization'* should be clarified in order to establish the discussion on an accurate basis. The term, computerization, is directly related with the digitization and automation of the processes, computation, whereas, is procedure of calculation involving *rationalization, reasoning, deduction, induction, extrapolation, exploration, and estimation* (Terzidis, 2006, p. 12). These two terms are important because as Verebes (2013) stated, there is a shift from computerization of design to computation of more adaptive procedures (p.168). The computational design methods, which are widely used in architecture, basically enable designers to produce complex forms and patterns, and to manipulate them algorithmically. Moreover, use of computational design techniques in architecture triggers designers to revisiting the relations between space and form to design through associative geometries. In the field of urban planning, the introduction of the computational design techniques let the emergence of *parametric urban design.* In recent years, a range of design studies have been carried out, most of which are conducted in the architectural schools, to integrate

parametric design techniques into urbanism. In this context of the research, computational design methods and their use in urban design will be examined within this chapter. Based on the critical review, a parametric model proposal for plot–based urbanism will be discussed.

4.1. Design in Digital Age: *Computational Design*

Since the computer was invented, its applications has been expanded to various professions including design. As one of those professions, architecture draws attention. Use of computational design methods have begun to change the understanding of design by allowing the controlled production of complex form–patterns. Furthermore, computer–aided design methods paved the way for creative thinking and made designers more free by providing flexible design procedures (Elezkurtaj & Franck, 2001, p. 1). In this context, the way of form production in architecture has been changing from the use of conventional drafting packages to the more experimental use of computational design tools (Leach, 2009, p. 8). The algorithmic approach, which forms the basis of computational design methods, stands out as digital structures introduced by computer science, and allow multiple operations in more productive manners. In its simplest definition, the algorithm is a set of rules that explicitly define a series of processes to produce an output or to solve a problem (Terzidis, 2006, p. 17). In other words, the algorithm represents a comprehensive description, *a recipe*, to reach to the target. The productive framework of the algorithms affected the architectural design within different scales and made the design processes more complex and responsive. Unlike traditional methods, computational design with the generative design tools enable designers to design and manipulate the forms (Khabazi, 2010, p. 2). The use of algorithms in the field of architecture has led to the creation of new conceptions, so '*Algotecture'*, in this context, implies emerging field of algorithmic architecture (Terzidis, 2006, p. 37). Conventional design methods do not provide a productive base for designing and modeling free and relational forms, *algotecture* facilitates the production of the required operational framework to design coherent formal and spatial systems. Thanks

to this multi–layered relational structure the computational / algorithmic design methods enable the production and complex form patterns in a parametric manner. (Figure 4.1) Moreover, since the algorithms are capable of coping with complex design problems, they enable designer to create numerous possibilities of the geometries in the way of revealing alternative design solutions for the specific goals

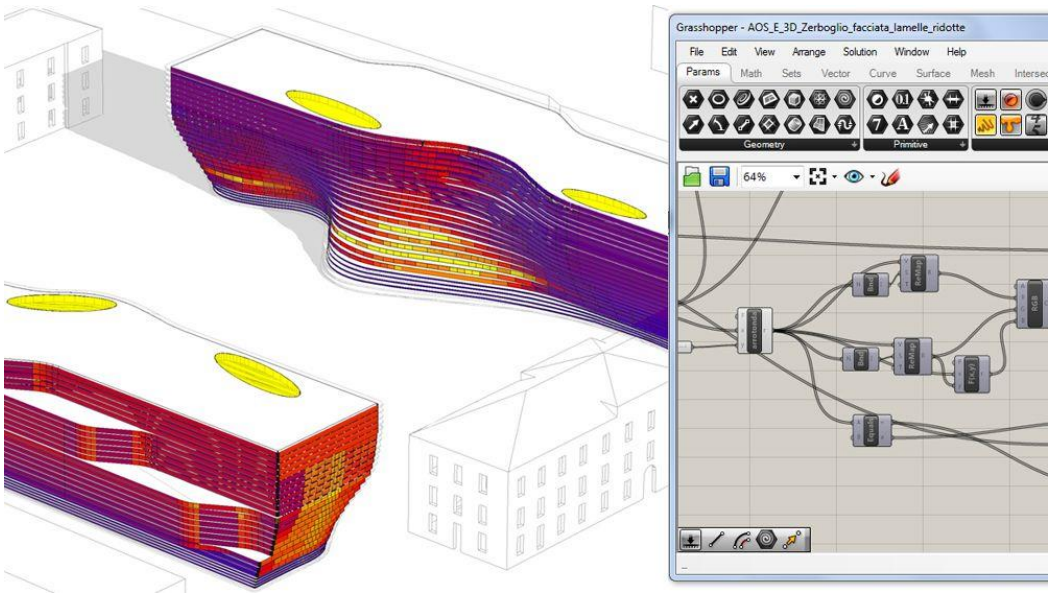

Figure 4.1. Flexible geometry of the building façade that produced with computational methods (Retrieved from Top Design Ideas Website, 2018)

(Khabazi, 2010, p. 169). In this way, computational design suggest a serious shift from *top-down approaches to more generative, bottom-up systems* (Verebes, 2013, p. 168) by enabling the control of the processes of design. *Parametric design*, as one of the prominent computational design methods in recent years, attracts attention with its widespread use in architecture. It fosters designers to create more adaptable design solutions that responsive to the specific context, and provides a relational framework to discover the new ways of form–finding as well as enhancing the complexity of design processes (Aish & Woodbury, 2005, p. 1). Parametric design differentiates from conventional design methods since it creates more coherent framework to associate all the components of design procedures in order to reach emergent way of form production. Moreover, it *enables the recognition of patterns of geometric*

behavior and related performative capacities and tendencies of the system (Khabazi, 2010, p. 21). The interaction between the architecture and urbanism on different scales has led to the usage of the similar design methods in urban design, as well. Parametric design comes forth as one of those specific approaches used both in architecture and urbanism. In the following section, computational design methods within the special focus of parametric design will be discussed in the context of urban design.

4.1.1. Parametric Design in Urbanism

Plan diagrams that fully illustrate the compositional qualities of the urban form have evolved into a rule–based design control framework that works with design codes over time. The combination of the masterplan and the building code, which is the basis for shaping the modern cities of the past century, is now subject to a number of methodological searches within itself due to the constraints experienced in urban development and control of transformation. Conventional planning methods are quite insufficient to meet the spatial needs of evolving and developing cities. The uncertainties faced in the production of urban space and the involvement of many actors into the process (i.e. developer, contractor, designer, user and local government) make the design process more complex through uncertainty. Moreover, lack of the cooperation and coordination between design codes and spatial plans cause the problems in the context of design control. In this context, it is necessary to develop new planning and design approaches to overcome the deficiencies of the conventional planning. Moreover, development of flexible and adaptable systems is crucial to provide an operational basis for the creation of the responsive urban environments (Schnabel, 2008, p. 2). The computational design methods, which would operate as a design code–based, flexible and algorithmic framework draw attention as a methodology suggesting the necessary scope to eliminate constraints of conventional plan–based control of spatial development. Computational design methods used to be integrated in architecture, step forward in urbanism with many emergent concepts like '*parametric urban design'* (Beiaro, Nourian, & Mashhoodi, 2011), '*generative design'* (Campbell, 2011; Mehaffy, 2008), *'associative urbanism'* (Verebes, 2009)

and '*relational urbanism'* (Llabres & Rico, 2012). The shared feature of these approaches is that they formulate the production of urban form within a very adaptive framework by constituting a relational computational structure for spatial design. Within the scope of this study, these methods, which can be generalized as parametric design methods in urbanism provides a generative framework that would enable the bottom-up formation of urban fabric. As stated by Campbell (2011) generative design systems require multiple solutions rather than a single predictable result (p.69). In this context, parametric design works *with the potential of quickly generating large number of options within a short time span that would be unaffordable by using conventional drafting techniques* (Llabres & Rico, 2012, p. 320). Moreover, algorithmic framework that the parametric design empowers the control capacity of the designers since it allows the manipulation of each stage of design processes. In this way, parametric modeling is used to stimulate the bottom–up development of urban form through pre–defined spatial parameters. It paves the way for the generative processes by triggering the step–wise process by which the form may emerge from piecemeal and gradual actions (Mehaffy, 2008, p. 1). The idea of generative design, which forms the basis of '*A New Theory of Urban Design'* by Alexander et.al. (1987), suggests an alternative against top–down design methodologies. It emphasizes that control of the design process in an incremental way is more crucial instead of designing the final form in a single phase. In this context, parametric design enables urban form to be designed and controlled in a procedural manner. It, therefore, provides the opportunity to experience different conditions for the future of cities rather than suggesting end–product. Moreover, parametric design creates an *open-source* design process which enables the designers to understand and manipulate the design within different scales to reveal the generic qualities of form (Steinø & Obeling, 2014, p. 1). Herein, it makes easier to evaluate design alternatives with the combination of different datasets and rules which allow the rapid production of complex geometries in a bottom–up manner (Burry, 2003, p. 210). Since parametric design methods have the rule–based framework and they control the complex relations between the different design components, they promote the interdependent relations

between the parts and whole. In this manner, the change of a single parameter of the sub–components in the generative system *ends up with a spontaneous transformation within the other components in parametric models* (Çalışkan, 2017, p. 3). Correspondingly, parametric design methods work in a holistic framework that produce associative geometries on different scales of intervention. In this way, parametric design boosts designers to deal with a variety of design ideas which are connected to each other and encourage to develop new design rules within specific design aspects (Woodbury, 2010, p. 171). (Figure 4.2) By relying on all these, it would be possible to argue to parametric design method provide a highly relational framework for generative design which promotes the bottom–up development of spatial fabric.

Figure 4.2. Variety of form patterns within the urban fabric that produced by computational design methods by using different parameters (Retrieved from NBJJ Website, 2019)

The parametric design, which enables the rapid evaluation of the design alternatives, provides the rule–based definition and control of the spatial relationships between the different urban components. Despite this generative framework and operational basis that the parametric urban design approach reveals, it is pretty hard to claim that the current understanding of the potentiality of parametric modelling in urbanism is in an

appropriate level. Accordingly, it would be useful to explain the roots of the concept of *parametric urbanism* before proceeding the discussion on the implementations of parametric design in actual urban context.

The term of *'parametricism'* is coined by Schumacher (2008) as a new architectural style that is used in order to understand the form production patterns of avant-garde architecture that provides an *increased level of formal complexity* (p.1). According to him the only way to sustain parametricism is to maintain the form production potential of the computational design methods like scripting and algorithmic modelling. In this context, in order to develop these techniques, Schumacher(2008) introduced five agendas into the discourse of the parametricism so–called; *parametric inter-articulation of sub-systems, parametric accentuation, parametric figuration, parametric responsiveness and parametric urbanism* (p.2). Accordingly, the inter-articulation of sub–system refers to a framework in which all sub–components are interrelated (from a single detail of the façade to the building envelope). Since all sub–components of the system are in a systematic relationship, parametrically, any change in one system is correlated with differentiation in the other components in design (Ibid). Herein, the main emphasis was on the creation of richness in form articulation through the adaptation of different compositional systems. 'Parametric figuration', on the other hand, proposed that the complex geometries can be associated within parametric models through *extremely responsive variables* in order to create coherent framework that allows to control the each parameters of the systems which also include external (i.e ambient and observer) parameters (Ibid). Parametric responsiveness reveals the intrinsic capacity of the urban and architectural environments that make the changes and adaptations possible over time. Last but not least, what Schumacher (2009) defined parametric urbanism as a system of *deep relationality.* The main motivation behind parametric urbanism was associating all the components of the built environment from the general layout of the urban fabric to architectural morphology. In this sense, the parametric accentuation, parametric figuration and parametric responsiveness work as tools of parametric urbanism in

order to ensure the deep relationality (p.17). Despite such an ambitious conceptual and practical framework, the recent proposed implementations of parametric urbanism are yet to be developed to respond such a conceptual (methodical) framework. In this regard, the next section will cover the examples of the parametric urban design projects which considered in the context of either academic research or actual spatial planning and design practice.

4.1.1.1. Parametric Urban Design in Practice and Research

As it is stated above, there are a few studies has been done in the context of the parametric urban design both in the practice and the research. In this sense, six different examples of parametric urban design application will be examined in this section. First four examples will cover the experimental studies from research while following two will exemplify the current state–of–art in practice.

Relational Urbanism – Arnavutköy, Berlage Institute, 2011

The research theme of Berlage Institute, in 2011, was the '*Relational Urbanism'* with in context of the rapidly growing environment of the Arnavutköy locating in the western part of the İstanbul. Since the project area was one the most populated districts in İstanbul, the major focus of the studio was to overcome the problems (i.e. natural and infrastructural) caused by the rapid population growth by developing a computational model. In this context, a '*relational model'* was created to *explore different patterns of distribution of this hybrid fabric* (Llabres & Rico, 2012, p. 328). The project site is shaped by hilly topography therefore the initial point of the model was to create flexible grid which control subdivision pattern of the plots. (see Figure 4.3) Following step was to generate the typological variations in accordance with a set of rules. The main motivation behind the typological variations was to generate an urban fabric that allows diversity within the activities rather than generating a mono-functional residential fabric (Llabres & Rico, 2012, p. 330). The land–use decision of the site was conditioned by the relational model that provide a holistic framework for the site by taking the river as a primary control element. (see Figure 4.3) In this sense,

although the context of the project has some limitations to respond the generative design processes, the *relational model* created allows the development of a design approach that responds to different scales of interventions by utilizing algorithmic design coding. Barely, since the interface of the model provides an overall control of the urban morphology (Llabres & Rico, 2012, p. 323), one could argue that the generative side of the parametric modelling used in a limited framework.

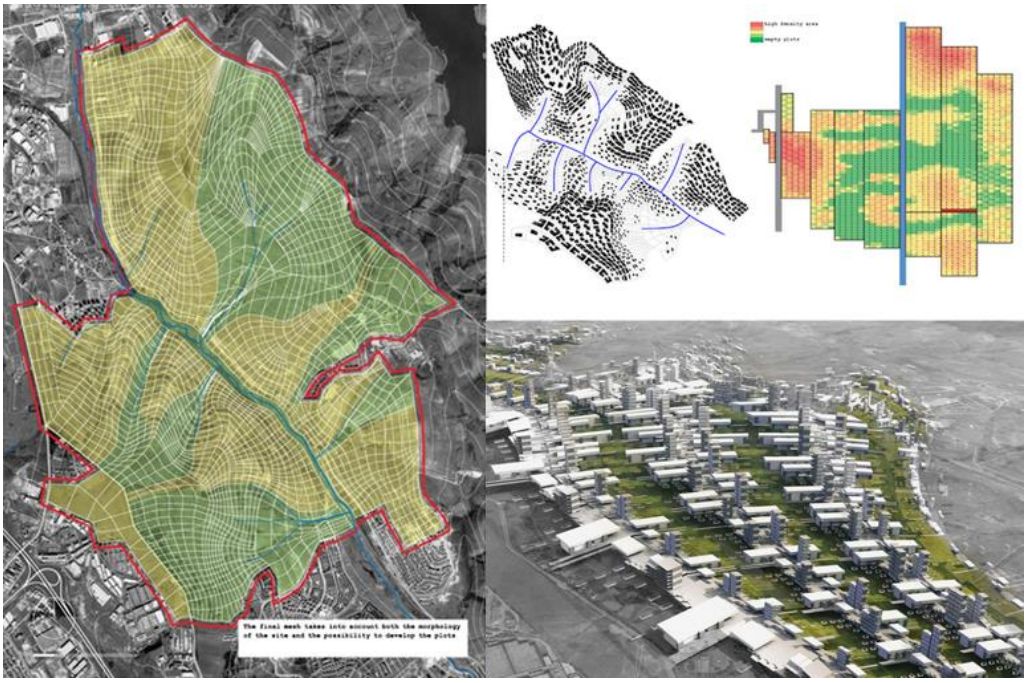

Figure 4.3. The flexible grid to control the subdivision pattern of the area (left), usage of the river as a main catalyst to determine the overall density and land use (right–above) and the aerial view of the different typologies (right–below) along the urban axes (After Llabres & Rico, 2012, p. 329;331;332)

Parametric Pearl River Delta – Hong Kong, OCEAN CN, 2009

Suffering from the rapid urbanization, the Pearl River Delta was shaped by the top–down planning mechanisms and profit-oriented architectural fabrication that resulted with homogeneous character (Verebes, 2013, p. 158). OCEAN CN, Hong Kong–based consultancy firm, prepared an exhibition for the Hong Kong-Shenzhen Biennale with an agenda of urbanism challenging in the current context of the Pearl River Delta with the theme of '*design their own city'.* Accordingly, they developed a computational model that work in an algorithmic framework consisting spatial

attributes of 11 cities (Verebes, 2013, p. 158). The interface of the model designates different parameters that enable visitors to design their own city. *The model demonstrates variations of urban models, from initial seeds, typologies, program mixes, and density data* (OCEAN CN, 2014). (Figure 4.4) In the model, there are four buildings that constitute a context for the design alternatives. Accordingly, the visitors design the given site as they want by manipulating the pre–defined parameters. (Figure 4.4) In this context, parameters of the model provide a relevant context to use generative design codes while designing the urban form by enabling both designers and visitors to produce the alternatives of the built environment from their point of view. Barely, although the parametric basis of the model provides a defined framework in the context of computational design, as a matter fact of the model is created only in an experimental framework without an explicit concern to be implemented in an actual urban context.

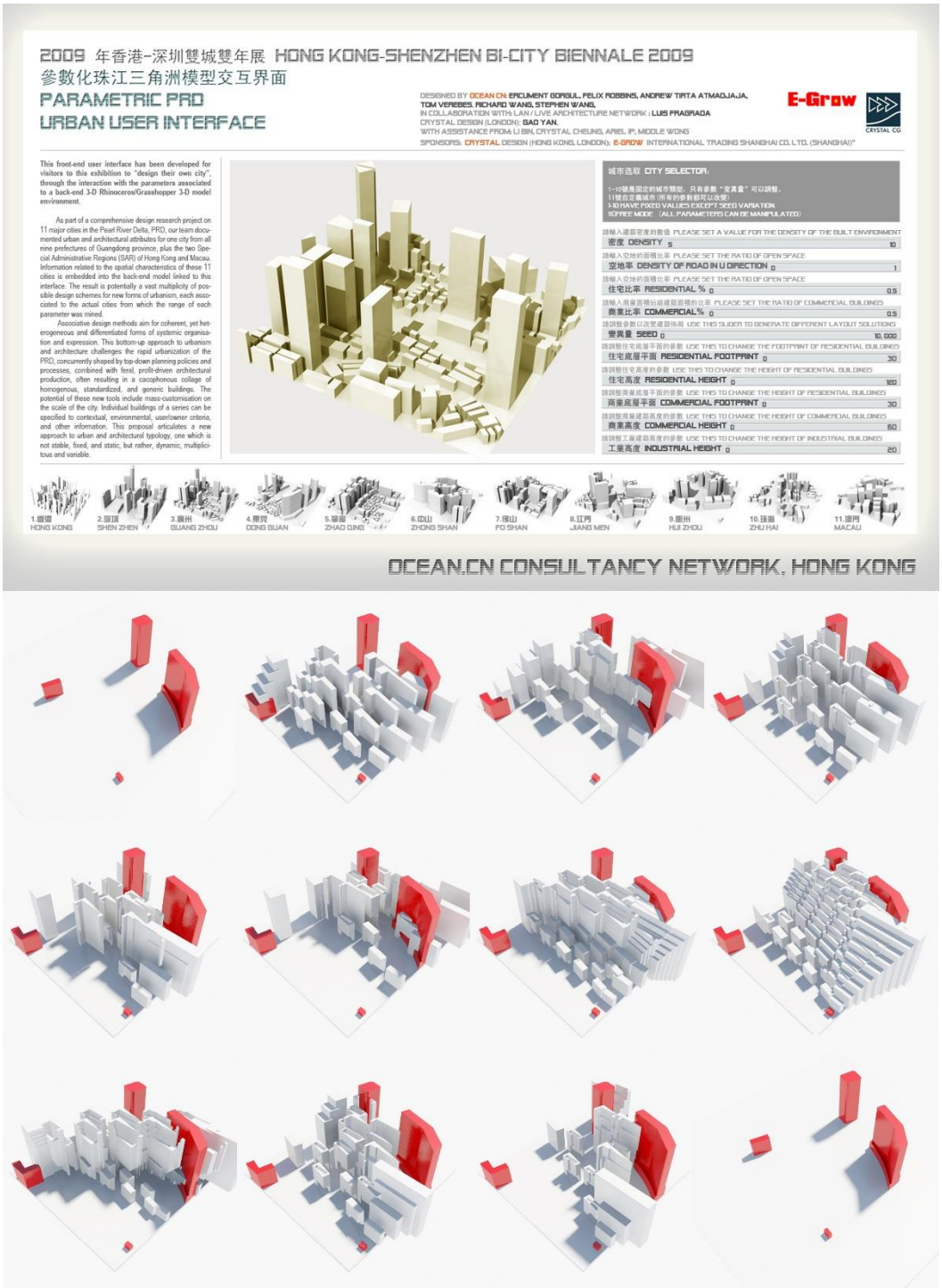

Figure 4.4. The interface of the model (above) and diversity of the block formations produced according to the parameters of the model (below) (OCEAN CN, 2014)

Weaving the city through the torn urban fabric – İstanbul, METU Parametric Urban Design Studio, 2016

Taking the urban fragmentation in the metropolis as the main design problematic within the context of the contemporary urbanism, 2015–2016 METU Parametric Urban Design Studio conducted an experimental study in the Ataşehir, one of the most populated districts, located at the eastern side of the İstanbul. The main objective of the study was to *design a large–scale urban fabric via the morphological codes to ensure internal diversity in typology and external continuity in form and structure* (METU PUD, 2016). In accordance with this objective, the design team of the studio developed an algorithmic based parametric model after a set of systematic analysis of morphological elements of urban fabric by associating them in a relational framework. In this sense, the morphological character of the area is controlled by a main *spine* which can be flexibly determined by the parametric model. The spine, which is composed of different sub-segments, is used to generate different design interventions and to generate different building typologies. (see Figure 4.5) In this context, the main objective of the studio was to create a link between urban design and the computational design. Despite having an intention to run generative design process, since the building typologies and overall urban fabric is controlled by a single algorithm, the method of the generation of the urban form was actually in contrary to the idea of generative urbanism which is based on the bottom–up, incremental development processes by its definition. Herein, one could argue that although the algorithmic framework of the parametric model provides an operational basis to generate a relational urban fabric, the control of the urban fabric by a single algorithm essentially make the design process top–down.

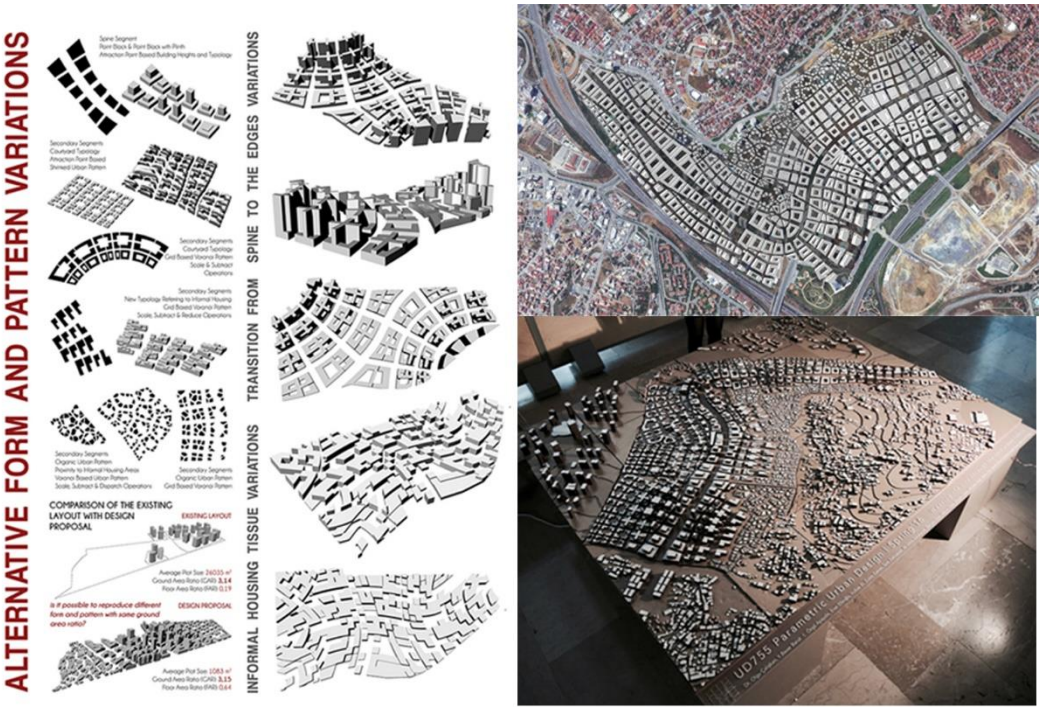

Figure 4.5. An alternative form and pattern variations produced for the site (left), a general layout of the urban fabric generated by the parametric model (right–above) and an aerial view of the 3D-model of the site (right–below) (Retrieved from METU PUD Website, 2016)

'Talking Tissues': Collective Formation of Urban Fabric – İstanbul, METU Parametric Urban Design Studio, 2017

Having a self–critical reflection on the previous study of the studio, METU Parametric Urban Design Studio revisited *the idea of associative control of urban form within the incremental nature of urban complexity* (METU PUD, 2017). In this sense, Ataşehir has been selected as a study area once again. The studio started the design process by developing an algorithmic framework to associate the neighboring fabrics by defining a morphological (analytical) framework on an algorithmic basis called 'parametric morphology'. Herein, four different typo–morphological variations have been generated to create the system of a 'talking tissues': *distorted grid, hexagonal grid, substrate and tartan grid*. (see Figure 4.6) Rather than controlling the overall urban fabric with a single algorithm, the four different generative codes have been developed by the design groups. Correspondingly, morphological variations were associated to generate the binary spatial relations within the intersections of the variations. Since

the urban formation is controlled by different algorithms, the overall urban fabric reflects the spatial diversity of the multiple codes of the algorithmic framework. In this manner, the parametric model developed by the collaboration of the design teams, provides a responsive framework to associate the different design approaches within the same context. On this basis, having an algorithmic framework, the parametric model makes the bottom–up development processes possible within the proposed morphological complexity by design. (Figure 4.6)

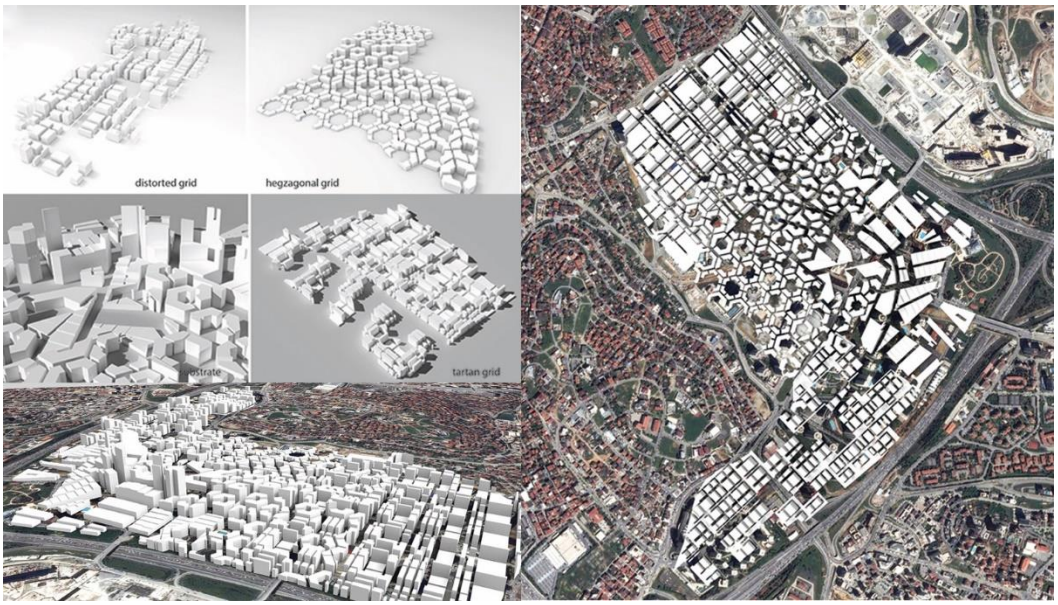

Figure 4.6. Typo–morphological variations generated for the site (left–above), aerial view of the generated urban fabric (left–below) and the overall urban morphology composed by 'talking tissues' (right) (Retrieved from the METU PUD Website, 2017)

Deep Ground – Shenzhen, GroundLab, 2008

As winning entry to the international design competition for Longgang Center and Longcheng Square, the Deep Ground, a regeneration project, was designed by GroundLab, a London-based architecture and landscape architecture company. The main objective of the project was to associate the mixed–use urban fabric and the landscape of the site in order to cope with the challenges of the problems of the contemporary urbanism in China. To this end, design team developed the *'thickened ground'* concept which provides urban coherence in the site by fostering the *intuitive*

orientation and connectivity (Verebes, 2013, p. 237). The advantages of the parametric modelling was used to ensure the relationality within the different levels of the urban fabric. Utilizing the thickened ground concept as the generator of space, design team aimed to increase the adaptability of the project to the local context. (see Figure 4.7) Furthermore, they developed a parametric model to generate numerous building typologies through different levels of density, height, and footprint. Although the algorithmic framework of the project provides an efficient basis to create bottom–up development of the site by fostering the associative relations of different forms, the final form of the urban fabric were generated for the whole site on limited variables such as number and location of density nodes (Bullivant, 2012, pp. 257–258 cited in Çalışkan, 2017, p.13). In this context, it would be possible to argue that the design team did not benefit from the intrinsic potential of the parametric model. That's why, although having a *systemic 'relational' structure in itself, the model, consequently, could not alter the settled perspective of total design by parametric modelling as opposed to the incrementalist understanding of generative urbanism* (Çalışkan, 2017, p. 13).

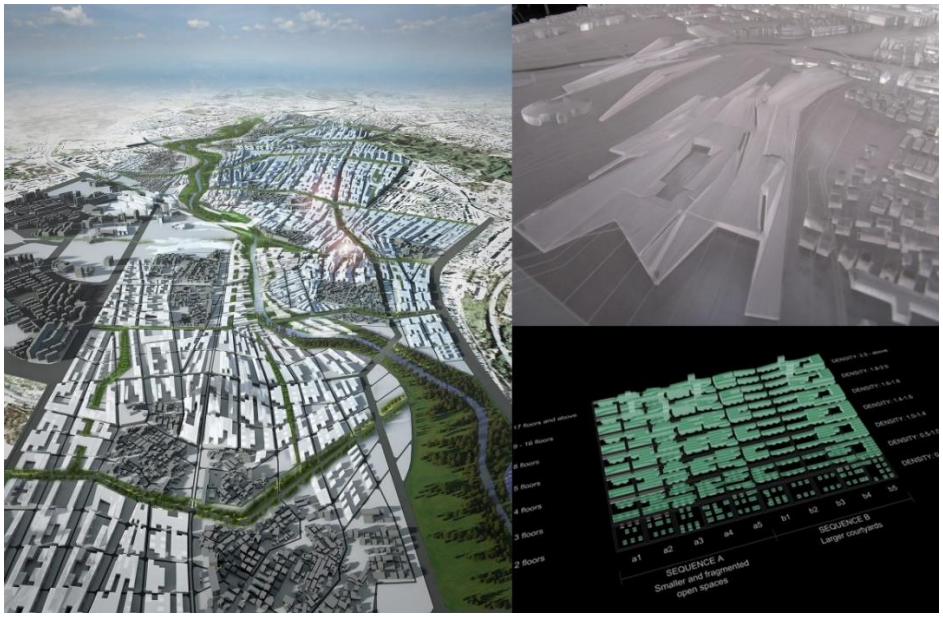

Figure 4.7. An aerial view of the master–plan (left) which shows the variety of the forms and adaptability of the plan to its' context, the thickened ground (right–above) and the variety of the massing (right–below) in terms of typology, height and footprint (GroundLab, 2008)

Kartal/Pendik Masterplan Project – İstanbul, Zaha Hadid Architects, 2006

The masterplan of the Kartal/Pendik designed by Zaha Hadid Architects which won the first prize in the master plan competition in 2006 is one the most well–known example of the parametric urban design projects. Indeed, it is an influential parametric urban design project that has been engaged in actual planning practice. As the project side, Kartal, Istanbul, is one of the potential sub-centers to reduce the development pressure of the core of Istanbul. To this end, Istanbul Metropolitan Planning and Urban Design Center has held the design competition entitled as 'Kartal Sub-Center and Kartal-Pendik Coastal Area Urban Transformation Project' in 2006. The main objective of the competition was to redevelop the industrial zone as a mixed-use residential area. The competition area is located between the D-100 highway and the coastline and it covers 550 hectares land. The Zaha Hadid Architects won the competition with their *parametricist* master plan proposal based on the parametric manipulation of the syntax of the urban fabric. Accordingly, the primary intention of the plan was increase the accessibility of the site by connecting the area to the surrounding urban areas. For this purpose, the area was weaved with the so–called '*soft grid'* which was stretching by minimizing average detour factor to create linkage points of the competition site to the external urban fabric (Schumacher, 2009, p. 20). The urban grid was totally controlled by algorithmic model which works with 'Maya' the parametric design software. Since the urban grid was generated by the parametric model, it was quite flexible and responsive to provide a connected street network for the project area. (Figure 4.8) Zaha Hadid Architects worked with two different building typologies in order to create different forms (i.e. tower blocks and perimeter blocks). These typologies were act like *geno-types* which allow the configurational variations since they were emerged from parametric form generation (Schumacher, 2009, p. 20). (Figure 4.9) They used building typologies to form the urban blocks. The urban blocks was designed according to architectural programme of the site which includes 6 million m2 buildable area including housing, business and socio–cultural facilities (Schumacher, 2009, p. 19). The compositional character of the urban blocks

Figure 4.8. The path network of the competition site generated by the soft grid (left) and the general layout of the urban fabric shaped by the path network (right) (Retrieved from the Zaha Hadid Architects Website, 2019)

is given by different articulation of building typologies in accordance with *nodes that are emphasized by height differences in the form of rising towers locating on the neighboring islands* (Çalışkan, 2017, p. 16). (Figure 4.9) In order to ensure the deep relationality, the design team used the associative geometries *by involving the systematic modulation of tectonic features* (Schumacher, 2009, p. 21). To that end, they designed *calligraphic blocks* which emerged from different building typologies. In this way, the urban block typologies were generated parametrically rather than characterizing by the fixed forms determined by a masterplan. Since the interior

courtyards of the calligraphic blocks are open to each other, the overall permeability within the urban fabric is ensured. Moreover, the urban blocks and the building typologies were geometrically associated with each other in terms of size, location and height (dimension) within the different plots of the urban fabric (Schumacher, 2009, p. 21). Thus, the parametric approach of the masterplan results with the urban fabric which is inherently consistent with architectural typologies. Furthermore, the coordination of residential areas, landscape areas and the public spaces provided a holistic framework for the development of the site. (Figure 4.9)

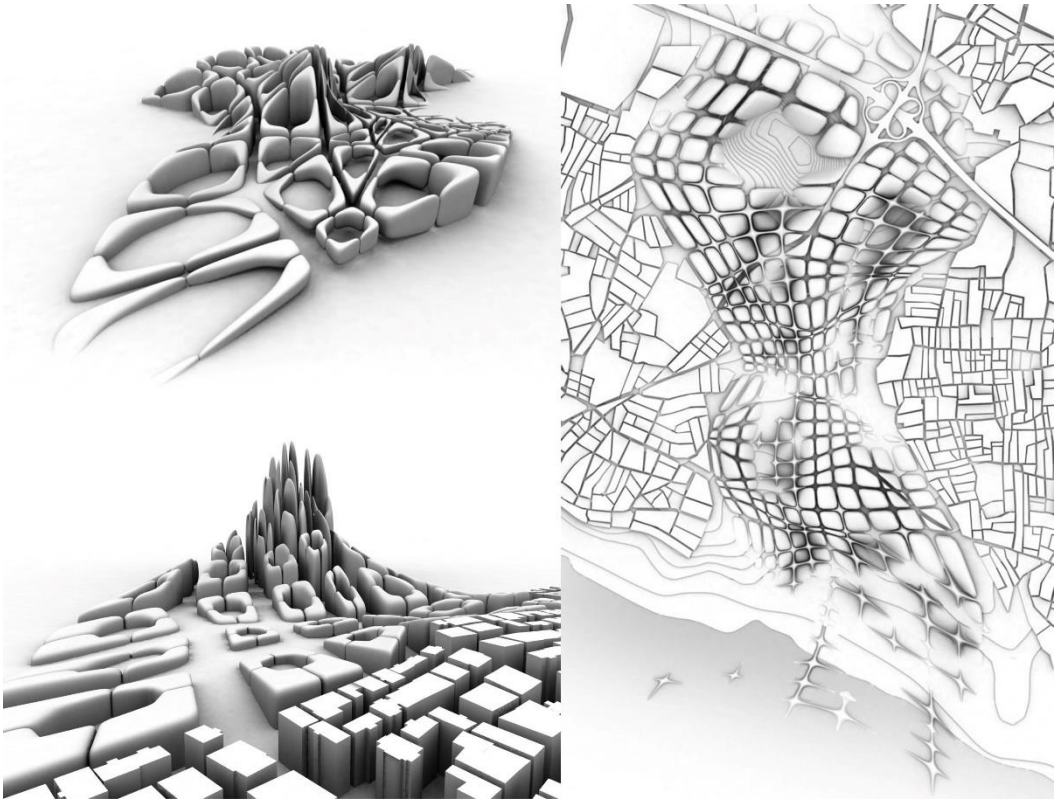

Figure 4.9. The block layout composed by different building typologies(left) and the masterplan scheme of the overall area (right) of the Zaha Hadid Architects for Kartal/Pendik Master Plan Design Competition, 2006 (Retrieved from the Zaha Hadid Architects Website, 2019)

The ambition of the design was *to control a large section of the development area via a single plan scheme* (Çalışkan, 2017, p. 16) In this manner, the Kartal–Pendik Master Plan proposed by the Zaha Hadid Architects attempts to implement a highly top–down and holistic design approach utilizing parametric modelling. As Schumacher (2008,

2009, 2010), one of the pioneers of the parametric design approach argues that parametric urbanism can be used as a tool to promote coherent and complex patterns of urban development. However, the masterplan decisions of the Kartal are totally in sharp contrast to the requirements of the theory of complexity and generative design. Furthermore, this situation constitutes a contradiction to the paradigms of the contemporary urbanism and its underlying theory entailing the incremental, bottom–up and evolutionary development of coherent and integrated urban fabric (Alexander et al., 1987; Jacobs, 1961; Marshall, 2009; Rowe & Koetter, 1983). Moreover, although it is one of the most well-known examples of parametric urbanism, it does not offer an innovative perspective sufficiently in terms of contemporary urban design practice that promotes generative development framework (Campbell, 2011; Campbell & Cowan, 2016; Mehaffy, 2008) despite the advanced computational technique it uses. In this sense, the contemporary implementations of the so–called parametric urbanism has become one of the main critical issues in the context of planning and design control. As argued by Çalışkan (2017), in spite of the capacity of parametric design to generate infinite forms, the primary need to change the current perception/understanding of the parametric design approach is to use the inherent potential of the method as a *design control tool* rather than a *'design machine'*. Herein, flexible design support systems with a simplified mathematical interface are needed to control urban development via spatial design codes within complexity of the planning processes. In this context, an operational framework of the algorithmic systems, allowing multiple alternatives, and generating different spatial patterns that can respond to different scenarios would constitute an efficient framework for design control *producing complex forms and structures based on simple rules* (Sakamoto & Ferré, 2008, p. 3). Moreover, the algorithmic systems, which composed of numerous inputs, ensure the interdependent relations of parts and whole. However, in order to eliminate the uncertainties of the design process that arise from the dynamic nature of the parametric design in the planning practice, the rule–based framework should be defined the potentiality of the design control through algorithmic systems. In this sense, the tool of *parametric modeling* suggests a relevant basis for design control

through generative design processes. From the computational perspective, one of the most important feature of parametric modelling is that it works with algorithms which ensure the gradual control of the design form. In other words, *one single action triggers a chain of reactions within the built system* (Çalışkan, 2017, p. 4; Woodbury, 2010, p. 171). In this manner, parametric modelling provides a very operational framework in the context of design control because it is capable of controlling the every sub–component of the city within the responsive design process enabling designers to manipulate different components in a relational manner. Given this critical perspective and the experienced productive capacity of parametric modeling in terms pattern formation, the use of computational / parametric design tools in urban design control would provide a very relevant and operational basis to control the bottom–up development processes. In this manner, parametric modelling, unlike conventional design methods, tends to relate the design process to control the act of design (Woodbury, 2010, p. 12). Since parametric modeling composed of interrelated algorithms which to be manipulated during the design process, it enables the generation of associated design alternatives in an incremental manner. In this way, parametric modeling contributes to the formation of coherent spatial systems while ensuring the highly controlled structure which fosters formal diversity within itself (Schneider, Koltsova, & Schmitt, 2011, p. 68). This implies an operational framework which *can be readjusted at any time during the design process allowing for refinement of design goals*, simultaneously as well (Beirão, ArroBas, & Duarte, 2012, p. 168). In this sense, parametric modelling potentially suggest a prolific design process which is more responsive and adaptive to different development than that by analog design techniques.

From this perspective, in the scope the research, it is believed that using parametric modelling as a design control tool would constitute an efficient basis to ensure the generative design processes in urbanism. Herein, the form generation capacity of parametric design would be utilized in order to enhance the simulative capacity of urban design act through a series of alternative solutions (Çalışkan, 2017, p. 3). In this

context, the research tends to create an alternative design framework that aims to trigger the generative design processes as opposed to the fixed nature of blue–print plans. In accordance with this purpose, the research proposes a (parametric) *model* operating in an algorithmic framework. Since the generative structure of the parametric modelling makes the control of the sub-components of the urban fabric (i.e. building, plot, and block) possible, (re)production of urban fabric is ensured in a gradual manner by manipulating the morphological parameters. Hereby, the objective of the model is to reveal the potentiality of parametric modelling for the control of the development of urban fabric. To this end, the control parameters, which introduced in Chapter 3, are utilized as the main control parameters for the model. Since the control parameters are defined in relation to the plot, the proposed *model* will perform by focusing on the plot to control the urban fabric. In this way, the *model* is to provide an operational framework for plot–based urbanism, as well.

4.2. Parametric Design Control for the Plot–Based Urbanism: *A Model Proposal*

As defined by Soddu (1994), generative design is a *process using algorithms structured as nonlinear systems for endless, unique and unrepeatable results performed by an idea-code* (cited in Agkathidis, 2015, p. 16). In this sense, the concepts of generative design and digital (algorithmic) systems are exceedingly associated. Since the emerging technologies of algorithmic design methods are qualified to control complex design processes, design and technology become much more interrelated. *Parametric modelling*, as one of the outstanding method for algorithmic design, provides a highly efficient framework to control the design process. Working with interdependent parameters, parametric modelling ensures an operable structure for *real time comparison of many alternative scenarios* by manipulating the parameters (Galli, 2014, p. 481). Furthermore, the rule–based framework of the algorithmic system enables parametric modelling to create the relational whole which totally responsive to its parts. Within the complex nature of the cities, parametric modelling has great potentials to control the development of the urban fabric through generative processes. As argued by Çalışkan (2017) *involving a*

large number of inputs controlled by few processing rules, parametric design models can be considered within the notion of organized complexity (p.3). In this context, with the capacity to associate numerous components, parametric modelling establish a generative design control mechanism within a rule–based context in a new understanding *of typological to procedural thinking* (Fusero, Massimiano, Tedeschi, & Lepidi, 2013, cited in Tedeschi, 2014, p. 476). Aiming for controlling the overall urban formation, the emerging paradigm of plot-based urbanism suggests a fruitful basis to develop a new methodological approach to urban design that would be more responsive to the very condition of complexity in the contemporary urban context. In this manner, plot–based urbanism comprises a very relational context for the rule–based framework of the parametric urban design modelling, as well.

Based on the theoretical framework, the research aims to develop an experimental parametric model to integrate computational design to development control in the emerging context of plot–based urbanism. The proposed model approach argues that the parametric modeling in the context of urban design control could essentially help producing coherent urban fabrics. In this sense, the model takes the study of Baş (2003), who proposed a creative re–handling of the existing zoning codes to ensure the development of better urban forms, as a starting point. The main argument of the study was that the flexibility of the legislative framework of the Turkish spatial planning system provides a relevant framework in terms of design control. From this point of view it would be possible to argue that, the code–based (parametric) basis of the Turkish planning system does also provide a highly efficient and relational framework to encode the parameters within an algorithmic framework. In this context, utilized as the already existing codes of Turkish spatial planning system, the actual building rules are taken as the basic parameters of the plot–based generative formation of urban fabric by the model proposed, in addition to the new parametric codes to be suggested.

4.2.1. Aim of the model

Relying on the potentiality of the parametric modelling on design and development control, the model proposal of the research operates in accordance with particular objectives. Correspondingly, since the model is constituted in an algorithmic framework, it is aimed to support generative design processes for the formation of urban fabric. To this end, the model primarily seeks to control the development of the fabric through the scale of the plot. As argued by Campbell (2011), plot is the most operable component of urban fabric to provide generative design processes. In this context, developing the control parameters for the plot is crucial to ensure the incremental development process. Herein, encoding the control parameters for the plot within the algorithmic framework is the prominent aim of the model. Since plot has nested spatial relations with urban block and the building, the model of the research also aims to control the development of block and building by defining the control parameters of them in a parametric manner, as well. Within this algorithmically controlled framework, the model provides an efficient basis to produce alternative design solutions for the actual built environment which is shaped by the current zoning regulations. In this context, it would be possible to argue that, the model seeks to create an ideal morphological framework in terms of the close relationships between building, plot and urban block. It should be noted that, the drawbacks of the countless form production capacity of the parametric design should be turn into advantage by controlling it with certain codes in design. In this context, adding to control parameters for the block, the plot and the building, the model provides a set of spatial indicators to evaluate the environmental performance of the alternatives suggested for production of the built environment. Operating as an environmental assessment tools, these indicators would be utilized to run the shadow, radiation, airflow and sky view analyses of the design alternatives. In this way, the alternative compositions generated by the algorithmic framework of the parametric model, would be assessed in the environmental context to condition the better design solutions within a specific context, as well.

4.2.2. Methodology – *The Pseudo Algorithm*

As it is stated beforehand, the research suggests the control parameters for the urban block, the plot and the building. By utilizing them in an associated framework, these parameters would operate as a main control parameters for generating the alternatives of the block formations. At this point, the Grasshopper, a plugin for Rhinoceros with a highly flexible algorithmic operating system, is utilized to create such a comprehensive parametric model. In this context, as a first phase of the model, each control parameters have been modelled to establish a flexible enough basis for the final model which generates the alternatives. At this stage, all control parameters have been developed in relational manner. In other words, although the each parameter has been modelled separately, they are capable of running together within one single algorithm.

Once we have the parametric code of each control parameters, as a next step of the model, all control parameters would be associated with each other by utilizing the generative framework of the Grasshopper. Since each control parameters have been coded to respond the conditional changes, the final code of the model will be capable of running sufficiently flexible to generate different urban block formations within different conditions. In this context, as a first step to create the final code of the parametric model, the control parameters of the urban block (i.e. block size and number of subdivisions) have been defined within the algorithmic framework of the Grasshopper. Right after that, the actual block boundaries from the selected site have been introduced to the model. In this way, the model is associated with the actual context. Then, control parameters of the plot (i.e. plot size, coverage, FAR, setbacks and buildable volume ratio) have been included to the model. Since the control parameters of the plot condition the generation of the block formations, the block and the plot parameters have been associated, as a following step.

After this stage four different hypothetical urban block morphologies have been identified. The alternatives are differentiated basically with respect to the different

levels of floor area ratio and different layouts of plot. Accordingly, the first alternative generates the new block formation with the current subdivision pattern and current floor area ratio which is 1.4 while the second one utilizes the current subdivision pattern with higher floor area ratio which is 2.0 to generate the urban block. Alternative three and four utilizes a new plot layouts. Alternative three generates the new urban block with the current floor area ratio while alternative four have higher floor area ratio which is 2.0. After the conditions of the hypothetical variations have been identified, the next step will be the generation of building footprint with respect to the setbacks and the coverage. Four different footprint (i.e. I shaped, L shaped, U shaped and Perimeter) have been introduced in the model. In order to increase the morphological variations within the urban block, the model has been coded to generate a new footprint by utilizing at least two of the introduced footprints together. In this way, new footprint typologies has been emerged in a generative way to ensure the diversity. After generation of the footprints, the control parameters for the building (i.e. height, setbacks, frontline) have been involved to the model to articulate the block formation within three dimensional context. In this way, all the control parameters for the urban block, the plot and the building are become associated within the generative framework of the Grasshopper to establish an efficient basis to generate hypothetical block formations.

As a final operation, the optimization of the urban blocks have been performed by including the performative indicators into the model for testing the environmental performances of the urban blocks. Ladybug and ArchiDynamics, which are the Grasshopper components, have been utilized to run the environmental analyses. In this sense, all the parameters and indicators have operated synchronically to generate the optimum urban block formation. After generation of the urban block morphologies, one of the urban blocks in each hypothetical variations has been selected to formulate the generative design codes on the scale of the plot by decoding the urban block (Figure 4.10).

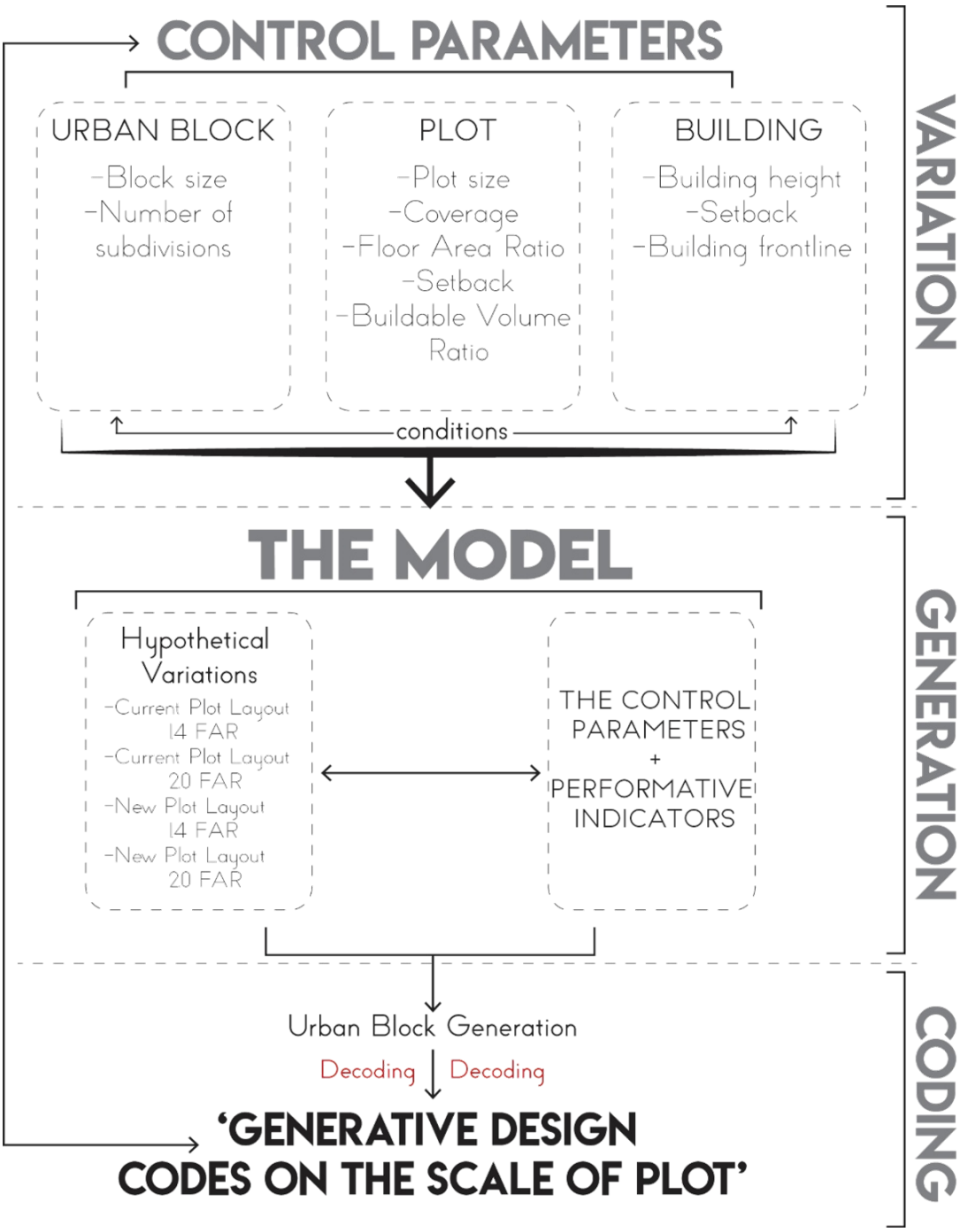

Figure 4.10. Methodological flow of the research

4.2.3. Design Simulation and Testing – *The Code*

Before detailing the experimental design studies, it would be useful to briefly explain the study area that hypothetical variations have been formulated within it. In this context the study area is selected from the western part of Gaziantep that has been designed with a very typical implementation plan in the context of Turkish urbanism practice in the late 1970s. The plan was envisaged the plot–base development by triggering the piecemeal transformation of the urban fabric so the selected area provides a relevant basis for the scope of the study. Herein, four urban blocks has been selected to develop a design alternatives with respect to the experimental conditions. (see Figure 4.11 and Figure 4.12)

Figure 4.11. The current urban fabric of the western part of the Gaziantep (Source: Gaziantep Municipality, 2018)

Figure 4.12. The aerial view of the study area within the piecemeal urban fabric

With respect to the abovementioned methodical framework, the model proposal of the research aims to develop an ideal framework to enhance nested spatial relationships between building, plot and urban block by integrating the control parameters of each urban component within the associative algorithm. In this context, the block size and number of subdivisions directly controls to the urban block while number of subdivisions also conditions the plot sizes. Plot size, coverage, floor area ratio, footprint and the buildable volume ratio on the other hand ensure the highly controlled framework for the plot. Since the control parameters of the plot also conditions the urban block and the building by formulating the generative design codes on the scale of the plot, in the model they were coded flexible enough to associate with the control parameters of other urban components. Lastly, building height, building frontline and setbacks have been utilized to determine the three dimensional articulations within the urban block. Such a relational and efficient basis of the model provides a highly operational framework to control the algorithmic generation of the urban form and

formation. In this way, the model is capable of generating diversity within the (trans)formation processes of urban while aiming to sustain a good quality of urban form by enabling the emergent morphological formations within the generative nature of algorithmic framework. In this context, this sections of the research would cover the generated urban block formations in accordance with the four different hypothetical variations.

Each experimental conditions have been generated by differentiating the floor area ratio and the plot layout. In this context, first two variations utilize the current subdivision pattern while the last two have new plot layout which generated by the model. The floor area ratio also differentiates for each alternatives. In this context, for each variation three different alternatives have been selected to simulate the morphological variations within the formation of urban block. Since the selected alternatives have been optimized by the model through morphological parameters and performative indicators, each variation has great potentials to ensure morphological diversity and optimum environmental quality to generate the good quality of urban form.

4.2.3.1. Hypothetical Variation 01: *Current Plot Layout with current development rights*

As it demonstrated in Figure 4.13, three different urban block morphologies have been generated for the first experimental condition. Each alternative has distinctive spatial characters that reveals the typo–morphological variations and morphological coherency within the ensemble. Among them, alternative two has been selected to decode to develop the generative urban design codes on the scale of the plot. (see Figure 4.13)

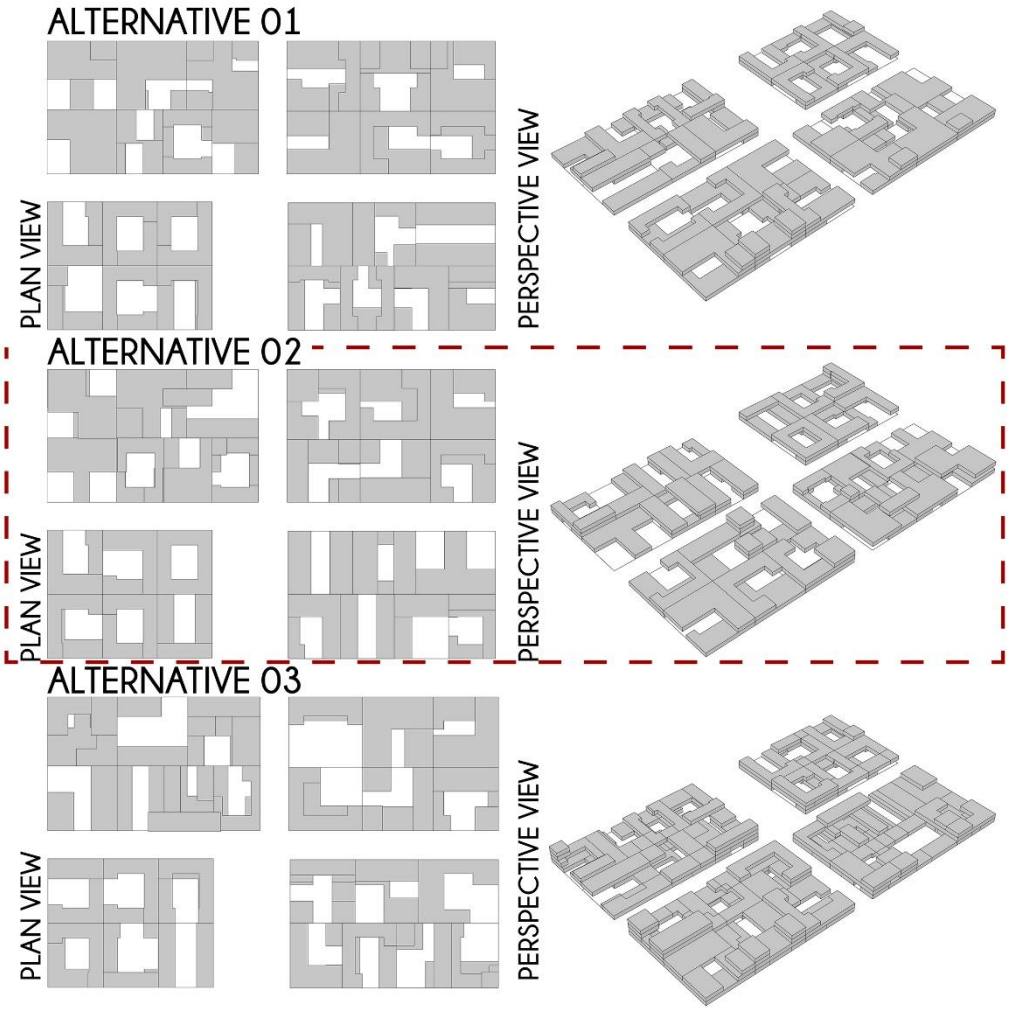

Figure 4.14. Alternative urban block morphologies for hypothetical variation 01

For the alternative 2, the floor area ratio is accepted as it is in the actual urban context which is 1.4. To ensure an equal development rights with the current conditions, each urban blocks within the ensemble has been designed with subtle design codes which formulated on the scale of the plot. (see Figure 4.14) Although each urban blocks has some specific design codes to ensure the morphological variations, there are some common characteristics that shape the overall morphology of the ensemble. In this sense, for this alternative the model provides an effective framework to create a

morphological coherency within urban fabric by aiming to ensure continuity on the edges, porosity within urban block mass, building height differentiations, and openings on the ground floors. (see Figure 4.15) Moreover, the generative framework of the model also enables the emerging of different forms and formations that triggers diversity within the urban fabric through dynamic and non–linear processes within the (trans)formation process of urban blocks.

Figure 4.13. The plan view of the selected ensemble

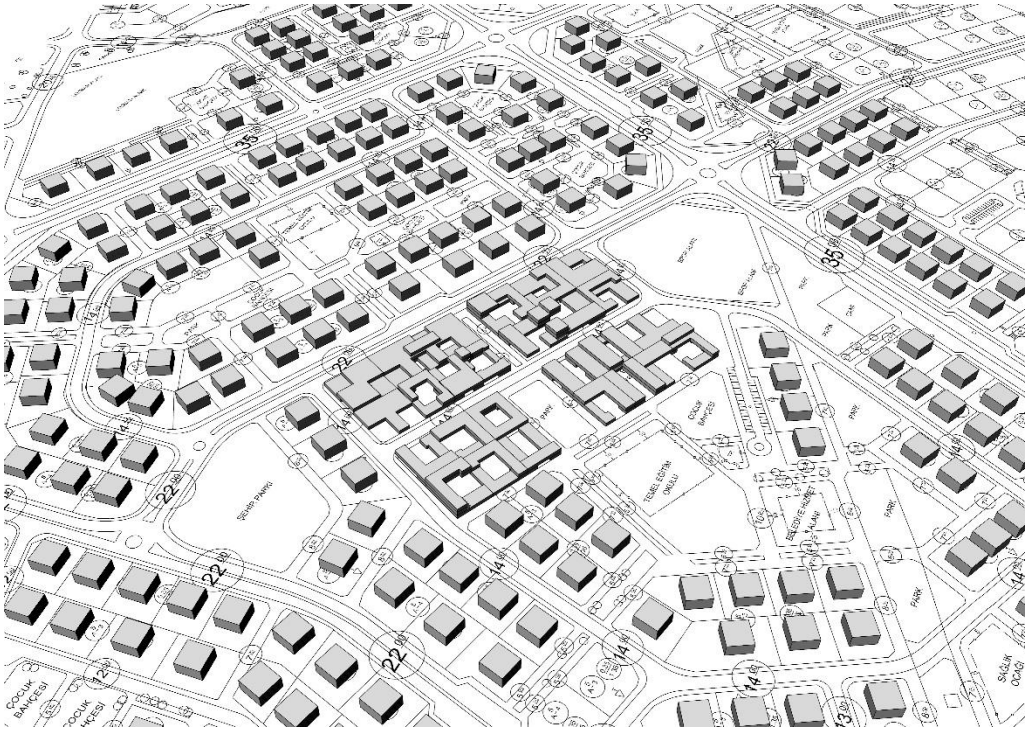

Figure 4.14. The aerial view of the selected alternative within the actual urban environment

As it is stated beforehand, the algorithmic basis of the model functions methodically to operate the generation of the urban blocks and the testing of the generated morphologies synchronically. In this context, the results of the radiation analysis (see Figure 4.16) is considerably increased compared to the current urban fabric. With the technical expressions the total radiation of the ensemble is 45.4 while the current urban fabric has the score of 22.4. As it demonstrated the images below, the visual representation of the analysis has different colors which differs from light blue to red. In this sense, the red color represents the most advantageous places in terms of solar radiation while the blue ones reflects the worst condition. For the outdoor air–flow analysis, on the other hand, the blue color represent the most suitable places while the red one reflects the worst condition (see Figure 4.17). In this sense, it possible argue that selected ensemble has great environmental conditions.

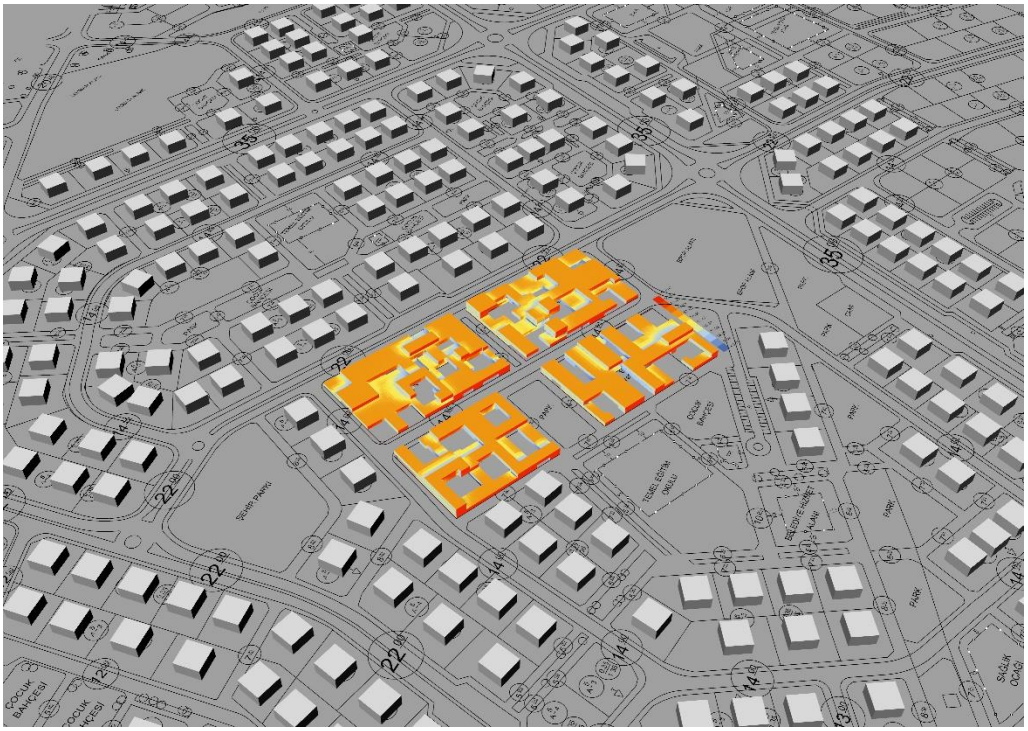

Figure 4.15. The radiation analysis of the selected alternative

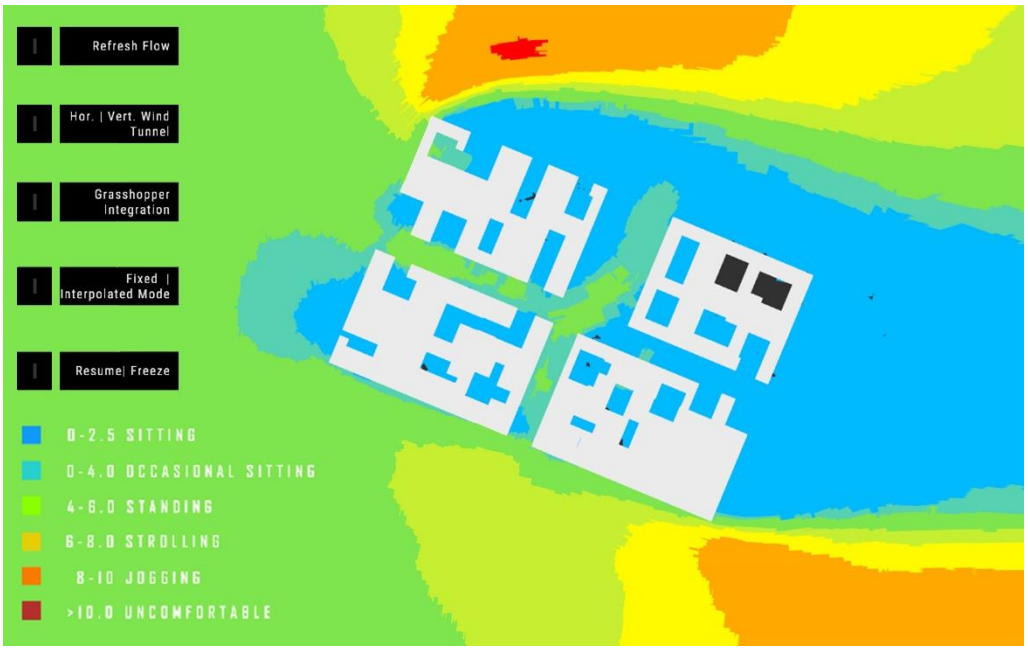

Figure 4.16. The airflow analysis of the selected alternative

As widely argued beforehand, plot is the elementary control unit to ensure the incremental development of urban form within the scope of this research. Therefore, in order to reveal the morphological character of the selected urban blocks, one of them has been selected to decode to formulate the design codes on the scale of the plot to foster generative design processes. In this manner, for this hypothetical condition, urban block–3 has been selected to decode. (see Figure 4.14). In order to integrate the model with the actual planning practice in Turkey, the generative design codes have been formulated within the format of plan notes. In this context, the plan notes for urban block–3 should be codified as follows;

1. *Building heights within the urban block shall be measured in number of stories.*
2. *Stories may not exceed 3.5 meters from finished floor to finished ceiling except for a first floor commercial function which must be minimum of 3 meters with a maximum 4.*
3. *The Floor Area Ratio for the urban block should be 1.4.*
4. *Plot 3, the corner plot, should have 3 storey to frame the urban block.*
5. *All plots should have non–built space on the ground that covers minimum %20 maximum %30 of it.*
6. *The second floor of each plot should cover at most %66 of the surface.*
7. *If the second floor of a building has full–coverage then it should give a passage on the ground floor.*

The selected urban block draws attention as a complex block that consisting of characteristic buildings and having spatial relations with neighbor urban blocks in the second and third dimensional context. Therefore, in order to make the design codes more understandable a series of diagram has been prepared to operate with the design codes. (Figure 4.18) In this way, it would be easier to identify the unique characteristics of the urban block–3. The first and the foremost characteristic of the urban block is openings on the ground floor of each building that makes the urban block more permeable within the given development rights. Secondly, non–built surfaces on the second floor of each building would have potential to be utilized as semi–public spaces. Passages are also identify the urban block to enhance

relationships of ground floor with street. And finally the height differentiation that reveals itself on the corner plot frame the urban block in three dimension. Although morphological diversity and richness within urban block are mainly controlled by control parameters, the model proposal have potentiality to generate emergent morphological formations such as passages and openings.

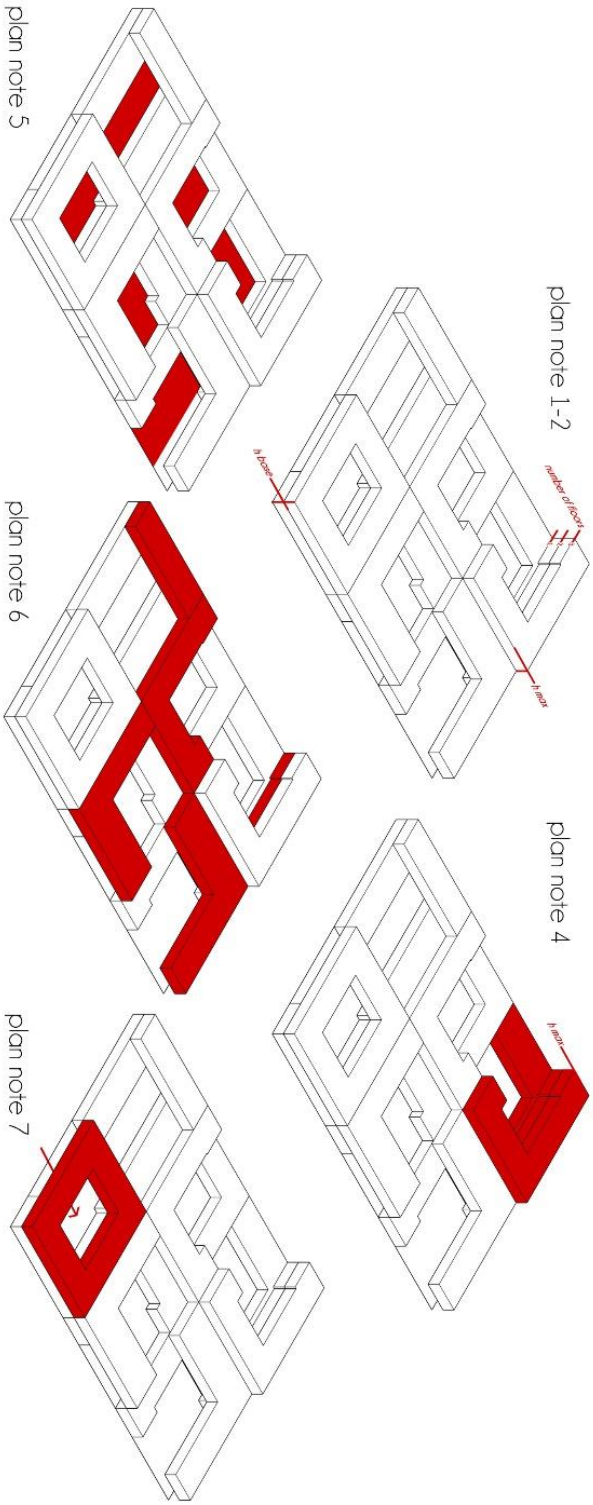

Figure 4.17. Diagrams of the design codes for Urban Block 3

4.2.3.2. Hypothetical Variation 02: *Current Plot Layout with increased development rights*

In accordance with the methodological framework, hypothetical variation 2 also have three different ensemble variations that have inner morphological variations by utilizing the subtle control parameters.(see Figure 4.19) Among the alternatives, alternative three has been selected to detailed through the design codes that utilized to ensure generative formation of the urban block.

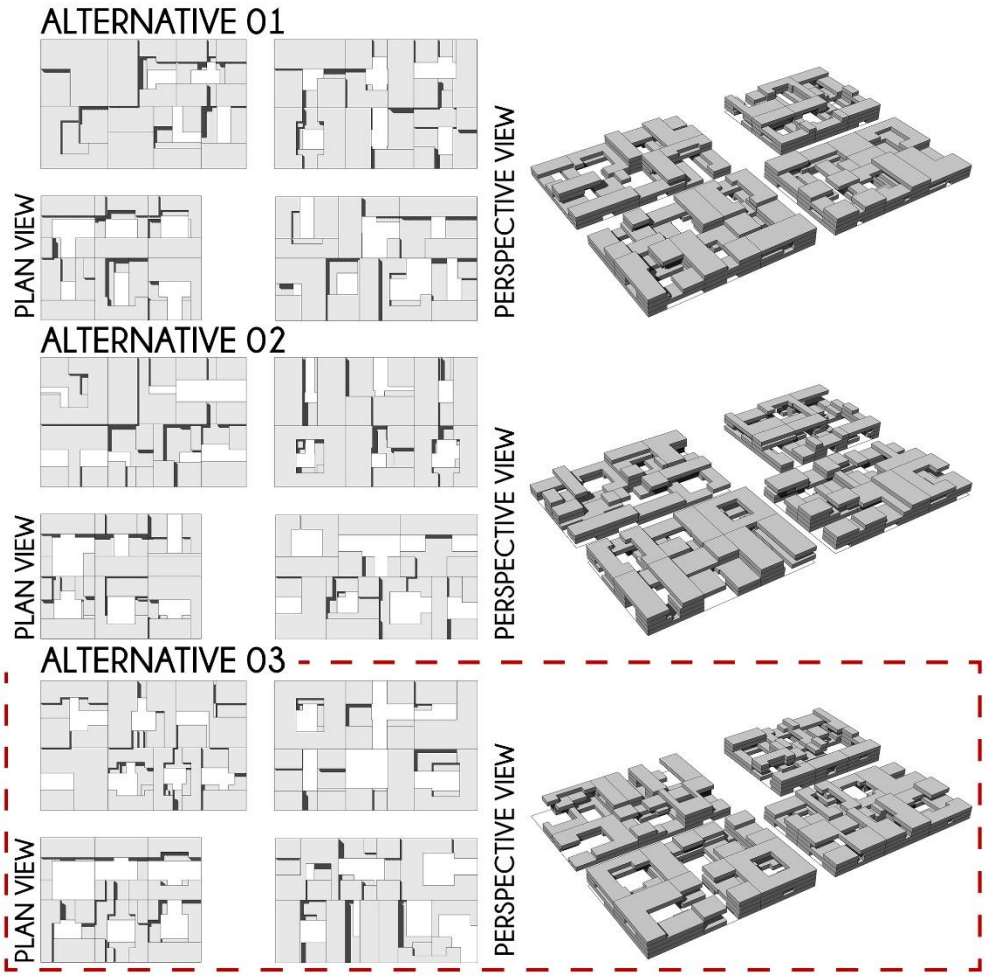

Figure 4.18. Alternative urban block morphologies for hypothetical variation 02

Unlike the first experimental design scenario, this alternative simulates an urban environment with increased development rights. In this sense, the floor area ratio would be accepted as 2.0 which results with extremely dense urban fabric. Within the algorithmic framework of the model, the generation process of the urban block morphologies for this scenario are mainly controlled by the building height, coverage and setbacks by utilizing these parameters to condition the other parameters. In this way, despite having a dense built fabric for this design simulation compared to the actual context, the associated framework of the model ensure a quality of urban form within the ensemble by providing morphological diversity. (see Figure 4.20 and Figure 4.21)

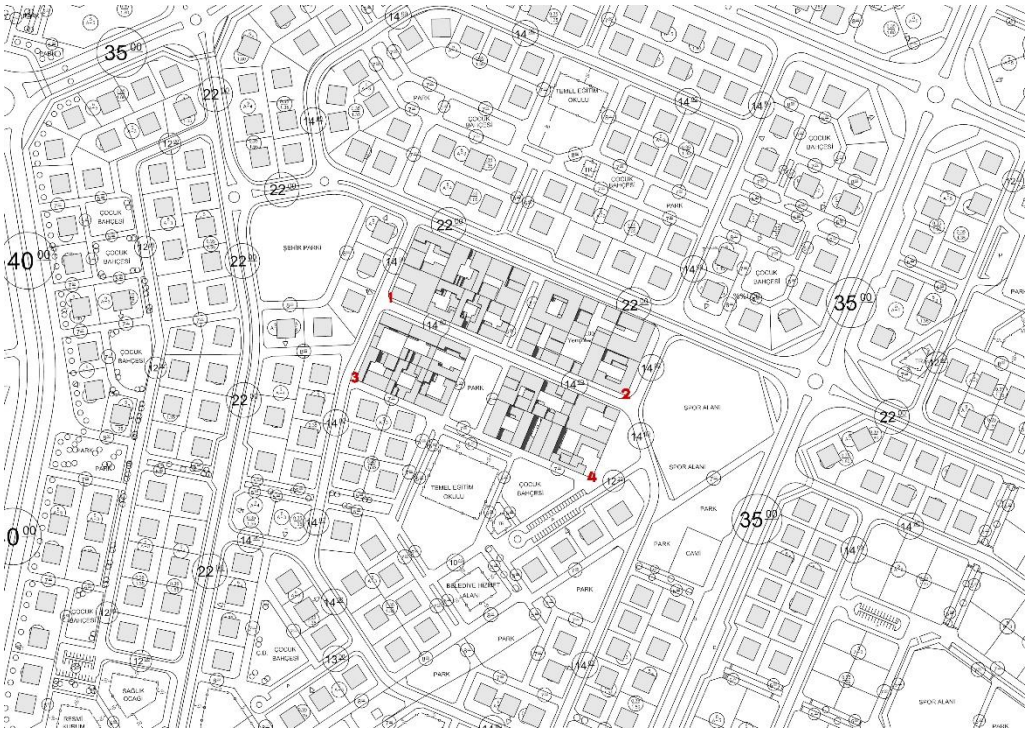

Figure 4.19. The plan view of the selected ensemble

Figure 4.20. The aerial view of the selected alternative within the actual urban environment

Since the alternatives are already selected from the optimized ones, the environmental performance the design scenario are is rather positive compared to the actual urban context. The important point is that, generating morphological variations that perform environmentally well for this experimental condition is quite challenging since the development rights have been considerably increased. As it is stated above, the model proposal of the research run the testing and the generation operations simultaneously. Therefore as it simulated in Figure 4.22 and 4.23, the selected ensemble provides a good environmental quality in terms of outdoor air–flow and solar radiation.

Figure 4.21. The perspective view of the radiation analysis for the selected alternative

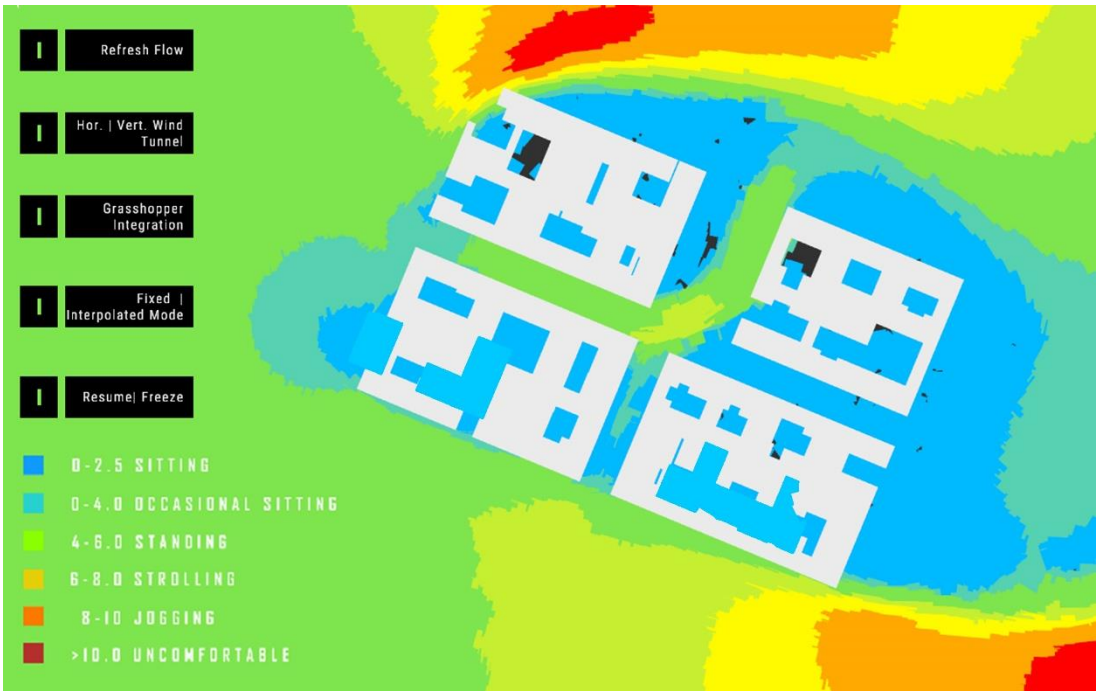

Figure 4.22. The airflow analysis of the selected alternative

In order to reveal the intrinsic morphological characteristics of the selected ensemble, for this hypothetical variation, urban block–3 has been selected to decode. (see Figure 4.20). Since the model utilizes the actual control parameters from the Turkish planning legislation, the generative design codes have been developed to aim to respond the actual planning processes in accordance with the framework of the plan notes. In this context, the plan notes for urban block–3 have been formulated as follows;

1. *Building heights within the urban block shall be measured in number of stories.*
2. *Stories may not exceed 3.5 meters from finished floor to finished ceiling except for a first floor commercial function which must be minimum of 3 meters with a maximum 4.*
3. *The Floor Area Ratio for the urban block should be 2.0.*
4. *Plot 4 should have 10 meters opening on the ground floor to ensure the inner street; to create an inner street following three building on the same corner should have minimum 5 meters rear setback.*
5. *If a building has an opening on the ground floor then following two buildings should have the openings within the mass.*
6. *Plots on the north should have non–built space that covers the minimum %20 maximum %30 of the ground floor.*
7. *Second floor of the buildings, which have openings on the ground floor, should cover at least %80 of the second floor to ensure the enclosure.*
8. *One of the buildings on the north should have minimum %30 maximum %60 openings on the ground level; others should have the openings within the mass that cover 1/3 of the surface.*
9. *Each plot should have independent habitable units which has minimum 200 m3 volume.*

The descriptive design codes enable the generation of the urban block in incremental way by providing a highly controlled framework while at the same time triggering the richness within the urban block. Moreover, with the detailed diagrams (Figure 4.24), abovementioned design codes operate like a detailed recipe to shape the characteristics of the urban block. In this context, the most important characteristics of this urban block is having two different morphological characteristics on the north and the south

part of the block. The buildings on the north draws attention with openings on the ground floor and relatively prefer to establish a relation with street less. On the other hand, the buildings on the south have inner street within the block that open to the street and they also have openings within the mass to make the urban block more permeable. The other important characteristics of the urban block is independent habitable volumes that provide morphological diversity by ensuring the emergent morphological formations.

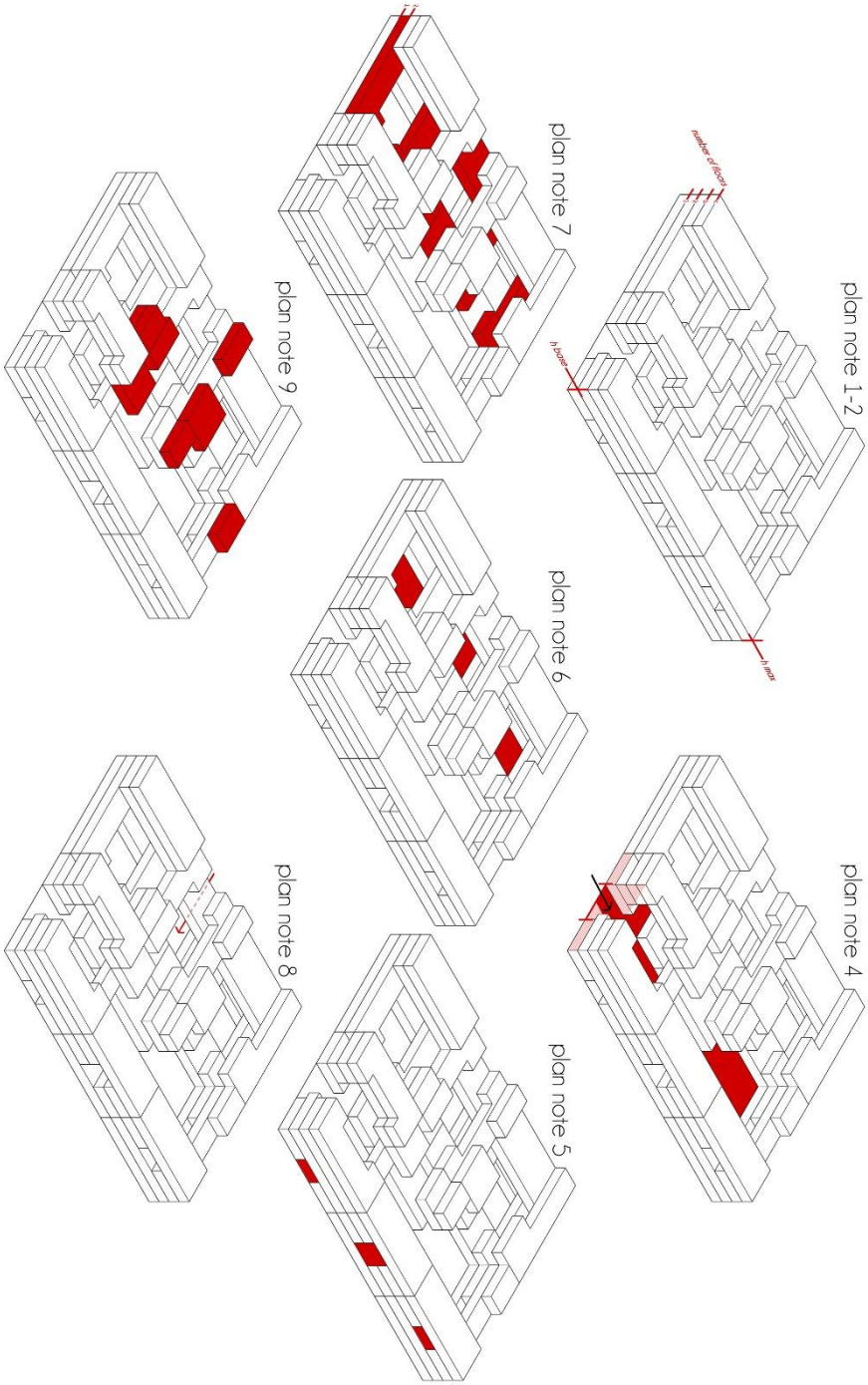

Figure 4.23. Diagrams of the design codes for Urban Block 3

4.2.3.3. Hypothetical Variation 03: *New Plot Layout with current development rights*

Like first two experimental design alternatives, three alternatives have been generated for the hypothetical variation 3 by utilizing the control parameters within the algorithmic framework of the model. (see Figure 4.25) In this sense, alternative three has been selected to detail through design codes.

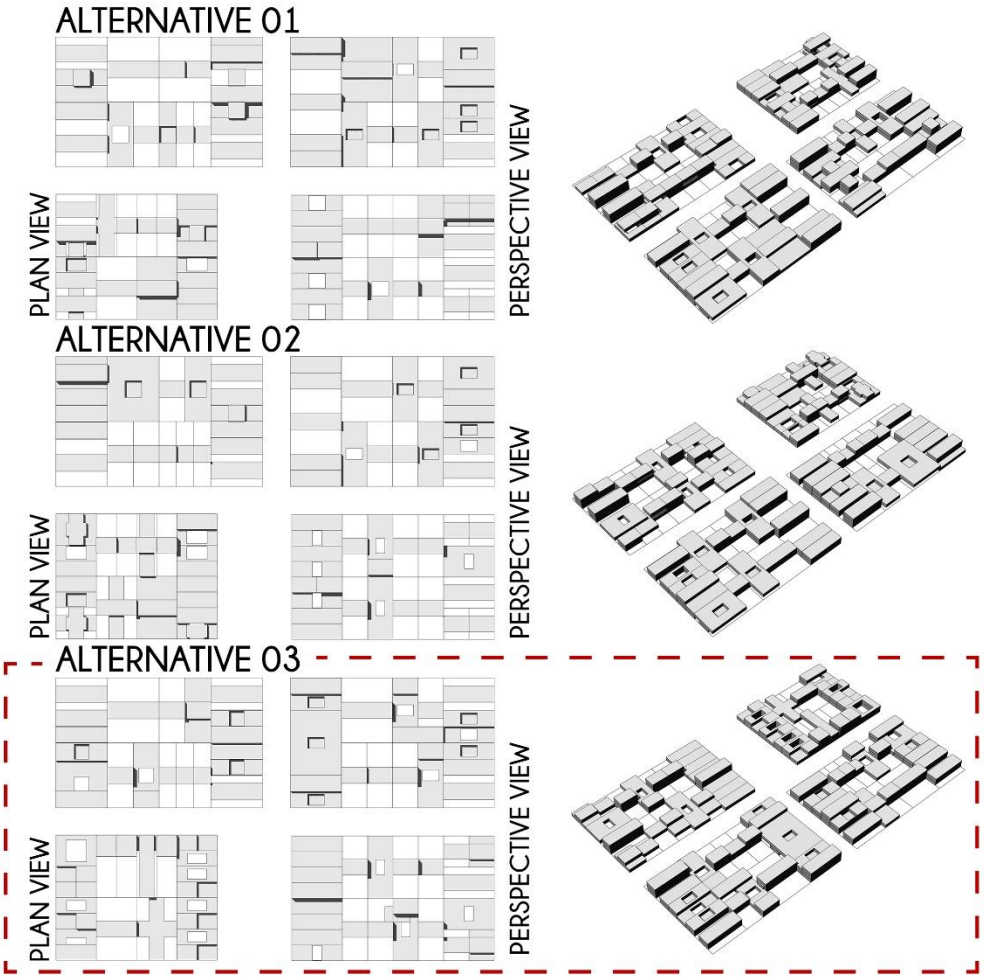

Figure 4.24. Alternative urban block morphologies for hypothetical variation 03

As a most distinctive characteristic, a new plot layout is introduced for the third experimental design scenario. Despite utilizing the current development right, this

alternative differs from the first two hypothetical variation by generating the essential unit of the urban form – plot – to shape the urban fabric. In this way, plot sizes and number of subdivisions have been involved to the model to generate such alternatives. In addition to plot sizes and number of subdivisions, coverage, setback and footprint are mainly utilized control parameters for this alternative. Since the new control parameters have involved to the system, it would be possible to argue that rather diverse and coherent morphological character has been ensured within the ensemble compared to the current urban fabric. (see Figure 4.26 and Figure 4.27)

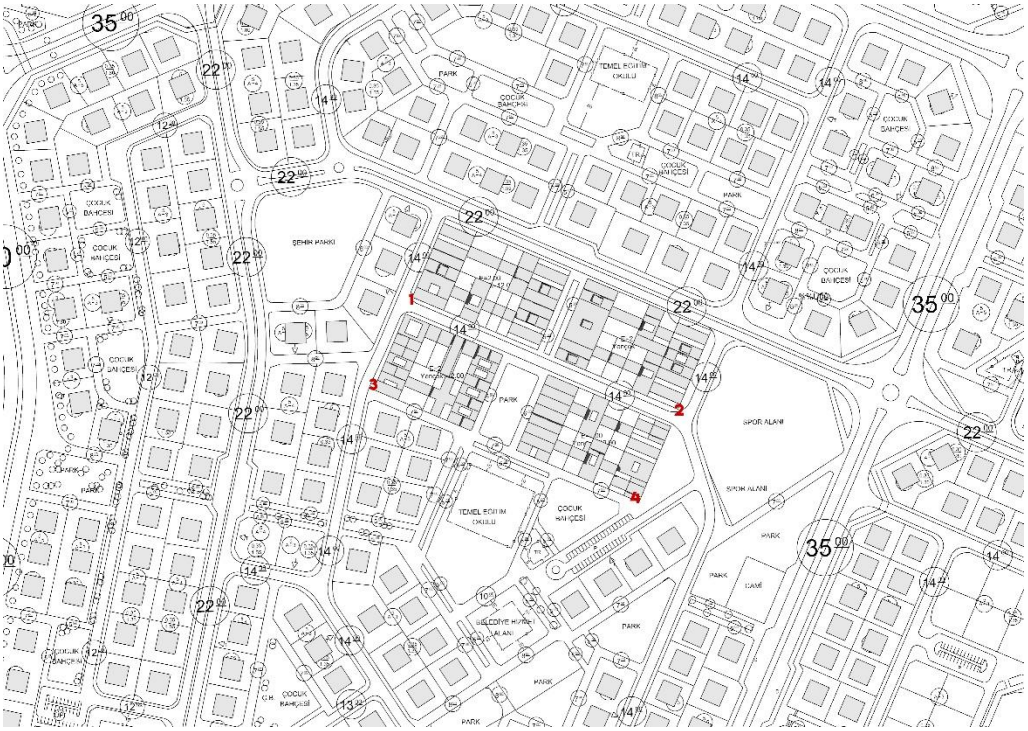

Figure 4.25. The plan view of the selected ensemble

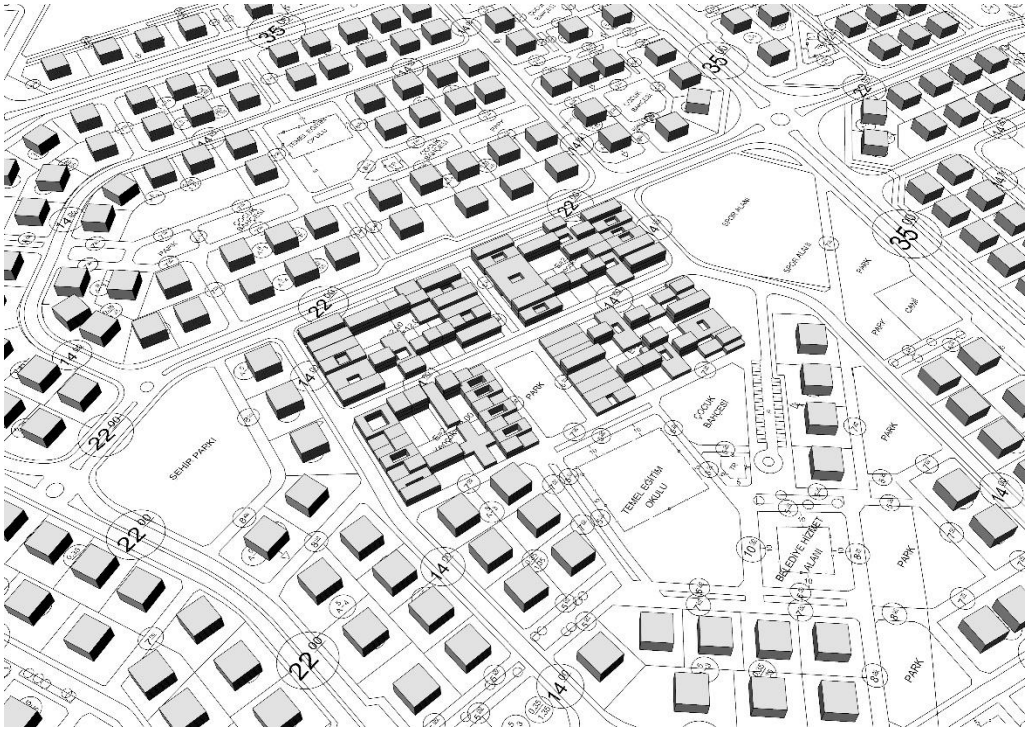

Figure 4.26. The perspective view of the selected alternative within the actual urban context

From the environmental perspective, although this variation ensure a better quality compared to the current fabric, it has the lowest score among four hypothetical variations. The morphological characteristics of the urban blocks are the main reason to fall behind among other simulations. But yet again, the selected ensemble is quite qualified in terms of environmental conditions since the model performs the testing and the generation operations simultaneously to determine the optimum urban block morphologies. (see Figure 4.28 and Figure 4.29)

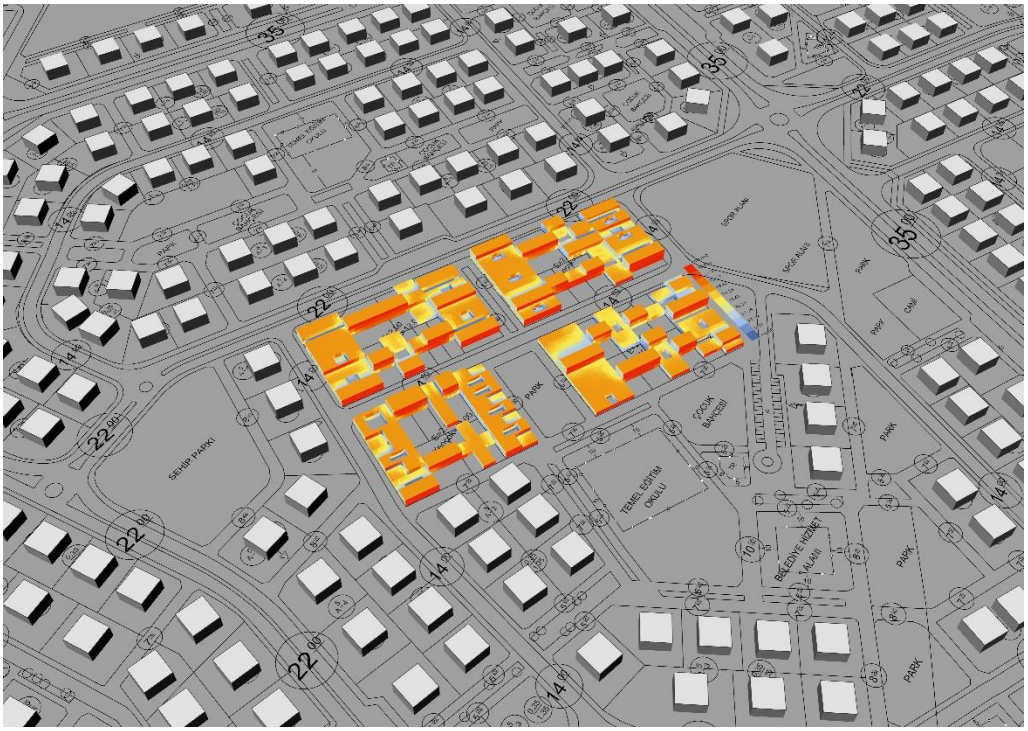

Figure 4.27. The radiation analysis of the selected ensemble

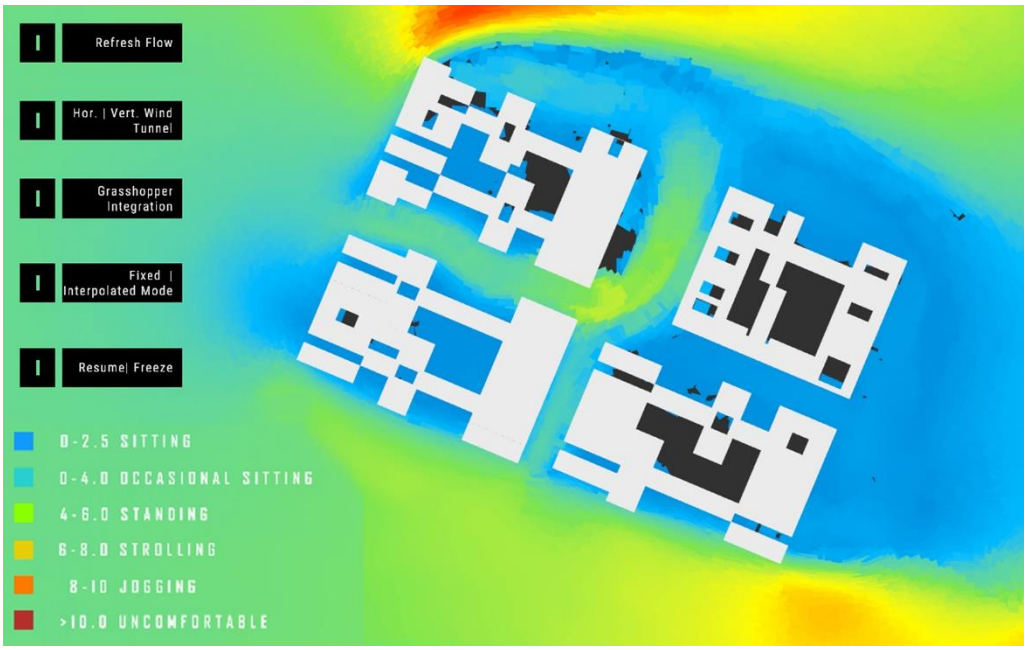

Figure 4.28. The airflow analysis of the selected alternative

For hypothetical example 3, urban block–3 has been selected to identify the morphological characteristics of the ensemble (see Figure 4.26). In this sense, the design codes for the block have been formulated in accordance with new plots. Within the generative framework of the model, the design codes for the urban block–3 have been organized as follows;

1. *Building heights within the urban block shall be measured in number of stories.*
2. *Stories may not exceed 3.5 meters from finished floor to finished ceiling except for a first floor commercial function which must be minimum of 3 meters with a maximum 4.*
3. *The Floor Area Ratio for the urban block should be 1.4.*
4. *The urban block should have 3 continuous edges.*
5. *Plots on the east and the west edge of the urban block should have non–built space that covers at most %30 of the ground cover; buildings that have not opening on the ground floor should cover at most the half of the second floor.*
6. *Buildings that located on the east and the west edges of the block should not have rear setbacks.*
7. *If the plots on the east and the west edges are bigger than 350 m2 then it should have non–built space on the ground floor that covers minimum 125 m2.*
8. *The first floor of the middle plots should be 4 meters.*
9. *One of the middle plots should have minimum 8 meters maximum 12 meters front setbacks to create street niche.*
10. *Middle plots should have rear setbacks that may differ between 8 meters and 15 meters.*
11. *One of the buildings on the middle plots, which is not neighbor to the buildings located on the east and the west edges, should penetrate up to mid–line; the one that penetrate should give a passage on the first floor.*

Since the new plot subdivisions has been introduced to the urban blocks, the morphological and the functional diversity have been enhanced. As one of the most distinctive characteristics of the urban block is controlled by the building height. Differentiating the height of the first floors, the design codes provide alternative usages for the ground floors. In this way, the urban block would have potential to be

a mixed–use area. The continuous façades on the ground floor draw attention as another important feature of the urban block. Lastly, the openings on the ground floor would have potentiality to perform as a public and semi–public spaces. In this context, it would be possible to argue that, the generative design codes provide a unique morphological character that ensure a good quality of urban form.

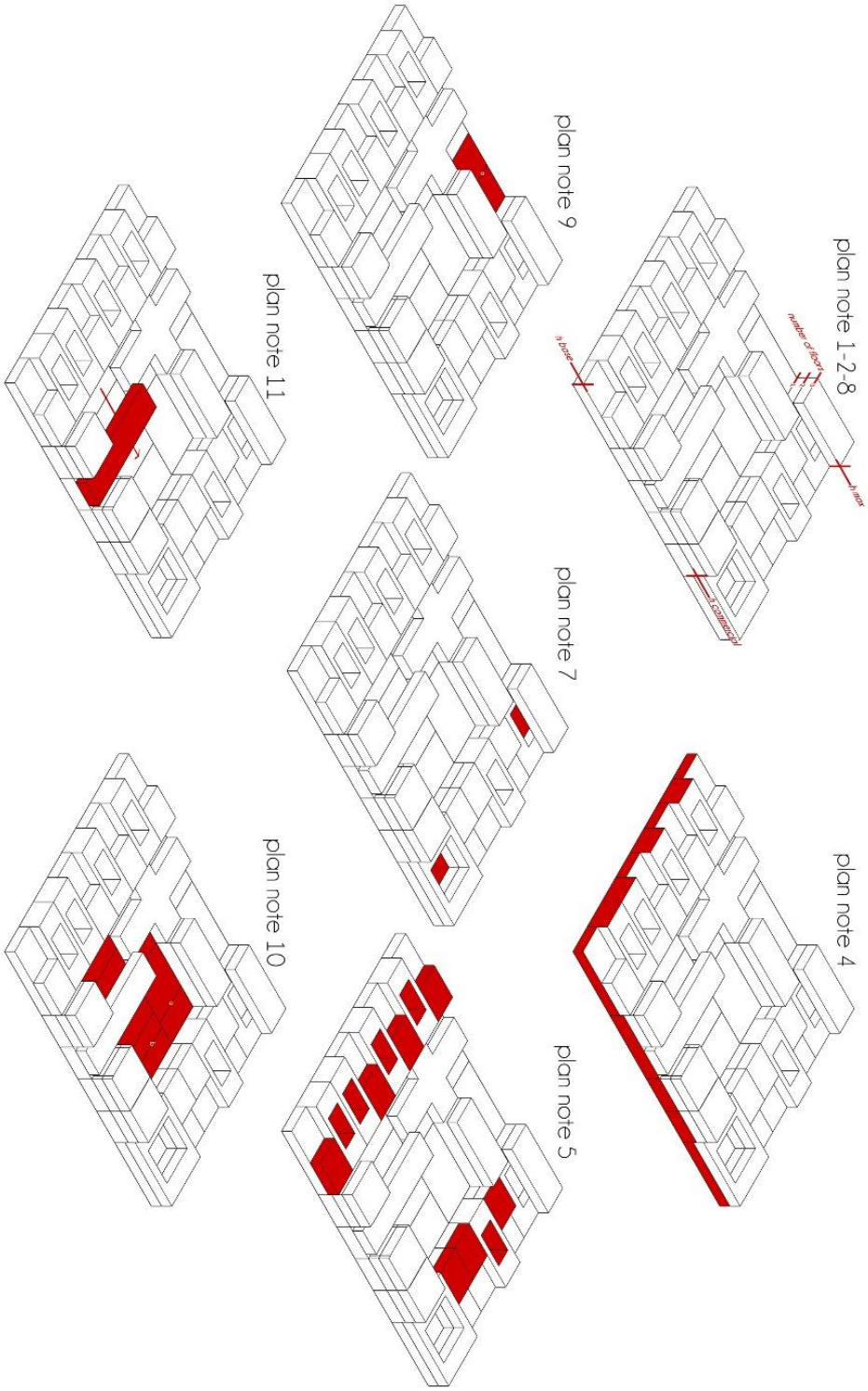

Figure 4.29. Diagrams of the design codes for Urban Block 3

4.2.3.4. Hypothetical Variation 04: *New Plot Layout with increased development rights*

As the last simulation of the experimental design studies, again three alternative have been generated by optimizing the urban blocks. Among these three alternatives, the second one is selected to simulate a formation of the urban block by utilizing the generative design codes. (Figure 4.31)

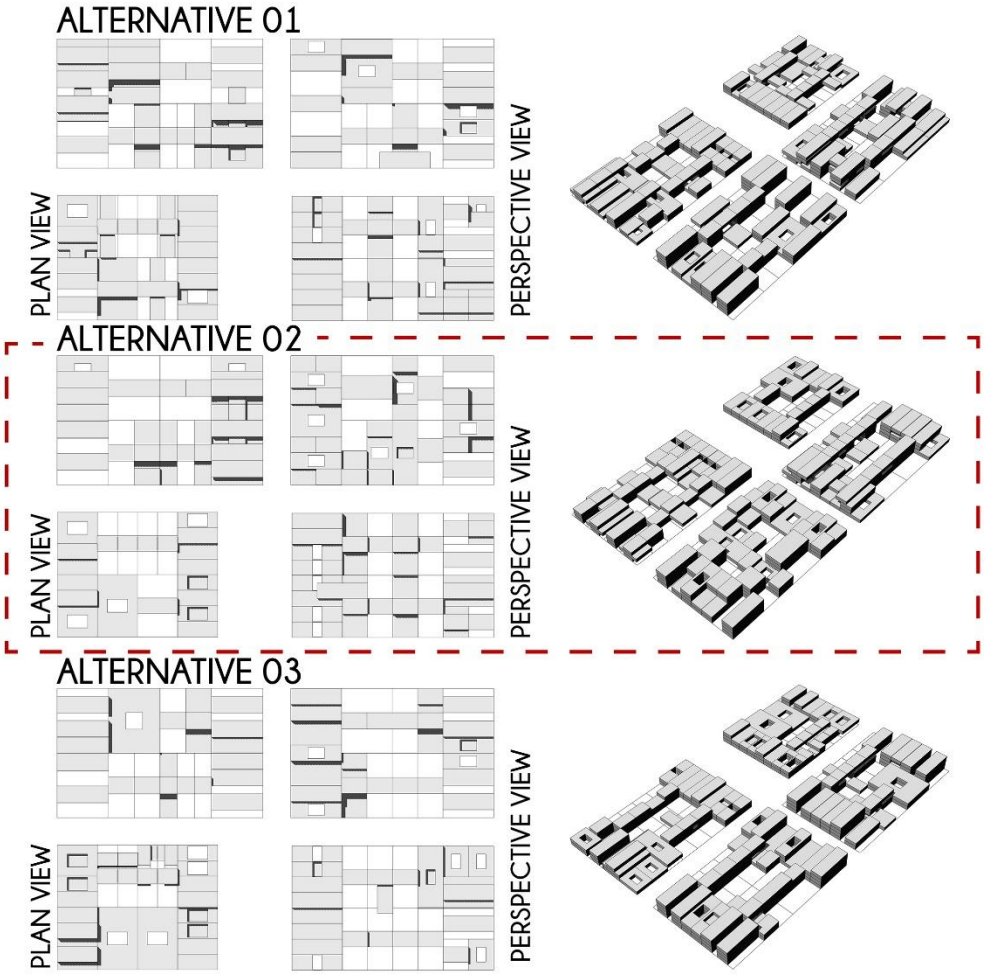

Figure 4.30. Alternative urban block morphologies for hypothetical variation 04

For the hypothetical variation 4, new plot layout is introduced that provides rather diverse urban fabric by utilizing the generative framework of the control parameters on the scale of the plot. Moreover, a development rights that envisaged by the implementation plan is also increased for this alternative from 1.4 to the 2.0. In this context, the most distinctive characteristics of the ensemble is ensuring morphological coherency with higher development rights while generating the diversity within the urban block formations by associating the control parameters. In this context, to control the plot layout, plot size and number of subdivisions have been added to the model. Having potentiality to enhance the control capacity of the model on the plot, the additional parameters are utilized as a main parameters in addition to the coverage, setback and footprint. In this way, despite generating a quite dense urban fabric, the model is capable of ensuring coherency and a good quality of urban form within the ensemble. (see Figure 4.32 and 4.33)

Figure 4.31. The plan view of the selected ensemble

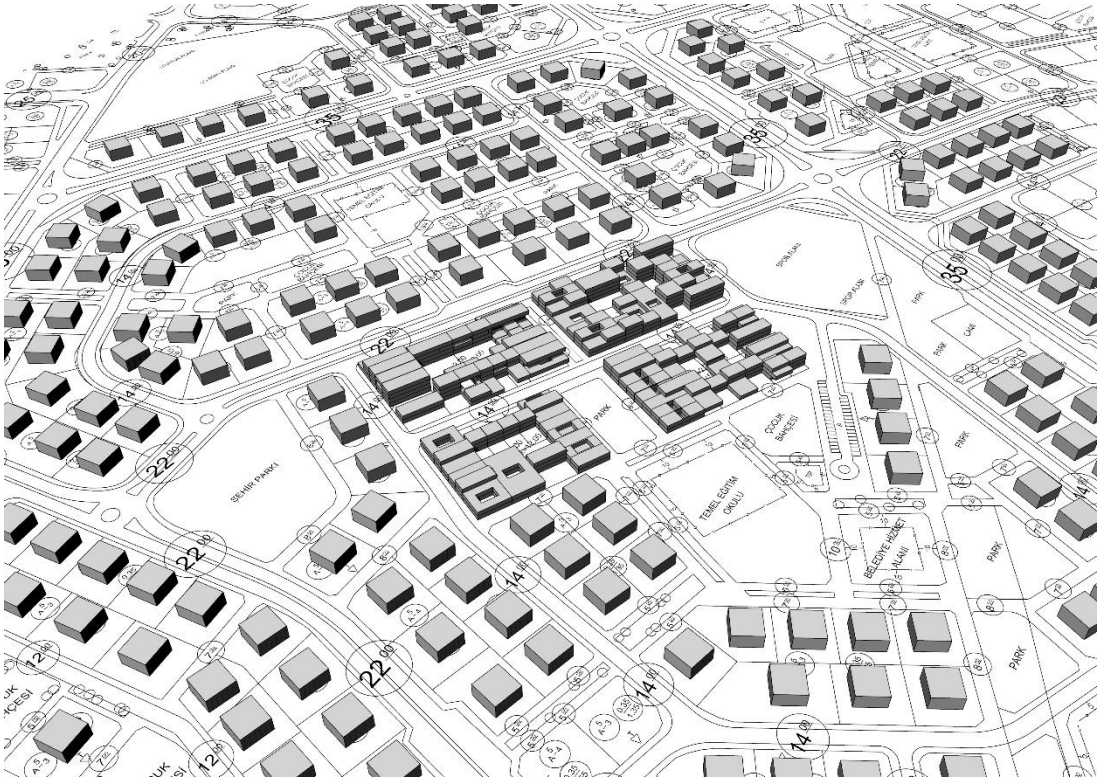

Figure 4.32. The aerial view of the selected ensemble within the actual urban context

The performative analyses of the ensemble have revealed that the selected urban block formations have great potentials to ensure environmental quality within the urban fabric. (see Figure 4.34 and Figure 4.35) In this context, one could argue that, the algorithmic framework of the model performs well to optimize the urban block formations in terms of environmental performance. For the specific context of the hypothetical variation 4, it would possible to argue that the generative capacity of the model perform well to ensure the optimum environmental conditions within the considerably higher densities.

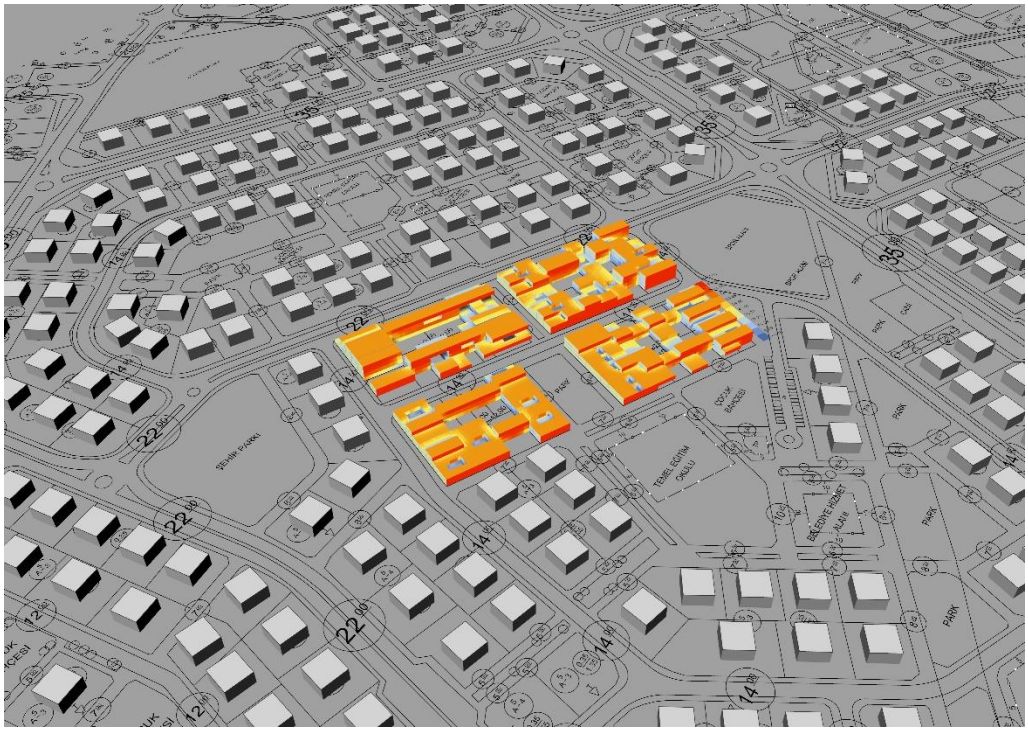

Figure 4.33. The radiation analysis of the selected alternative

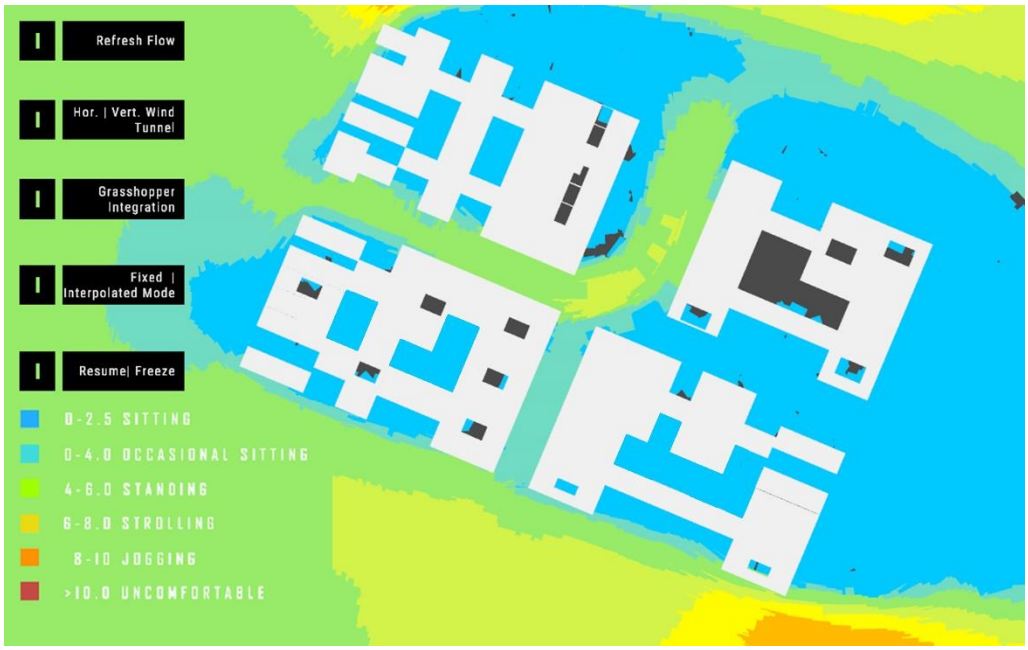

Figure 4.34. The airflow analysis of the selected alternative

As a final phase, urban block–2 is selected for this alternative to reveal the spatial qualities of the ensemble.(see Figure 4.31) To that end, like previous variations, some subtle design codes have been formulated to decode the selected urban block on the scale of the plot. In this context, the design codes for urban block–2 can be expressed as follows;

1. *Building heights within the urban block shall be measured in number of stories.*
2. *Stories may not exceed 3.5 meters from finished floor to finished ceiling except for a first floor commercial function which must be minimum of 3 meters with a maximum 4.*
3. *The Floor Area Ratio for the urban block should be 2.0.*
4. *Buildings on the east and the west edges of the block should have openings on the ground floor that cover at least %20; at most %35 of the ground surface.*
5. *If the buildings do not have openings on the ground floor then they should use at most the half of the third and fourth floor.*
6. *If a one building have front setback then following one should not have front setback.*
7. *On the east edge of the urban block there should be continuous surface to establish a relation with neighbor block.*
8. *The plots that are bigger than 450 m2 they should of 50 m2 openings on the ground floor.*
9. *Middle plots should have at least 7 at most 12 meters rear setbacks and if one plot has a rear setbacks then adjacent plot should not have rear setback.*

In this sense, one of the most important feature of the selected urban block is that there are two different morphological characteristic within the urban block. Accordingly, the middle plots and the edge (east and west) plots have distinctive features that come from the new plot layout. The buildings on the edge plots tend to cover to ground floor as much as possible while the buildings on the plot middle plots have front and rear setbacks to generate openings on the ground floor. Creating street niches, the randomized but continuous rhythm within the front setbacks draw attention as another morphological character of the urban block. Having strong relationship with the street, the urban block also have semi–public openings on the ground floor that generated by

the middle plots by manipulating the rear setbacks. Moreover, different plot sizes enable the morphological diversity within the urban block by providing different building sizes and building typologies. In this way, the generative urban codes make the emergent of the different morphological forms and formations even if they do not envisaged by the model.

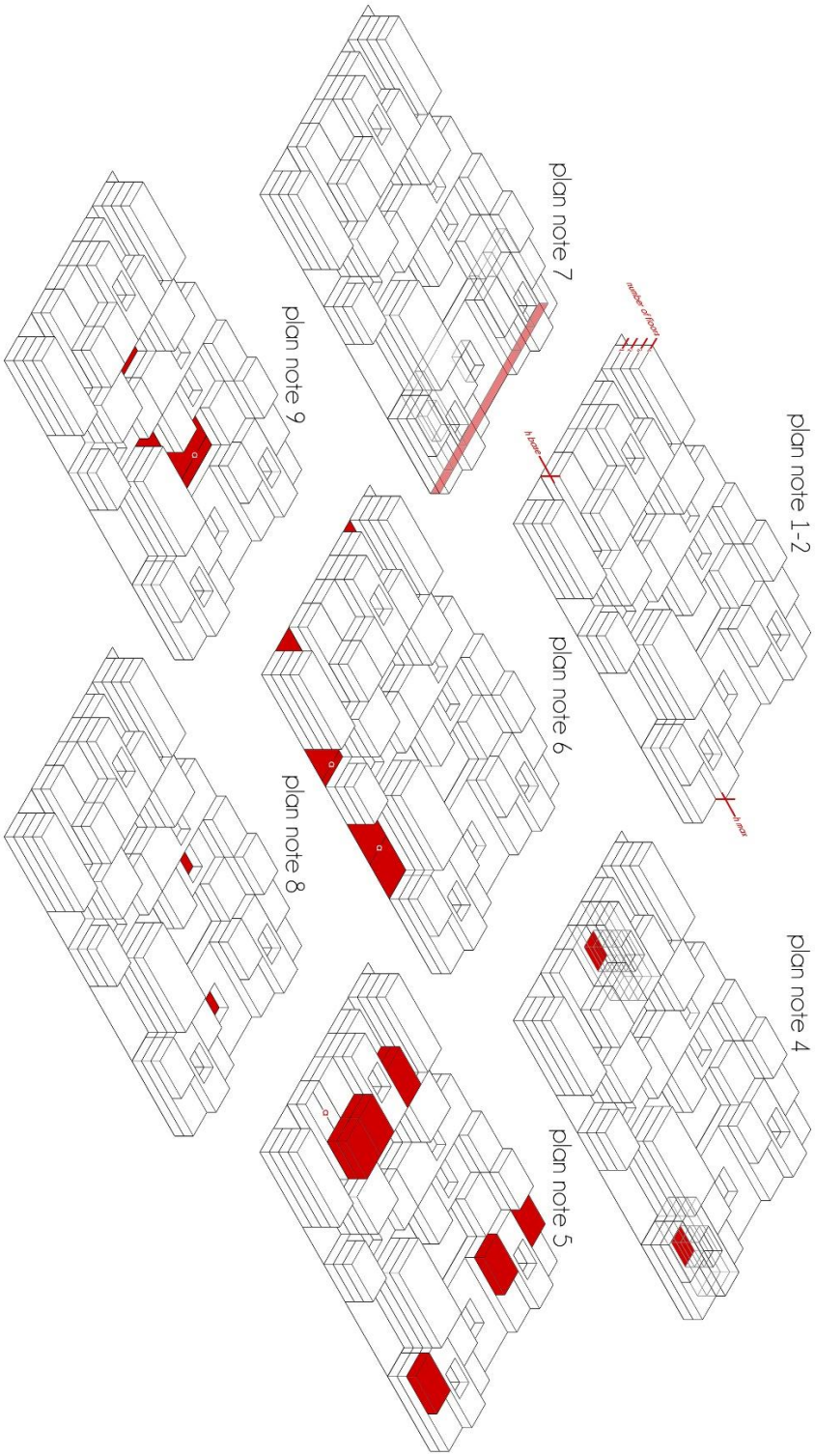

Figure 4.35. Diagrams of the design codes for Urban Block 2

4.2.4. Findings of the Model

The outcomes of the model has revealed that the parametric modelling has great potentiality to foster the bottom–up design processes for generation of urban forms and formations. Operating with an algorithmic framework, the parametric modelling provides an efficient framework to come up with coherent unities within reach morphological diversity. In this context, it would be possible to argue that, the model proposal of the research is quite flexible and responsive to generate different urban block formations by associating all the control parameters of the urban block, the plot and the building. Moreover, having capability to produce compositional alternatives of different block formations, the model simulates the optimum design solutions by operating the different performative indicators and the control parameters synchronically. In this way, the generation of the optimized hypothetical variations have shown that parametric modelling have great potentiality to be utilized as a design control tool rather than a 'design machine' by associating the control parameters and performative indicators within the formation process. In addition to this, the model also demonstrates that the plot–based urbanism provides rather diverse and coherent urban fabrics by utilizing the plot as an essential control unit of the formation processes within the algorithmic basis of the parametric modelling. In this way, the collaboration of the plot–based urbanism and parametric modelling in the context of the design and development control provides an efficient framework to respond the shortfalls of the planning practices in Turkey. Despite having an algorithmic basis, the model proposal of the research still is not capable of ensuring the incremental development of form within generative design processes due to some technical constraints. Barely, the generative design codes which formulated on the scale of the plot would aim to foster the incremental development of urban forms and formations. In this context, one could argue that the manual design coding would perform as a complementary design control tools for the algorithmic design codes by enhancing the control capacity of the model on the plot. Last but not least, the experimental design studies have shown that the model proposal of the research is qualified enough to

formulate an alternative design framework that aims to foster the generative design processes as opposed to the fixed nature of blue–print masterplans.

CHAPTER 5

CONCLUSION

The research propounds a critical perspective to the conventional understanding of urbanism that result with static master plans by addressing the emerging approach of the so–called plot–based urbanism. In the context of design control, the thesis introduces parametric modelling as a new tool to control to urban formation. In this manner, the research seeks to develop an efficient framework for generative design processes to ensure the bottom–up development of urban form. As response to the intrinsic nature of generative urbanism, the research reveals the potentiality of parametric modelling to control the urban form by utilizing the plot as an elementary unit of incremental form and formation. By the new control parameters suggested for the urban block, the plot and the building to enhance nested spatial relations of them, the motivation of the research is develop an alternative design control method for the Turkish spatial planning system while improving the control capacity of urban form by developing design codes on the scale of the plot.

Relying on the abovementioned framework, this study problematizes shortcomings of the urban planning and design practices in Turkey by indicating the gap between theory and the practice on the issue of design control. The top–down and hierarchical planning mechanisms in Turkey come up with poor quality urban fabrics which are composed of identical plots that consequently lack the diversity and coherence. In this sense, developing an operational on design control, plot–based urbanism and parametric design, the research suggest a new framework that utilizes the plot–based character of urban form in Turkey to ensure the incremental (therefore coherent) development of urban fabric. To respond such a conceptual and methodical framework, the study utilizes the parametric modelling to simulate better quality of urban form by fabricating the different alternatives which would be tested through morphological and environmental indicators. In this context, associating the very controlled framework of parametric modelling and urban design, the research aims to

provide an efficient operational and algorithmic basis for plot–based (trans)formation in the specific context of design control in planning.

5.1. Evaluation of the Model Application

As stated above, in the scope of the research, with the algorithmic basis of the model four different hypothetical variations have been simulated for urban block within the selected site. The alternatives are differentiated basically with respect to the different levels of floor area ratio and different layouts of plot. Thereafter, the essential control parameters have been identified to generate the optimum urban block formations. Since the block alternatives have been reflected on to formulate the generative design codes on the scale of the plot, the model basically utilizes the plot as the main control unit to shape the built environment in the context of urban ensemble (urban block–group).

In this context, the environmental performance and the morphological quality of the model outcomes have been proved that parametric modelling can be utilized to improve the existing design control system in Turkey by introducing the new control parameters within an algorithmic framework. The optimized urban block formations reveal the possibility of designing better urban spaces even by utilizing the design parameters within the existing spatial planning legislation. Simulation of the different alternatives for a specific planning context shows that generative design processes foster flexible and adaptive procedures which enables an effective control of the bottom–up development of urban land.

Different form compositions that generated by the model also verified that the existing plot–based development patterns of Turkey can be re–produced by the parametric approach by generating rather diverse and coherent urban fabrics. Despite the fact that the model does not operate in a ‘generative’ way that enables incremental production of the urban fabric, the model is able to run the integrated algorithm that associates all the control parameters for the urban block, the plot and the building. In this way, the control parameters for the plot (i.e. coverage, footprint, floor area ratio) basically

condition the formation urban block. Moreover, since the fundamental design codes that would guide the implementation plan are codified on the scale of the plot, it would be possible to argue that the plot–based character of the Turkey could be revisited within an alternative (algorithmic) control framework.

5.2. Implications for Urban Planning and Design: *Towards an Algorithmic Design Control*

The primary potential of the model is to fabricate coherent and compact urban form within the complexity of the nested relations of the urban block, the plot and the building. Having capability to produce compositional alternatives of different block formations, the model simulates the optimum design solutions by operating the different performative indicators (i.e. radiation, outdoor air flow, and shading). Since the model operates the testing of block configurations and the performative indicators simultaneously, it is capable of determining the optimum conditions for the urban block based on environmental performance. Therefore, one could argue that the model proposal of the research provides an efficient framework to produce better quality urban form by associating pre–defined urban design rules. Developing highly controlled framework to produce design alternatives, the research utilizes the parametric modelling as a design control tool rather than a 'design machine' as widely argued (Çalışkan, 2017). In this way, the form production capacity of the parametric modelling turned into advantage by developing an algorithmic basis to the parametric control of urban form and formation. Though the current legislative framework in Turkey has few control parameters which were potentially to produce 'good urban form' the actual applications, actually fall short to respond the needs of changing dynamics of the contemporary urbanism. In this manner, the model tends to provide an associative framework to operate all of the control parameters in a relational, flexible and therefore dynamic manner. In this regard, providing new control parameters, the model also reveals the inherent potentiality of the Turkish spatial legislative framework as well as developing a broad framework in the context of

design control to trigger the incremental development of urban form on the scale of the plot.

Generating the wide range of possibilities of different urban block formations, the model is also capable of simulating the levels of density within the given context through manipulating the specific control parameters (i.e. coverage, floor area ratio, building height). In this sense, it would be possible to argue that the algorithmic framework of the model, which works in a holistic way by associating all the external conditions (i.e. climate, planning regulations, and property) and control parameters, could ensure the higher density levels in the urban fabric while still providing livable urban form through certain level of porosity within dense block fabric. This indicates, the model to be utilized in designing of new development areas as well as in urban transformation projects that aim to design new urban spaces through increasing 'develop rights' by density. Since urban transformation is a highly preferred planned urban process in the current context of the planning practices in Turkey, it is believed that the model would find a fruitful basis in practice, as well.

The parametric logic of the model suggest a real potentiality to specify the shortfalls of the existing urban spaces in terms of their environmental performance. Since the model is capable of operating environmental analyses (i.e. radiation, air–flow, shadow), it could serve for the local transformation within the existing fabrics. In this way, the model proposal of the research does not only contribute to the future planning decisions of the newly developed areas, but also provide an effective tool to ensure the better quality of urban form within already existing built–fabric.

5.3. Limitations and Further Studies

Although the model proposal of the research has great potentials to generate coherent urban forms, it has some limitations that indicates the need for further studies. Firstly, the model is developed within the default interface of the Grasshopper, which is an open–source plug–in for the digital modelling software in Rhinoceros, by utilizing the algorithmic framework. Unlike other plug–ins for Rhinoceros for instance

RhinoScript, Grasshopper does not require a knowledge about scripting. Barely, the Grasshopper is also compatible with the script–based framework which operates with C#. Since the script–based framework of the C# is more flexible, controllable and easy to develop than any conventional components of Grasshopper, it is easier to formulate more complex conditions with C#. Moreover, since the current components of the Grasshopper are not capable of developing the urban fabric in an incremental way, the model proposal still operates in a top–down manner. In this sense, script–based operative structure of C# offers an efficient basis to simulate the emergent development of urban fabric through generative processes (Schumacher, 2016, p.13). Furthermore, since scripting provides highly controllable structure for each step through specific codes, it is compatible to create an effective framework for the simulation of the bottom–up development of urban form. Secondly, the model proposal of the research requires recursive algorithms that allows the fabrication of the associated geometries within a circular which has pre–defined by a set of rules. Although the components of the Grasshopper are capable of running recursive procedures, it falls short to run iterative actions for an actual generation of complex form–patterns. Lastly, although the model utilizes the immense power of computer operations, the multi–layered algorithmic framework of the study leads to slow operations. Since the model runs the different analyzes and fabrication of the different form compositions simultaneously, the testing process to determine to optimum conditions takes a long time within the current framework. Supplementary scripting would also provide an efficient basis to complete such a complicated series of action within shorter period of time through multiple operations occurring synchronically.

In this context, to make the development of the coherent urban form possible through the generative process, the model proposal of the research essentially needed to re–handle within the creative nature of script–based framework to enhance to control capacity by developing the specific codes for further studies. Moreover, the model proposal of the research need to be improved by extra coding works for scripting to enable a kind of non–linear operation in a generative manner In this way, highly–

controlled and deeply efficient framework which aim to control the production of the urban form in incremental way would possible to be formulated to generate the relational whole which totally responsive to its parts.

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