DESIGNING (WITH) COMPLEXITY:
IMPROVING ADAPTIVE CAPACITY OF URBAN FORM BY DESIGN

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ABSTRACT

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In the last century, as parallel to the transitions and paradigmatic shifts in the history of science, urbanism has experienced important theoretical breakthroughs and transitions, as well. At that point, emerging paradigm of complexity theories has come into the contemporary agenda of urban planning and design agenda by representing a dramatic shift from the conception of cities as totally controllable and designed artefacts. In that sense, the complexity-based perspective in urbanism asserts that the settled planning and design approaches conceptualizing the city as a finite and static product of a single mastermind that tends to predict its future state via deterministic projection mechanisms, and designing it with a clear image of an optimal form inescapably fall short to operate effectively. Adoption of complexity theories’ perspective portrays a city which is far from-equilibrium, dynamic, ever-evolving and full of uncertainties.

From this point on, it is explicit that designing cities as static and non-progressive physical artefacts by controlling and regulating everything beforehand in accordance with a fixed image makes urban form fragile against the emerging uncertainties and changing spatial needs; and, decreases its capacity to respond different circumstances
in a successful manner. For that reason, planning theory and practice should discover and develop a new form of intervention which would be more responsive to the uncertainties by relying on the derived understandings of complexity theory.

The most fundamental motivation behind this research is to develop a model approach improving the adaptive capacity of urban form to respond emerging uncertainties and changing needs by operating design within the revealed context of urban complexity. To that end, the research investigates the morphological and programmatic characteristics of an adaptable urban form by revisiting the theoretical implications of the notion of adaptability and examining historical plot-based urbanism examples demonstrating an enhanced capacity of responsiveness. Moreover, two different contemporary urban design and development projects – IJburg, Amsterdam (the Netherlands) and Middlehaven, Middlesbrough (UK) – are examined in detail to develop a better understanding about the kind of design approach which helps to achieve the morphological and programmatic characteristics required to improve the adaptive capacity of urban form.

**Keywords:** urban complexity, uncertainty, responsiveness, adaptive capacity, urban form
ÖZ

KARMAŞIKLIĞI TASARLAMAK:
KENT FORMUNUN UYUMLANMA YETİŞİNİ GELİŞTİRMEK

TÜMTÜRÇ, Onur

Yüksek Lisans, Kentsel Tasarım, Şehir ve Bölge Planlama Bölümü
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Geçtiğimiz yüzyılda bilim tarihindeki paradigma değişim ve dönüşümlere benzer olarak, şehircilik disiplini de önemli kuramsal değişimler ve dönüş noktaları yaşamıştır. Bu noktada karmaşıklık kuramı, çağdaş kentsel planlama ve tasarım yükününde gündeme gelerek, kentsel mekanın tüm yönleriyle kontrol edilebilir bir tasarım nesnesi olarak kavramsallaştırması konusunda farklı bir bakış açısı ortaya koymuştur. Bu bağlamda, şehircilikteki karmaşıklık bakışı, kentsel mekanı tek bir üst-akıl tarafından üretilen, durağan ve değişime kapalı optimum biçim ve oluşumlar olarak tanımlayan geleneksel planlama ve tasarım yaklaşımlarının yetersiz kalacağıını savunur. Karmaşıklık kuramının şehircilik çağısta çalışma alanına uyarlanması, kararlılık ve durağanlıkta uzak, oldukça devingen, evrilebilir ve gelecek biçim ve koşulları belirsizliklerle dolu olan bir mekan kavramsallaştırmasına işaret eder.

Bu bakış açısı kapsamında mekanı, tüm bileşenleri sabit bir image ve uzgörü dahilinde, durağan, değişime kapalı ve evrimsel değişim-dönüşüm süreçlerine işaret etmeyen fiziksel nesneler olarak planlama ve tasarım aracı biçiminde; mekanın, ortaya çıkabilecek belirsizliklerle ve değişen gereksinimlere yanıt verme ve uyumlanma yetisini olumsuz etkilemekte ve bu anlamda bir kırılganlığa yol açmaktadır. Bu nedenle, şehircilik
kuram ve uygulama alanlarının, karmaşık kuralın önünü açtığı yeni kavrumsallarştırmaları ve anlayışlara dayanarak, belirsizliklere ve tahmin edilemez durumlara daha iyi yanıt verecek yeni ve alternatif bir müdahale biçimi keşfetmesi ve geliştirmesi gerekmektedir.

Bu araştırmanın temel amacı, kent formunun oluşumsal ve beklenmedik belirsizliklere ve değişen koşul ve ihtiyaçlara yanıt verebilmek için ‘uyumlanma yetisi’ni geliştirecek ve ortaya konulan kentsel karmaşıklık durumu içerisinde işleyecek bir model yaklaşımlardır. Bu bağlamda araştırma, uyumlanabilir kent formunun morfolojik ve mekânsal programa dair özellikleri saptamak üzere; ‘uyumlanabilirlik’ kuralının kuramsal yansımalarını ve gelişkin uyumlanabilirlik örnekleri sunan parsele dayalı tarihî şehircilik örneklerini incelemektedir. Bunun yanı sıra, araştırma kapsamında iki farklı çağdaş kentsel tasarım projesi – IJburg, Amsterdam (Hollanda) ve Middlesbrough (İngiltere) – incelenerek, kent formun uyumlanma yetisini geliştirmek için gerekli olan morfolojik ve mekânsal programa dair özelliklerin ne tür bir planlama ve tasarım yaklaşımıyla işlevsel kılınabileceği yanıtları aranır.

Anahtar Kelimeler: kentsel karmaşıklık, belirsizlik, yanıt verebilirlik, uyumlanma yetisi, kent formu
For *change*…
and to the ones, who read at least one page of it…
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TABLE OF CONTENTS

ABSTRACT.................................................................................................................................................. v
ÖZ ................................................................................................................................................................. vii
ACKNOWLEDGEMENTS................................................................................................................................. x
TABLE OF CONTENTS.................................................................................................................................... xi
LIST OF FIGURES ........................................................................................................................................... xvi
LIST OF TABLES............................................................................................................................................. xxi

CHAPTERS
1. INTRODUCTION ........................................................................................................................................ 1
   1.1 Context and Problem Definition ................................................................. 1
   1.2 Aim of the Study and Research Questions .................................................. 4
   1.3 Methodology of the Research ........................................................................ 5
   1.4 Structure of the Research ............................................................................... 6
2. EMERGING PARADIGM OF COMPLEXITY SCIENCES ................................................. 11
   2.1 Paradigm Shifts in Scientific Approaches: From Scientific Reductionism to
       The Theory of Complexity..................................................................................................................... 11
       2.1.1 Reductionism ......................................................................................................................... 11
       2.1.2 Dynamical Systems Theory ................................................................................................. 12
       2.1.3 From Top Down to Bottom Up Perspectives ....................................................................... 12
       2.1.4 Emerging Ideas of Unpredictability, Non-linearity and Chaotic Systems 13
       2.1.5 Systems Theory ...................................................................................................................... 14
       2.1.6 Critical Reflections: Is A New Cognitive Breakthrough Possible? ............ 15
   2.2 The Origins of Complexity Theories and Complex Systems ............................ 17
       2.2.1 Definition of Complexity and the Complex Systems ......................................................... 19
       2.2.2 Common Characteristics of Complex Systems ................................................................. 22
   2.3 Paradigm Shifts in Urbanism: From Deterministic Approaches to The
       Complexity-Based Perspectives............................................................................................................ 25
       2.3.1 Deterministic Approaches in Urban Planning and Design ................................. 26
       2.3.2 Critical Perspectives to the Deterministic Approaches Through the Lens
of Complexity ................................................................. 31
2.3.3 Complexity Theories of Cities ............................................ 37
2.4 Ongoing Transformation Of “The Kind of Thing a City Is” ............... 38
2.5 Concluding Remarks ............................................................ 42
3. URBAN COMPLEXITY AND EMERGENT NATURE OF CITIES ............ 45
3.1 Cities, Planning and Complexity ................................................ 45
3.1.1 Cognitive Challenges in Translating Complexity into Urban Planning
and Design .............................................................................. 46
3.1.2 Translation of Complexity into Urban Planning and Design: Organized
Complexity of Cities .................................................................. 48
3.1.3 Implications and Contributions of Complexity Theories of Cities in
Urban Planning and Design ......................................................... 53
3.2 Emergent Nature of Urban Complexity ............................................ 59
3.2.1 Evolution, Planning and Design: Are They Compatible or Not? ........... 61
3.2.2 Emergence: Definitions, Models and Principles ............................... 62
3.2.3 Emergence, Cities and Emergent Urban Order ............................... 69
3.3 A Brief Review of Contemporary Design Approaches ............................ 77
3.3.1 Rule-Based Planning and Design Approaches .................................. 78
  3.3.1.1 Christopher Alexander ....................................................... 78
  3.3.1.2 N. John Habraken .............................................................. 84
  3.3.1.3 New Urbanism and Form Based Urban Coding ......................... 86
  3.3.1.4 From Shape Grammars to Urban Grammars .............................. 86
3.3.2 Simulation Approaches for Urban Planning and Design ..................... 89
  3.3.2.1 Cellular Automata and Agent-Based Models ............................. 90
  3.3.2.2 Game Urbanism: Serious Games to Design Urban Space ............... 92
3.4 Concluding Remarks ................................................................... 94
4. DESIGNING (WITH) UNCERTAINTY: TOWARDS A RESPONSIVE
URBAN PLANNING AND DESIGN APPROACH ................................ 99
4.1 Uncertainty: Inherent Feature of Complex Urban Formation Processes ...... 99
  4.1.1 ‘Wicked Problems’ of Urban Planning and Design: From Obsession
with Certainty to Acceptance of Uncertainty .................................... 100
4.1.2 What Does Uncertainty Imply for Urban Planning and Design? .......... 103

xiii
4.1.3 Uncertainty: Paralyzing or Move on? ................................................................. 105
4.2 Ensuring Adaptive Capacity of Design for Tackling Uncertainty ..................... 107
  4.2.1 From Fail-Safe to Safe-to-Fail: Why ‘Adaptability’ is Key to Cope
      with Uncertainty ........................................................................................................ 108
  4.2.2 Adaptation and Adaptive Capacity of Urban Space ........................................ 111
  4.2.3 Resilience and Robustness: Offering Diverse Set of Choices ...................... 115
  4.2.4 Flexibility: Leaving Room for Change ............................................................. 120
  4.2.5 Critical Remarks on the Synthesis of Resilience and Flexibility:
      Adaptive Capacity of the Urban Space ...................................................................... 123
  4.2.6 Key Principles of Adaptive Urban Design Approach ................................. 126
4.3 Steering Urban Adaptation: Plot-Based Urban Design ...................................... 128
  4.3.1 ‘Lost Art of Subdivision’: Plot as the Most Suitable Design-Control Tool
      for Urban Adaptation ................................................................................................. 130
  4.3.2 Plot-Based Urbanism: What Makes ‘Plot’ Key for Steering Urban
      Adaptation? ................................................................................................................ 132
  4.3.3 Learning from International Plot-Based Urbanism Examples .................... 136
      4.3.3.1 The New Town – Edinburgh ........................................................................ 136
      4.3.3.2 Eixample – Barcelona ................................................................................. 142
      4.3.3.3 Alamo Square – San Francisco ..................................................................... 150
  4.4 Overlapping the Key Lessons of Plot-Based Urbanism and Principles of
      Adaptive Capacity of Urban Form ............................................................................. 157
      4.4.1 Formal (Design) Principles of Adaptive Capacity of Urban Form .............. 161
      4.4.2 Formation and Re-formation (Post-design) Mechanisms of Adaptation:
      Change of Form and Function .................................................................................. 167
  4.5 Concluding Remarks ............................................................................................ 168
5. IMPROVING ADAPTIVE CAPACITY OF URBAN FORM BY DESIGN:
LEARNING FROM CONTEMPORARY DESIGN PRACTICES
IJBURG, AMSTERDAM & MIDDLEHAVEN, MIDDLESBROUGH ......................... 173
  5.1 Ijburg, Amsterdam, The Netherlands .................................................................. 176
      5.1.1 Planning and Design Process ......................................................................... 176
      5.1.2 Evaluation of the Adaptability in Form ......................................................... 183
      5.1.3 Evaluation of the Adaptability in Formation ................................................ 195
5.2 Middlehaven, Middlesbrough, UK .............................................................. 200
5.2.1 Planning and Design Process ................................................................. 201
5.2.2 Evaluation of the Adaptability in Form .................................................. 204
5.2.3 Evaluation of the Adaptability in Formation .......................................... 214
5.3 Concluding Remarks ................................................................................ 221
6. CONCLUSION ............................................................................................. 223
6.1 From Deterministic Place-Making to ‘Responsive Condition-Making’ ...... 225
  6.1.1 Creating Fine-grain Plot Configuration .................................................. 227
  6.1.2 Improving Plot-Street Relationship ...................................................... 228
  6.1.3 Promoting Incompleteness and Reserved Spaces .................................. 229
  6.1.4 Distributing Design Formation Over Various Parties ............................. 230
REFERENCES ............................................................................................... 235
APPENDIX
  A. Interview Questions for the Design Offices Responsible for the Development of IJburg, Amsterdam .............................................................. 251
LIST OF FIGURES

FIGURES

Figure 1.1: Organizational framework of the research………………………………8
Figure 2.1: Brian Castellani’s Map of the Complexity Sciences………………….18
Figure 2.2: Arturo Soria y Mata’s Linear City – Ciudad Lineal………………….28
Figure 2.3: Ebenezer Howard’s Garden City………………………………………28
Figure 2.4: Le Corbusier’s Radiant City – La Ville Radieuse…………………..30
Figure 2.5: Visualization of the simplicity, organized complexity and
disorganized complexity…………………………………………………..33
Figure 2.6: Christopher Alexander’s Diagrams of Semi-Lattice and Tree………35
Figure 3.1: Kinds of organized complexity and organized complexity of cities……51
Figure 3.2: Emergence and self-organization co-operating in a complex system……65
Figure 3.3: Schelling’s Segregation Model………………………………………66
Figure 3.4: Wolfram’s 30th Rule in cellular automata…………………………67
Figure 3.5: Fractal formations: Sierpinski Triangle and h-fractal formation……68
Figure 3.6: Piecemeal growth process of the University of Oregon……………80
Figure 3.7: A series of pattern examples in ‘a pattern language’…………………..81
Figure 3.8: Incremental development of the growing whole for the project area in
San Francisco……………………………………………………………………83
Figure 3.9: Christina Gryboyjanni’s generic architectural types…………………..85
Figure 3.10: Typo-morphological urban design codes in Montreuil, France……87
Figure 3.11: Shape grammar rules for producing urban blocks and diversification
of the generic design outcomes………………………………………………88
Figure 3.12: Bottom-up derivation of the Zaouit Lakhdar Zone in Marrakech
with the application of shape grammars………………………………………89
Figure 3.13: Urban growth simulation with cellular automata……………………91
Figure 3.14: A typical city game: emergent growth process of the model………..93
Figure 3.15: A series of iterations from a city game and observable
emergent order..............................................................................................................93

Figure 4.1: Conceptual shifts in urban planning and design in the context of uncertainty..............................................................................................................103

Figure 4.2: Overlapping attributes of resilience theory and responsiveness/robustness theory......................................................................................................119

Figure 4.3: Adaptive capacity as the synthesis of resilience and flexibility........124

Figure 4.4: Changes in plot configuration of London and Dublin......................131

Figure 4.5: Nested hierarchy starting with plot and forming street block, block and urban pattern respectively.................................................................133

Figure 4.6: A plan extract from 1917 Plan of Amsterdam illustrating different
designers responsible for each street front..........................................................134

Figure 4.7: James Craig’s plan for the Edinburgh – New Town..........................137

Figure 4.8: The aerial view of the New Town, Edinburgh......................................138

Figure 4.9: Transformation of plot configuration and composition in the New Town...............................................................................................................139

Figure 4.10: Emerged design variety in plot sizes, typologies, building frontages and functions ......................................................................................139

Figure 4.11: Rose Street revealing the intricacy of the New Town with diverse building sizes, forms, styles and functions.............................................141

Figure 4.12: The current plot configuration of the New Town...............................141

Figure 4.13: Plan of Barcelona – Eixample by Ildefons Cerda...............................143

Figure 4.14: Cerda’s research on the block typologies of Edinburgh–New Town and New York–Manhattan Island...............................................................144

Figure 4.15: Three different urban block typology offered by Cerda and their various compositions in Barcelona – Eixample..............................................144

Figure 4.16: Two distinctive plot-division plans for two different street blocks in the Eixample.........................................................................................145

Figure 4.17: Emerged design variety (in size and typology) for urban blocks as a result of diversity in plot configuration .........................................................146

Figure 4.18: Evolution of a sample block in Eixample........................................148

Figure 4.19: Today’s Barcelona – Eixample seen from above.............................149

Figure 4.20: Emerged design variety in plot-configurations and
plot-frontages (facades) ..........................................................149
Figure 4.21: Gridiron block-layout of the Alamo Square in San Francisco ..........150
Figure 4.22: (a) the grid structure and an identical urban block composed of
25-varas modules; (b) a typical urban block subdivided into 6 identical
lots; (c) different subdivision examples of lots into individual plots ...............152
Figure 4.23: Alamo Square at the beginning of twentieth century ..................152
Figure 4.24: Gradual change of the plot configuration and building footprints
in Alamo Square from 1899 to 1931, and to 1976 ..................................154
Figure 4.25: Variations in plot configuration in 1931 evolved from relatively
homogeneous distribution of plots in 1899 ........................................154
Figure 4.26: Aerial view of Alamo Square, San Francisco ..........................156
Figure 4.27: Sample section-cut from Alamo Square representing the co-existence
of various urban grains ...............................................................156
Figure 4.28: Aerial view of fine-grain townhouses, Steigereiland, The Netherlands ...............................................................158
Figure 4.29: The joint framework of the adaptive capacity of urban form
through ‘plot-based urbanism’ ..........................................................161
Figure 4.30: Enhanced modularity of the urban space via the subdivision
of the land into many small individual plots ........................................162
Figure 4.31: Illustrative diagram of the notion of ‘spatial capacity’ ..................163
Figure 4.32: Permeability at structural scale ...........................................165
Figure 4.33: Permeability within urban block ...........................................166
Figure 5.1: Aerial view of IJburg Urban Development Project area and its
immediate surroundings ....................................................................174
Figure 5.2: Aerial view of Middlehaven Urban Development Project area
and its immediate surroundings ...........................................................175
Figure 5.3: Pampus City plan developed by Van den Broek and Bakema .......177
Figure 5.4: Palmbout Architecture’s archipelago plan for IJburg ....................177
Figure 5.5: Illustrative masterplan of IJburg 1st phase ...............................179
Figure 5.6: Interviewed design offices and correspondent designers responsible
for different urban blocks in IJburg ...................................................180
Figure 5.7: Aerial view of IJburg – Haveneiland, Amsterdam ......................182
Figure 5.8: Grid-based spatial structure of IJburg Plan
Figure 5.9: Evolution of the proposed grid structure in masterplan and its
capacity of change
Figure 5.10: Uniqueness of each urban block in IJburg
Figure 5.11: Houses (suburb) and apartments (urban) mixed in the
street-facades
Figure 5.12: Formal exteriors (fix) and informal interiors (flexible)
of urban blocks
Figure 5.13: Fine-grain plot-based housing typology in IJburg
Figure 5.14: Various possible urban-grain strategies to shape the interior of the
urban blocks
Figure 5.15: Block-17 and Block-30 in IJburg
Figure 5.16: Block-1 and Block-18 (right) as typical examples of solid
typology in IJburg
Figure 5.17: Variety of the architecture offices responsible for each
individual block/lot in IJburg
Figure 5.18: Aerial view of the project site: Middlehaven
Figure 5.19: Will Alsop’s masterplan
Figure 5.20: Illustrative masterplan of Middlehaven
Figure 5.21: Overlapping character areas in Middlehaven
Figure 5.22: Benchmark heights and maximum heights
Figure 5.23: Plot-subdivision plan in Middlehaven
Figure 5.24: Diverse configurational solutions within standard lots achieved
by subdivision and amalgamation operations
Figure 5.25: Diverse architectural typologies by relying on diverse
plot/lot configurations
Figure 5.26: A sample urban block demonstrating fine-grain composition of
diverse subdivisions for all parties of design and development process
Figure 5.27: Frontage plan
Figure 5.28: Change of spatial composition in Middlehaven
Figure 5.29: Formal and functional change of soft-centred blocks
through incremental adaptations
Figure 5.30: The Urban Pioneers project site and subdivision of blocks……………217
Figure 5.31: Illustration of main design principles………………………………..219
Figure 5.32: The first completed design project in the Urban Pioneers Project……220
Figure 6.1: Responsive condition-making as an interface between deterministic
place-making and uncontrollable self-organization………………………………..226
Figure 6.2: General framework of the synthesized model approach:
‘responsive condition- making’ ……………………………………………………232
LIST OF TABLES

TABLES

Table 4.1: Ten distinguishing properties of wicked problems..........................101
Table 4.2: Contradictory definitions of adaptability related with capacity for
change and remain fit for purpose..............................................................113
Table 4.3: Changeability types related with the notion of flexibility...............122
CHAPTER 1

INTRODUCTION

1.1 Context and Problem Definition

History of science and intellectual thought progressed not in a cumulative manner; instead, by means of distinctive revolutions representing critical shifts and ruptures between different scientific paradigms (Kuhn, 1962) – from conventional approaches of reductionism and determinism to the contemporary perspectives of systems theory and complexity sciences. These critical transitions unavoidably affected the way in which science and scientists approach to the problems of real world; and naturally shaped the general perspective of the public. As parallel to the transitions and paradigmatic shifts in the history of scientific thought, the theory of urbanism has also experienced important cognitive breakthroughs and theoretical transitions in company with various critical reflections emerged during the last century.

In that sense, the end of nineteenth century represents an important turning point in which the first matured theoretical concern about cities and their formation process was constructed with a revolutionary discourse of Modernism. This ideological perspective – assuming that the problems of urban space could be handled by designing cities like machines, planning them at the scale of whole city in a top-down manner, ordering their spatial layout hierarchically via clear geometrical structures and integrating the production of urban space with arising industrial technologies and advances – was a natural output of that era’s dominant scientific perspective, reductionism, which was asserting the idea of reducing a studied phenomenon or a scientific problem into its individual parts and understanding its nature with the sum of these individual parts (i.e. the whole is sum of its parts). This optimist – and to some extent, naive – belief was challenged by the changing, dynamic and complex needs and problems of twentieth century. The reductionist formulation of the urban spaces
as simple, static, predictable and projectable problems and the comprehensive control mechanisms based on the optimistic belief of the predictability of future has given much of its place to new conceptualizations, emerging criticisms and operational planning and design strategies. Within the context of this transition, complexity theory has constituted a transdisciplinary approach affecting not only natural sciences but also other branches of social science like urbanism and architecture.

Adoption of the complexity-based perspective in urbanism has represented a dramatic shift for the conceptualization of cities as totally controllable and predictable designed artefacts. In that sense, Jane Jacobs and Christopher Alexander were hailed as the pioneers of critical approaches conceptualizing cities as ‘complex systems’ which are dynamic, ever-evolving, and showing hard-to-predict behaviours through time – that refers to the anti-reductionist expression of ‘the whole is more than sum of its parts’. By criticizing the simplistic and deterministic nature of modern planning, Jacobs (1961) in her seminal book ‘The Death and Life of Great American Cities’, defined the city as an ‘organized complexity’ which emerges from the collective actions of individuals, evolves by responding to changing circumstances, generates an unexpected diversity and heterogeneity and functioning in a holistic behaviour without the help of a central control mechanism. In addition, Alexander (1965), in his remarkable essay ‘A City is Not a Tree’, criticized the structure of comprehensively planned cities because of their simplistic hierarchical structures resembling trees – by asserting that cities should have a more ‘complex’ structure which is called ‘semi-lattice’. By following these two protagonists’ contribution along with the emerging paradigm of complexity theories, many scholars started to conceptualize cities as complex systems and paved the way for a matured accumulation of knowledge for the field of urban planning and design in the last decades (Allen, 1997; Batty, 2007; De Roo and Silva, 2010; Portugali, 2011; Marshall, 2012). Contrary to the comprehensive planning approaches – emerged from the reductionist perspectives of science – where the urban space was perceived as a predictable, static and linear system; complexity theories portrays a city which is far from-equilibrium, dynamic, ever-evolving and full of uncertainties.
Therefore, within the abovementioned context of complexity theories of cities, it
would not be wrong to assert that any planning and design approach conceptualizing
the city as a finite and static product of a single divine hand, trying to predict its future
state with deterministic projection mechanisms and designing it with a clear image of
optimal form and structure would inescapably fall short to understand the nature of
urban complexity. Uncertainty, unpredictability and instability are the intrinsic and
inherent consequences of complex systems. However, it does not mean that all kind of
planning and design interventions and tools are in vain; instead, it means planning
theory and practice should discover and develop a new form of intervention which is
more responsive to the uncertainties by relying on the derived understandings of
complexity theory.

As adopting the complexity thinking and translating its derived notions and concepts
into its own agenda, the discipline of urban planning and design has developed various
planning and design approaches to address the question of ‘how to operate spatial
planning and design within the mind-challenging condition of complexity’ – such as;
rule based design approaches using patterns, types, codes, generic guidelines and
urban grammars; simulation models and systems including cellular automata, agent-
based models and city games; and, analytical tools to evaluate design solutions and
compare them with acceptable standards by using space syntax, place syntax, route
structure analyses and geographic information systems. However, all of these valuable
approaches remained limited by offering responsive approaches and methodologies
only for the ‘urban planning and design process’; and ignoring the responsiveness of
the ‘urban form’ to some extent. In other words, while these approaches are quite
different from conventional planning and design perspectives and draws a framework
which is responsive to the emerging uncertainties in planning and design process; the
urban spaces designed with these approaches are not different from static, fixed and
optimal end-states. Therefore, within that sense, there is a distinctive theoretical gap
in the complexity theories of cities: ‘responsiveness of the urban form’ to the
emerging uncertainties and unpredictabilities even after its implementation.
The tangible reflections and spatial implications of this theoretical gap can be traced within the urban spaces, as well. In that sense, the steady increase in population concentrated in urban settlements and the pressure of demographic, socio-cultural, economic and most importantly physical transformations bring about a vital need for dealing with the issue of ‘urban growth and change’. Because of the fact that, most of our urban spaces are conceptualized as static end-states having optimum size and form and pre-defined form-function relations; the notions of uncertainty, unpredictability, change, evolution and responsiveness – which are inherited and unavoidable characteristic features of cities as being complex systems – are not essential traits of their nature. As asserted by Sennett (2008),

“the result of over-determination is another paradox, namely that these frozen cities decay much more quickly than urban fabric inherited from the past. As uses change, buildings have to be replaced, since fixed form-function relations make them so difficult to adapt […] The over-specification of form and function makes the modern urban environment a brittle place” (p.3).

The main reason of this vulnerability is designing urban spaces as standardized solutions leading to static, non-progressive and unchangeable physical outcomes by using conventional methodologies that controls and regulate everything beforehand with fixed objectives in an obsessively certain manner. That makes urban spaces fragile against the emerging uncertainties and changing spatial needs; and, decreases its capacity to respond different circumstances in a successful manner. Within the abovementioned context of complexity theories and by relying on both the theoretical gap and its spatial implications on urban spaces, this research would focus on the problem of formal and functional adaptation and responsiveness of urban spaces to the changing spatial needs and emerging uncertainties in time.

1.2 Aim of the Study and Research Questions

The aim of this research is to provide an enhanced understanding about complexity theories of cities; to conceptualize uncertainties as inherent and unavoidable
characteristic features of cities rather than seeing them as potential risks and failures; to suggest alternative design approaches to improve adaptive capacity of urban form for emerging uncertainties and changing needs by design. To that end, implications of complexity theory will be translated into the language of urban planning and design, possible achievements and contributions of this approach will be revisited, and alternative ways of dealing with the notions of uncertainty, unpredictability and adaptability/responsiveness would be quested to create an extensive theoretical basis on which the related discourse of adaptability and responsiveness would be constructed. After creating this theoretical perspective and defining its complexity-based contextual statements, the research would focus on the issue of ‘how to improve adaptive capacity of urban form by operating design within the context of urban complexity’.

This broad research objective would be fulfilled within the framework of two specific research questions. The first research question – ‘what are the morphological and programmatic characteristics of an adaptable urban form’ – would be investigated to identify necessary physical pre-conditions and structural qualities by relying on theoretical discussions and historical case studies. The second research question – ‘what kind of design approach enables to create defined morphological and programmatic characteristics of adaptability by avoiding from rigidity and over-determination’ – would be examined to develop a more responsive urban planning and design approach allowing adaptation to emerge, develop and continue through time – even after the implementation of design. Therefore, rather than dreaming about a ‘good city form’ or an ‘optimal’ urban form and structure intending to last centuries and resisting to respond uncertainties and spatial changes, this research entails the idea of ensuring a responsive design structure and framework which enables urban space to adapt changing circumstances both formally and programatically.

1.3 Methodology of the Research

This explorative research would be conducted by integrating comprehensive literature review of complexity theories in urbanism, and examining relevant historical and
contemporary case studies. In order to create a solid theoretical framework on which the general discourse of the research would be constructed, a retrospective view would be developed to understand the problem’s history by focusing on early protagonists of the critical approaches to conventional urbanism after 1960s – such as Jacobs (1961), Alexander (1965), Habraken (1998) and so on. Following this retrospective perspective, contemporary urban design theory would be reviewed within the context of complexity theory’s literature to re-interpret the recent challenges of urban spaces by taking the vital issues of time, change, uncertainty and adaptation into consideration.

After creating the theoretical background and contextual framework by an extensive literature review to provide an enhanced understanding about complexity theories of cities, case study research would be used to identify necessary physical pre-conditions and structural qualities of the adaptable and responsive urban spaces. Within the context of first research question, overlapping the key lessons of ‘adaptability’ derived from literature review; and, morphological and programmatic characteristics of historical case studies demonstrating high level of responsiveness would provide tangible understandings for the ‘adaptive capacity of urban form’. Within the context of second research question complementing the former one, more contemporary case studies would be revisited to understand what kind of design approaches and development strategies enable them to achieve morphological and programmatic characteristics of adaptability. Moreover, in order to develop an enhanced understanding about these special cases and obtain inside information about their design approach, a fair number of interviews would be conducted with wide range of authorities responsible for the design and development process of these urban spaces – such as master-planners and project directors, representatives of international architectural offices, architects and designers.

1.4 Structure of the Research

This study is organized in six parts (Figure 1.1). The current chapter, Chapter 1, provides an introductory outline of the study including contextual statements, problem
definitions, objectives of the study, research questions and methodologies. Following this part, Chapter 2 introduces complexity theories and complex systems by tracing the revolutionary shifts and ruptures in the history of science. As similar to the paradigmatic shifts in the history of scientific thought, paradigm shifts in urbanism from deterministic approaches to the critical perspectives and complexity-based theoretical frameworks are also examined in this part. In Chapter 3, the notions derived from the complexity theory are translated into the urban planning and design agenda and a broad theoretical framework is constructed for the notion of ‘urban complexity’. This chapter demonstrates the contributions of complexity theory into urban planning and design; and briefly reviews the contemporary design approaches addressing the question of how to operate spatial planning and design in the revealed condition of urban complexity. Following these theoretical chapters offering a broad contextual framework, Chapter 4 conceptualizes ‘uncertainties’ as inherent characteristics features of complex systems of cities and discover their conceptual implications for urbanism. As the core part of the research, this chapter presents ‘adaptability’ and ‘responsiveness’ as the necessary solutions to cope with emerging uncertainties in urban spaces; draws a general framework for the notion of ‘adaptive capacity of urban form’ by identifying its characteristic features, spatial components and design principles; and, refers to the key principles of adaptive urban design approach. In the second part of this chapter, three historical case studies (Edinburgh, New Town; Barcelona, Eixample; San Francisco, Alamo Square) which could be named as plot-based urbanism examples is investigated to understand the role of ‘plot’ and ‘fine-grain spatial configuration’ in improving adaptive capacity of urban spaces. Thus, derived key lessons of examined case studies and pre-defined characteristic features of ‘adaptability’ or ‘adaptive capacity’ is overlapped to develop a better understanding about the morphological and programmatic characteristics of an adaptable urban form. In Chapter 5, two different contemporary urban design and development projects (IJburg, Amsterdam and Middlehaven, Middlesbrough) are examined as case studies and qualitative interviews are conducted with responsible design parties. The extracted knowledge from the synthesis of these case studies complements the formal principles and characteristics features of an adaptable urban space – discussed in Chapter 4 – and enable to draw an operational framework to
Figure 1.1: Organizational framework of the research
improve adaptive capacity of urban form by design. Finally, Chapter 6, offers a new model approach named as ‘responsive condition-making’ in order to achieve morphological and programmatic pre-conditions of an adaptable urban space by moving away from over-deterministic, comprehensive and large scale place-making approaches. It also presents concluding remarks and critical evaluations of the research by briefly expressing the implications drawn from the theoretical discussions and examined case studies.
CHAPTER 2

EMERGING PARADIGM OF COMPLEXITY SCIENCES

2.1 Paradigm Shifts in Scientific Approaches: From Scientific Reductionism to The Theory of Complexity

Throughout the history of intellectual thought, dominant philosophies related with the different branches of science and its structure have experienced revolutionary shifts and ruptures. These changes critically affected the way in which science and scientists approach to the problems of real world; and naturally shaped the general perspective of the public. It would not be wrong to argue that these critical shifts had important impacts on not only the core scientific domain of mathematics and algebra but also a wide spectrum from natural sciences (physics, chemistry, biology etc.) to the social sciences (anthropology, sociology, economics etc.).

2.1.1 Reductionism

Until the beginning of the twentieth century, most dominant way of thinking has been Reductionism. Descartes, as the most prominent figure and the earliest proponent of reductionist approach, has explained his fundamental method thus: “to divide all the difficulties under examination into as many parts as possible, and as many as were required to solve them in the best way” and “to conduct my thoughts in a given order, beginning with the simplest and most easily understood objects, and gradually ascending, as it were step by step, to the knowledge of the most complex.” (1637 p.17).

In more general terms, reductionism is about the idea of reducing a phenomenon or a complex systematic relationship into its individual parts and understanding its nature with the sum of these individual parts. Intrinsically, reductionism accepts the studied problems as if they are stable and in equilibrium throughout the time; and have very linear and predictable trajectories. In fact, it was really uncommon and hard to reject
and challenge this settled and conventional perspective. According to Hofstadter (1979), “Reductionism is the most natural thing in the world to grasp. It’s simply the belief that a whole can be understood completely if you understand its parts, and the nature of their sum. No one in her left brain could reject reductionism” (p.312). Although reductionism has dominated the scientific studies through a long time, some revolutionary discoveries prepared a background for constructive criticisms and paved the way for the crucial concepts of dynamics, non-linearity, non-equilibrium and chaos.

2.1.2 Dynamical Systems Theory

Dynamical Systems Theory or Dynamics is mainly interested in the notion of ‘change’ and it attempts to describe and predict the systems which are emerging from the collective act of individual components at the microscopic level and showing very complex changing (dynamic) behavior at the macroscopic level (Mitchell, 2009). As the most leading scientist in the field of dynamics, Isaac Newton’s fundamental principles drew a picture of a ‘clockwork universe’, which has its own simple rules to operate. Actually, Newton’s discovery was a dramatic moment for man’s scientific act because of the fact that it made the whole intellectual community to believe the comprehensibility and predictability of the universe based upon these rules. Even if this overarching scientific theory’s main interest was about the concepts such as dynamics, motion and change; dynamical system theory has continued to treat the problems of scientific domain as if they are in equilibrium through the dynamic flow of time. In addition to this, as similar to scientific reductionism, dynamical systems theory was a centralized and top-down scientific perspective which tends to break down the studied system or phenomenon into its sub-components or sub-systems to comprehend and predict its nature.

2.1.3 From Top Down to Bottom Up Perspectives

According to Batty and Marshall (2012), it was not Galileo or even Newton but Darwin with his revolutionary arguments about the theory of evolution in 1800s. Darwin has
triggered a more decentralized and bottom-up perspective against the long years of hegemony of deterministic and reductionist scientific approaches; and provoked novel insights especially for the life sciences: “the notion that life must be generated from the bottom up without the need for a divine hand” (Batty & Marshall, 2012, p.22). The shift from centralized perspectives to the ones mostly bottom up and decentralized was observed not only in the field of natural sciences but also across a wide spectrum of intellectual thought. Adam Smith’s contribution to the social science literature with his book The Wealth of Nations (1776) arguing that the social and economic activities is organized and held together via the ‘invisible hand’ is remarkable in that sense. The concept of invisible hand refers critically to the idea of self-organization from the bottom up instead of a centralized control from the top down.

If we have a look at the nineteenth century and before, the idea of ‘science and its structural rules can solve all the real-world problems’ can be easily grasped. Batty (2012) reflects upon this naïve state of believing that the world was truly explicable and predictable in all terms by stating that: “There was a deep-seated notion that the world was fundamentally explicable, [...] there was a widespread feeling amongst scientists that we were well on the road towards complete understanding” (p.6). These settled ideas have been questioned and challenged with the discoveries of the concepts of uncertainty, unpredictability and non-linearity in the following years.

2.1.4 Emerging Ideas of Unpredictability, Non-linearity and Chaotic Systems

At the beginning of the twentieth century, two crucial scientific discoveries led to both disturbances and excitements among the leading scientists and intellectuals. The discovery of Heisenberg’s ‘uncertainty principle’ which states that the exact values of the position and momentum of a particle cannot be measured at the same time; and the hypothesis of Maxwell, which is “influences whose physical magnitude is too small to be taken account of by a finite being, (but which) may produce results of the highest importance” prepared a ground for the criticisms of top-down and centralized...
perspectives which are mostly based upon the deterministic ideas of certainty, linearity and predictability. According to Mitchell (2009), uncertainty which is neglected at the first place can lead to huge errors and new uncertainties in the final outcome or system. This key principle is known as ‘sensitive dependence on initial conditions’ and summarizes the intrinsic nature of chaotic systems: non-linearity and unpredictability.

Mitchell (2009) draws attention to the controversy between reductionism and non-linearity by stating that: “Linearity is a reductionist’s dream, and non-linearity can sometimes be a reductionist’s nightmare” (p.23); because in non-linear systems the macro behavior of the whole cannot be understood by just understanding the micro components individually. Although reductionism has served well and contributed to scientific thinking so many years, at the beginning of twentieth century, it was explicit that reductionism has lost its function against the complex, dynamic, non-linear and unpredictable problems of the contemporary era such as: complex adaptive nature of living species, growth of the communication networks and complex computer systems, ever-changing and dynamic economic, political and social behavior of society and so on. The anti-reductionist expression of “the whole is more than the sum of its parts” came to the scientific thought agenda and led to the far-reaching and influential outcomes for the studies of chaotic systems, network theory, systems theory and most importantly complexity theory.

2.1.5 Systems Theory

According to Senge (1990), “System thinking is a discipline for seeing wholes. It is a framework for seeing interrelationships rather than things, for seeing patterns of change rather than static snapshots” (p.68). It was introduced in 1930s by biologist Ludwig von Bertalanffy against the scientific reductionism with the radical claim of classical scientific approaches using deterministic and reductionist strategies are insufficient to comprehend the complexity of certain systems. These systems are conceptually open systems and they interact both with each other and with their surroundings in a continuous process of adaptation and evolution to achieve new states ‘equilibrium’.
From perspective of systems theory, this process is so complex that it is not possible to understand the essence of the whole by simply decomposing the system into its individual parts. Therefore, it would be appropriate to state that “the whole is more than the sum of its parts” (Simon, 1962, p.468). Within this context, systems theory represents a mind-shift from the components to the interrelationships between them. However, in spite of its focus on interrelationships between components, according to Batty and Marshall (2012), from the perspective of systems theory, ‘equilibrium’ was viewed as the usual state of system and the notion of ‘hierarchy’ in a centralized and top down manner was one of the most important features. For this reason, in terms of the most scientific disciplines which was conceptualized and studied in a top-down manner in 1900s, “the systems approach did not represent a radical departure. [...] the systems approach represented one of the last gasps of a model established in the late nineteenth century” (Batty & Marshall, 2012, p.28).

When the systems theory came up, the idea that equilibrium is an impossible illusion to reach was not in the context of scientific and intellectual thought. For this reason, even if it did not represent a radical departure from the idea of equilibrium in a centralized or top-down perspective, system thinking opened up new discussions and led to the new and revolutionary insights for the following studies of cybernetics, system dynamics, and eventually the complexity theory for the recent problems of our age: uncertainty, disequilibrium, non-linearity and dynamism.

2.1.6 Critical Reflections: Is A New Cognitive Breakthrough Possible?

From the beginning of the man’s civilization to the Renaissance and to the contemporary scientific thought of 20th century, philosophy of science has experienced radical and dramatic shifts in its perspective to the problems and realities of the world. These transformations of the thinking mechanisms were accompanied by the discoveries of new conceptualizations, revolutionary principles, challenging question marks and certain gaps in the branches of scientific theories and paradigms.
With a quick glance, it would be easy to see that scientific reductionism has dominated the area of intellectual though for many years with its approach to the ‘whole’ – which is stable - by understanding its components through the decomposition of the system in a top-down manner. Newton’s Dynamics challenged the idea of stable and fixed system in Reductionism by developing a new perspective depended on the concept of ‘change’. It drew an image of a ‘clockwork universe’ changing its state of being to reach new equilibrium states. Even if dynamical system theory has seen the universe through the lens of top-down or centralized approaches aiming the equilibrium, it has paved the way for the new conceptual understandings about the issues of change, dynamism and motion.

At the 19th century, Darwin’s Theory of Evolution has prepared a ground for a radical shift from top-down perspectives to the ones which are generative and bottom up. Following this crucial mind-shift, the discoveries of Heisenberg’s uncertainty principle, Maxwell’s sensitive dependence of initial conditions and the concepts of non-linearity, unpredictability and chaos affected the conventional idea of ‘whole as the sum of its parts’ and transformed it into the catchphrase of ‘the whole is more (or greater, or different) than sum of its parts’. At the mid of the 20th century, the systems theory has transformed the component based perspective to the whole into the perspective of relationships, but still with a top-down (centralized) perspective in a hierarchical manner.

At this critical recent point, there is a strong need for an overarching and comprehensive theory referring to the inevitable shift of viewing, understanding and treating the contemporary problems of our age as being full of uncertainties, continually out-of-equilibrium and showing non-linear trajectories with the dynamic and ever-changing structure from the bottom-up. In that sense, ‘complexity theories’ - as intrinsically related with the interrelationship-based approach of systems theory; but more importantly and contrarily in a bottom up and generative manner – seems to offer seminal insights for the development of scientific and intellectual thought further.
2.2 The Origins of Complexity Theories and Complex Systems

By the mid-twentieth century, after the critical shifts in the history of scientific thought, it was inevitably realized that the contemporary scientific approach cannot be directed by any single discipline. Because of the well accepted definition of the ‘complex’ and ‘dynamic’ problems of our age among the leading scientists and intellectuals, there was a strong need of an interdisciplinary approach. Actually, the years between 1940 and 1960 has witnessed some important attempts including interdisciplinary point of views and referring to the phenomena of ‘complexity’: systems science, cybernetics \(^2\) and eventually complex systems theory.

By taking its roots from the systems theory and cybernetics, complexity theory has emerged as a new way to understand nature – firstly in biological and physical sciences and then translated into the context of social sciences (Figure 2.1). Complexity theory has a deep-seated scientific background with the contributions of various scientific perspectives and disciplines, and according to Crawford (2016), “it is a developing field covering a wide range of natural, social and economic phenomena (e.g., rainforests, markets, cities, languages, the internet)” (p.2). Because of its intricate relationship with some other disciplines including both social and natural scientific point of views and the strong need for a comprehensive synthesis of complexity, in 1984, a group of interdisciplinary scientists and mathematicians founded the Santa Fe Institute, in Mexico to discuss the ‘emerging synthesis in science’ (Mitchell, 2009). Santa Fe Institute developed a body of knowledge representing ‘a new paradigm shift’ to understand the present reality of complexity. In addition to the precious efforts of Santa Fe Institute, Simon’s (1962) remarkable paper ‘The Architecture of Complexity’, Philip Anderson’s (1972) contribution with the article entitled ‘More is Different’, Prigogine’s (1980, 1984) studies on the issues of self-organization, and the

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2 Cybernetics is a scientific perspective dealing with mainly the issue of ‘relationship’ between natural and artificial systems. It was firstly conceptualized by Norbert Wiener and developed further with the contributions of W. Ross Ashby (cybernetics of mind) and Claude Shannon (information theory). Weiner (1948) defines cybernetics as ‘the scientific study of control and communication in the animal and the machine’. (For more, see: Weiner, N. (1948), Cybernetics, or Control and Communication in the Animal and the Machine. Cambridge: MIT Press)
Figure 2.1: Brian Castellani’s Map of the Complexity Sciences Showing the History of Its Development (Theory Culture Society Website, 2018)
efforts by Holland (1975, 1992) to create a unified theory of complexity was influential, as well.

2.2.1 Definition of Complexity and the Complex Systems

Melanie Mitchell, at the very beginning of ‘Complexity: A guided tour (2009)’, drew a speculative image of the Amazon rain forest which includes half a million ants marching through the forest: “No one is in charge of this army; it has no commander. Each individual ant is nearly blind and minimally intelligent, but the marching ants together create a coherent fan-shaped mass of movement that swarms over, kills, and efficiently devours all prey in its path” (p.3). Actually, this brilliant coherency between ‘minimally intelligent’ ants represents the concept of ‘collective intelligence’ which is a mysterious phenomenon for the systems that we describe as ‘complex’. Etymologically, complex come from the Latin word, ‘complexus’ which means variously surrounding, encompassing, twisted together or entwined. It is basically defined as “involving a lot of different but related parts” (Cambridge Online Dictionary). ‘Complexity’, as derived from the word complex, “is subjective measure of the difficulty in describing and modelling a system (thing or process), and thus being able to predict its behaviour” (Northrop, 2011, p.2). Beyond of that, the word complexity addresses to a transdisciplinary scientific field, and it has various definitions from different scientific point of views. According to Complexity Academy (2015), complexity is defined as a function of;

i. the number of individual components in a system,
ii. the amount of connectivity or interconnection within a system,
iii. the degree of the ability of individual components to adapt over time, and
iv. the degree of variety or diversity between the individual components of a system.

Although there has been vast amount of efforts to define and examine the ‘complexity’, there is an inevitable need to distinguish it from the terms which are
quite related but surely different, such as: complicatedness, arbitrariness, chaos, randomness and so on.

First of all, complex does not mean ‘complicated’. According to Holland (2014), even if the boundaries between these two words are fuzzy, another term ‘emergence’ distinguishes the word complex from the word complicated. In that sense, while complex is meaning an aggregate whole showing a different characteristic from the sum of the parts, complicated means just an accumulation of many different components. Therefore, it would be fair to argue that including many different components or parts in a whole (like it is in the case of complicated) is not enough to be complex: complex is more than the amount of the interconnected parts or components. While Bellut (2008) emphasizes the difference between these two terms by saying that: “Complicated can be profitably reduced and simplified – but the complex, in contrast, cannot be simplified with impunity” (p.111); Baofu (2007) states that: “a complex structure uses interwoven components that introduce mutual dependencies and produce more than a sum of the parts; on the other hand, a complicated structure is one that is folded with hidden facets and stuffed into a smaller space” (p.4).

Secondly, complexity does not necessarily include ‘randomness’. Randomness is a term that is used to refer insufficient amount of recognizable ‘purpose’ and ‘pattern’. According to Terzidis (2008), complex phenomenon includes irregularity in itself and it is difficult to be described. However, randomness represents state of maximum complexity. “If it is so complex that the information it contains cannot be compressed at all, we say that it is random” (p.80). Therefore, complexity can be positioned somewhere between regularity and irregularity contrary to randomness’ being closer to irregularity.

Thirdly, although complexity shares the principles of uncertainty and non-linearity of the ‘chaos’, according to Simon (1962) complex systems have structure which is not

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3 Holland (2014) describes the ‘emergence’ by the common phrase of “the action of the whole is more than the sum of the actions of the parts” (p.3).
one of the features of chaos. Therefore, complex systems are at the edge of chaos (Langton, 1990), but they are not chaotic at all. According to Sengupta (2006), adaptive behaviour in complexity is the most considerable difference between chaos and complexity. While complex systems tend to transform their whole state of being to adapt environmental changes, chaotic systems do not show any adaptive or evolutionary mechanism.

Within the context of above discussion – what is complexity and what is not at all – complexity represents a whole including many components linked through a set of interconnections and a structure which shows an adaptive and emergent behaviour. Thus, the complex systems would be described basically as the systems in which “large numbers of relatively simple entities organize themselves, without the benefit of any central controller, into a collective whole that creates patterns, uses information, and, in some cases, evolves and learns” (Mitchell, 2009, p.4). They are also information processing systems with their ability to store, process and eventually change the knowledge (Sengupta, 2006). Therefore, for complex systems ‘the whole is more (and different) than the sum of its parts’; and in that sense, despite being human creation in some cases, it is really hard to comprehend them.

There are various examples of natural, physical or social systems showing the common features of complexity and complex systems in itself: insect colonies, the brain, immune system, economies, the internet and even cities that we live in and so on. An ant colony – consisting of millions of individually non-intelligent ants but representing one of the most organized structure in nature – provide a good example for complex systems. The brain’s large-scale activities of consciousness, feeling, perception and intelligence is the result of complex interaction of simple and non-intelligent neurons. Economies - in which the interaction between individual components of people and companies leads to unpredictable and dynamic conditions for the market as a whole -

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4 Simon (1962) defines a complex system by saying that “Roughly, by a complex system I mean one made up of a large number of parts that interact in a non-simple way. In such systems, the whole is more than the sum of its parts, not in an ultimate, metaphysical sense, but in the important pragmatic sense [...]”. (For more, see: Simon, H. (1962), Architecture of Complexity, Proceedings of the American Philosophical Society, Vol. 106, No. 6., pp. 467-482).
are the most referred complex systems in the field of social science. As a self-organized system, the World Wide Web is composed of individual simple tasks of users without a central control; it grows, transforms and adapts itself to the new conditions and represents a complex systematic structure intrinsically (Mitchell, 2009). Although these diverse natural, physical and social systems are actually examples of transdisciplinary scientific studies and different from each other, they have so many common characteristics addressing to the general features of complex systems.

2.2.2 Common Characteristics of Complex Systems

Because of the fact that complexity and complex systems are associated with different fields of scientific studies, they are conceptualized variously with different perspectives (Waldrop, 1992; Simon, 1962; Holland, 1992; Baofu, 2007; Northrop, 2011; Sengupta, 2006; Colander and Kupers, 2014; Cowan, 1994; Prigogine, 1980; Mitchell, 2009). In that sense, although their emphasized characteristics vary from one discipline to another, a concise framework can be drawn for common features of complex systems. These common features can be grouped like: characteristics related with system structure, system organization and system outcomes.

*Network Based Interactional Structure*

Complex systems are composed of collective actions of individual components which are bounded each other with simple interactions. According to Corning (1998), these two attributes are essential for the complexity: having vast amount of parts or components and naturally many interactions or relationships between these parts. Therefore, Johnson (1997) asserts the importance of the ‘network’ as integral part of the complex systems. This network based structure represents a kind of order from the level of components to the sub-systematic interactions and to the systems’ itself.

Simon (1962), in his remarkable paper of ‘The Architecture of Complexity’, emphasizes the ‘hierarchy’ as an important characteristic for complexity: “the
complex system being composed of subsystems that, in turn, have their own subsystems, and so on” (p.468). However, complex systems are not simply decomposable hierarchical systems and Simon (1962) describes them as “nearly decomposable” by warning the reader about the trap of reductionism. Within this network based and nearly decomposable hierarchical structure, complex systems are the interactional organizations operating between various levels and scales with the combination of “top-down” and “bottom-up” effects.

Rule Based Self Organization

Complex systems process and produce the information self organizationally - without any central control by following simple rules defining the interactions between individual components. Sengupta (2006) emphasizes the “recursive and interactive dynamics” as the most intriguing property for the organization of complex systems: “Interactive dynamics can occur at any given hierarchical level (and across levels); they are informal, unplanned and uncoordinated by positional authority. This perspective de-emphasizes the centrality of authority and emphasizes instead the core importance of effective network dynamics” (p.251). Simple interactional rules and the continuous feedbacks between components across the various levels refer to the concept of ‘path-dependency’ (Crawford, 2016; Holland, 2014) make the self-organizational structure of complex systems possible.

Adaptation Through Evolutionary Process

Complex systems change and transform their behaviour in order to enhance their ability of survival; in other words, they adapt to internal and external changes through a continuous evolutionary process (Mitchell, 2009). Complex systems learn from the feedbacks between components, increase their experiences through path-

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5 “It means that interactions among elements belonging to the same parts are much more than interactions among elements belonging to different parts” (Simon, 1962). Different from fully decomposable systems, complex systems have cross-cutting sections or overlaps between components in different sub-systems.
dependency, assess the new situations and evolve into different structures self organizationally with the hope of an improved performance. According to Gandolfi (1999), complex systems which naturally show adaptive behaviour refer to a kind of ‘open system’ including organized and dynamic network of entities.

**Emergent Behaviours and Unpredictability**

The behaviours and the outcomes of complex systems are not fully predictable because of the number of components and relationships, adaptive behaviours and non-linearities. According to Marshall (2009), contrary to the systems in equilibrium, complex systems are never in equilibrium; instead, they are dynamic, constantly changes their behaviour, and for this reason; full of uncertainties and unpredictable. Characteristic of being unpredictable arises from the combined effects of interactions – which is emergence. As Holland (2014) stated that small changes in initial conditions would produce larger outcomes in complex systems. In other words, the whole (complex system) is more – or different – than sum of its parts (individual components). Therefore, complex systems exhibit emergent and hard-to-predict behaviours full of surprise. From this point on, it would be appropriate to define the complex systems generally. Complex systems are basically defined as the **systems involving many components interacting with each other by using the simple rules and generating emergent collective behaviour through the evolutionary processes of self-organization without a central control.**

Study of complexity and complex systems is an increasingly important approach not only to natural and physical sciences but also to social sciences and many other disciplines. According to Dawkins (1986), the world in which we live is dominated by the ‘creative designs’ of engineering and art works. Therefore, it is really hard to experience ‘a leap of imagination’ from reductionism to the idea of complexity. As a kind of overarching approach to all fields of scientific and intellectual thought, the efforts to understand and develop the theory of complexity would guarantee this promising mind-shift.
Urban planning and design as standing just at the edge of this ‘leap of imagination’, is likely to be developed further with the critical questions and quests of complexity theory. As parallel to the history of scientific and intellectual thought, history of urbanism and related studies with this discipline have experienced critical paradigm shifts and it seems that the more is on the way through the sciences of complexity. It would not be wrong for the disciplines of urban planning and design to argue that “a revolution in thinking was under way, that can be best understood by opposing it into the dominant world view, by contrasting the postmodern sciences of complexity with the Modern sciences of simplicity”\(^6\). Therefore, mapping the history of urbanism with its paradigm shifts and challenging the settled core of the discipline with the insights gained from the theory of complexity would be strongly influential.

2.3 Paradigm Shifts in Urbanism: From Deterministic Approaches to The Complexity-Based Perspectives

The deep-seated and longstanding history of urbanism includes a wide range of theoretical perspectives varying from the classical formalism to the Modernism; and from the organic approaches to the perspectives developed with the emerging paradigm of complexity theories. As similar to the transformations and paradigmatic shifts in the history of scientific thought, the theory of urbanism has also undergone important mind-shifts and theoretical transformations in company with various critical reflections during the past century. According to Batty (2005), while our perspective to the problems of urban space has been transformed from top-down to bottom-up, the conception of the urban spaces has changed from ‘a system which is fully predictable’ to the ‘one which is full of uncertainties’. These changes – which are parallel to the ones in contemporary science- has inevitably required the new approaches and fresh outlooks for the discipline of urbanism. After the mid-twentieth century, as parallel to the conceptual, theoretical and technological developments, urban theorists have turned to the contemporary science of complexity in order to reinterpret and re-

conceptualize the urban space by adapting to the changing needs and transformations of cities.

Adoption of the complexity-based perspective in urbanism has represented a dramatic shift for the conceptualization of cities as totally controllable and predictable designed artefacts. Within this new perspective, cities have been defined as “complex systems” which are dynamic, ever-changing and showing hard-to-predict behaviours through the time. After embracing the notion of complexity, theory of urbanism has started to develop different fields of studies to become wiser about dealing with the dynamics of cities: self-organization and emergence (Portugali, 1999), simulating emergent formations and complexity (Batty, 2005), morphological coherence (Salingaros, 2000), complexity and evolution (Marshall, 2009).

Theory of complexity and its implications on urban planning and design has transformed our design attitudes and interventions. In that sense, before understanding the notion of complexity in the context of urban planning and design, mapping the contemporary paradigm shifts from the deterministic approaches to that of uncertainty in urbanism would be helpful to understand the general perspective of complexity theories.

2.3.1 Deterministic Approaches in Urban Planning and Design

Although cities have been one of the major interest for human civilization starting from the ancient times, as stated by Batty and Marshall (2012) it was the late nineteenth century when the theoretical concern for the cities started to emerge. According to the protagonists of the urban planning and design theory, cities’ way of growing in a disordered structure was the main problem and it should be managed and solved by top-down interventions. As one of these pioneers, Arturo Soria y Mata (1892) emphasized even the need of an ‘architect’ for a city as a divine hand like an ‘architect for the universe’.

Especially with the rise of Industrial Revolution and its externalities related with urban
space, the need of control over the spontaneous, disordered and unprecedented urban formations increased immensely. Architects and urban planners tried to organize urban structures by using comprehensive ‘blueprints’ or utopian projects having strict and dominant geometries (Francoise, 1969). The idea of rational comprehensive planning, the optimist beliefs in long-term predictability and projection of physical and social systems in cities and the role of planners and designers as technical experts resulted in that the deterministic models and approaches dominated all the theoretical and practical fields of planning and design until the mid-twentieth century.

**Urban utopias** can be regarded as the first deterministic models pursuing the idealized physical, social and economic structures for urban spaces. The question of ‘what is the ideal city for the twentieth century’ is tried to be answered by utopians like Arturo Soria y Mata, Ebenezer Howard, Tony Garnier, Le Corbusier and many others.

Arturo Soria y Mata’s proposal of a linear city – *Ciudad Lineal* – in 1892 was the first example of urban ordering with a street-grid structure around a major transportation spine (Figure 2.2). According to him, a whole city or even a region should be planned or designed like a building with a centralized perspective of a single ‘architect’. In 1898, Ebenezer Howard’s idea of *Garden City* emerged as a utopia of self-sufficient cities in the countryside of London. According to Marshall (2009), familiar modern urbanism features of land use zoning, civic functions at the centre, industry at the periphery and housing and retail facilities at the intermediate zones were observed in the total design scheme of garden cities (Figure 2.3). At the very beginning of twentieth century, Tony Garnier developed his ideal city model of an industrial city – *La Cite Industrielle* – with the revolutionary features of functional separation for living, working and social life; physical separation of pedestrian and vehicle routes; and using concrete buildings for all uses of urban space. All of these utopian models could be seen as precedents to the deterministic and centralized urban planning and design perspectives with their desire of controlling the whole structure by using strict geometrical layouts.

Following these movements and idealized models of urban spaces, a revolutionary
discourse of architecture and urbanism has emerged: **Modernism.** This ideological perspective has assumed that the problems of urban space could be handled by designing cities like machines, planning them at the scale of the whole city in a top-down or centralized manner, ordering their structures hierarchically via clear geometries and integrating the production of urban space with new industrial technologies and advances.

**Figure 2.2:** Arturo Soria y Mata’s Linear City – *Ciudad Lineal*, 1982 (Wikipedia, 2018)

**Figure 2.3:** Ebenezer Howard’s Garden City representing one section of the town, 1902 (Cornell University Library – Urban Planning Website, 2018)
Following these movements and idealized models of urban spaces, a revolutionary discourse of architecture and urbanism has emerged: **Modernism**. This ideological perspective has assumed that the problems of urban space could be handled by designing cities like machines, planning them at the scale of the whole city in a top-down or centralized manner, ordering their structures hierarchically via clear geometries and integrating the production of urban space with new industrial technologies and advances. By criticizing the spontaneous developments of cities, Modernism has inspired from the totally controllable design schemes and layouts of early utopians and developed new ‘grand plans’ to recover the industrial cities of 19th century (Figure 2.4).

According to Marshall (2009), “*Le Corbusier combined the earlier pioneers’ ideas of linearity, extensibility, modern transport, regularity, rationality, zoning, and modern transport and construction technologies, and added in novel forms such as tower blocks on pilotis, grade separated cloverleaf intersections, interior streets and autoports*” (p.36). The principles of modernism in architecture and urbanism has been identified gradually with a series of international meetings – International Congresses of Modern Architecture (CIAM). Basically, the four functional components of urban space – dwelling, working, transportation and recreation – were considered as vital and necessary for an ideal modern city in a totally functionalist approach.

In spite of its explicitly dominant functionalist approach and emphasis on the physical features more than the economic and social ones, Modernism defines a revolutionary ideology which represents more than just building clearly ordered concrete cities. According to Marshall (2009), this intellectual formation originates from the ideals of the Renaissance which can be date back to ancient Greece as well; and, “*in its broadest interpretation, Modernism can be regarded as a belief in the possibility of progress*

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7 Le Corbusier (1925) criticized the traditional urban patterns and their ‘disordered’ structures by defining them as “path of the pack-donkey”: “The Pack-Donkey’s Way has been made into a religion. The movement arose in Germany as a result of the book by Camillo Sitte on town-planning, a most willful piece of work; a glorification of the curved line and a specious demonstration of its unrivalled beauties” (p.8).
Figure 2.4: Le Corbusier’s Radiant City – La Ville Radieuse, 1935 (ArchDaily Website, 2018)
through rational action” (pp.32-33). This optimist – and to some extent, naïve – belief was challenged by the changing, dynamic and complex needs and problems of 20th century. The formulation of the urban spaces as simple, static, predictable and projectable problem has given much of its place to new conceptualizations along with harsh criticisms. Shortly after 1940s, various critical approaches were observed against the deterministic and reductionist nature of early utopian idealizations and Modernist design proposals developed with highly strict geometries and top-down perspectives.

2.3.2 Critical Perspectives to the Deterministic Approaches Through the Lens of Complexity

In spite of its successes in providing modern dwelling and working units and transportation systems, Modernist urban planning could not have been sustained itself progressively against the various criticisms. The first criticisms were about that ideology of Modernism had focused physical attributes of urban space too much – with the concerns of functionalism – and ignored the relationship between urban space and human behaviour. Within this perspective, after 1950s, a group of intellectual architects and urban planners – Situationists including Guy Debord, Constant Nieuwenhuys and Gil Wolman – started to ask the question of “what does Mr. Le Corbusier know about human needs?” From this point of view, in addition to the concerns of human behaviour, Situationists opposed to the deterministic approach of Modernism producing static and homogenous urban scapes by stating that: “We believe that all static, unchanging elements must be avoided and that the variable or changing character of architectural elements is the precondition for a flexible relationship with the events that will take place within them” (Nieuwenhuys, 1996, p.63). Although the Situationists had developed very influential and critical ideas about the terms – such as flexibility, openness, heterogeneity and dynamism – which have responses from the perspective of complexity, their urbanism approach stood much closer to ‘urban chaos’ contrary to ‘urban complexity’ (Ayaroglu, 2007).

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At the mid-nineteenth century, a comprehensive theory about how cities have been organized or structured in an evolutionary manner was missing. According to Batty (2005), all the settled theories of urbanism was attempting to describe the observed spatial structure of cities as long standing and in equilibrium. Immediately after the developments of alternative approaches in natural, physical and social sciences studying the concepts of non-equilibrium, dynamism and unpredictability, cities started to be conceptualized as systems far-from-equilibrium and so many efforts have been observed about the issues of urban dynamics and change (Prigogine, 1997; Wilson, 1981). Although these studies introduced a mind-shift to the dynamical perspective for cities; unfortunately, they remained limited within standard centralized models and could not create a concern to think cities as collective actions of individuals or agents originating from bottom-up (Batty, 2005). This critical gap in the theory was filled with the development of systems theory and its mantra describing the systems’ working mechanism: ‘the whole is greater than the sum of its parts’. This conceptualization brought the idea of systems’ emerging from the parts through a bottom-up process, but as different from simply adding up the parts to create a whole.

At the same time, by tracing the new developments in systems theory, Warren Weaver proposed a new classification for the problems addressed by science. According to Weaver (1948), systems could be classified within the context of three different kinds of problem: ‘problems of simplicity’, ‘problems of disorganized complexity’ and ‘problems of organized complexity’ (Figure 2.5). While the problems of simplicity were referring to the two-variable problems of reductionist physical science, problems of disorganized complexity were about numerous – or close to infinite – variable problems suitable only for probability analysis. Contrary to these two classifications, problems of ‘organized’ complexity includes the feature of ‘organization’ representing a potential hidden ‘structure’ for the problem. Moreover, Weaver (1948) asserts that:

“*These problems—and a wide range of similar problems in the biological, medical, psychological, economic and political sciences— are just too*
complicated to yield to the old 19\textsuperscript{th} century techniques which were so dramatically successful on two, three, and four variable problems of simplicity. These new problems, moreover, cannot be handled with the statistical techniques so effective in describing average behavior in problems of disorganized complexity. [...] Science must, over the next 50 years, learn to deal with these problems of organized complexity” (p.538).

![Figure 2.5](image)

In the light of all these developments, Jane Jacobs opposed to the deterministic urban planning approaches lasting since the beginning of 1900s with the advent of Modernism. Jacobs took her inspiration from the Weaver’s (1948) tripartite classification of scientific problems and claimed that the cities could not be treated as if they are problems of simplicity or problems of disorganized complexity. According to Jacobs (1961), city is a complex living structure which should be defined as ‘organized complexity’, as an “organism that is replete with unexamined, but obviously intricately interconnected, and surely understandable relationships” (p.436). With this point of view, Jacobs was standing just at the opposite of all accumulated theory of urbanism and proposing a new understanding of cities focusing on the behaviors of individuals and bottom-up processes (Batty, 2010).
In her book *The Death and Life of Great American Cities*, Jacobs (1961) defined her main intent as “[… to attack on city planning and […] to introduce new principles of city planning and rebuilding, different and even opposite from those taught in […] schools of architecture and planning […]” (p. 3). With this intention, Jacobs harshly criticized one of the most influential urban models of nineteenth century determinism – Howard’s Garden City – by claiming that in this model city was seen as a two-variable problem: the relationship between the number of dwelling and working units; and the interface of town and greenbelt. Even in that context, Jacobs (1961) complained about Le Corbusier’s Radiant City model by defining it as “vertical and more centralized version of the two-variable Garden City” (p. 436).

In her point of view, design ideas like green belts, zoning, segregation of movement channels and the many others related with the conventional plan-making process is highly inappropriate for the complex problems of cities (Batty and Marshall, 2012). Even if she was against the comprehensive and large-scale master plans for the cities, she was not a supporter of laissez-faire approach in planning. Her main attack and criticism was about the simplistic and deterministic nature of modern planning to the dynamically changing elements of cities – buildings, streets, neighborhoods and the others – in response to the interaction with citizens. According to Jacobs (1961),

> “Cities happen to be problems in organized complexity, like the life sciences. They present situations in which half a dozen or several dozen quantities are all varying simultaneously and in subtly interconnected ways... The variables are many but they are not helter-skelter; they are interrelated into an organic whole” (p.433).

In this sense, the precious critiques of Jane Jacobs did represent an urban planning and design ideology which is emerging with the collective actions of individuals from the bottom-up; generating diversity and heterogeneity in the framework of an ‘organic whole’; and functioning in a holistic behavior without the help of a command and control mechanism.
Christopher Alexander

The other essential criticism against the deterministic and centralized urban planning approaches raised by the architect Christopher Alexander who worked mainly on the issues of incrementalism, organic growth and organic whole. In his Ph.D. thesis and first book Notes on the Synthesis of Form, Alexander (1964) argued that the design of cities was achieved **incrementally from bottom-up by trial and error**; and so, bottom-up design was the only way to reach ‘a good design’ which ‘fits’ to the changing contextual and complex problems by producing adapted solutions. Following this important study, Alexander published a remarkable essay A City is Not a Tree (1965), in which he criticized the structure of planned Modern cities because of their simplistic hierarchical structures resembling trees. According to Alexander (1965), the natural cities should have a more ‘complex’ structure including many overlapping elements – which is defined as ‘**semi-lattice**’ (Figure 2.6).

![Figure 2.6](image_url)

**Figure 2.6:** Christopher Alexander’s Diagrams of Semi-Lattice (left) and Tree (right). According to Alexander (1965), “It is not merely the overlap which makes the distinction between the two important. Still more important is the fact that the semi-lattice is potentially a much more complex and subtle structure than a tree” (p.5).
By referring to the urgency of this complex structure, he studied on patterns which are interacting with each other at different scales to create an open-ended, ever changing organic whole in the book A Pattern Language (Alexander et al. 1977). Although his approach was criticized as being top down because of the limited number of patterns implying universal rules, Alexander’s philosophy, like Jacobs’, was based on the idea of bottom-up design with the actions of individuals to generate complex urban structures (Batty and Marshall, 2012).

Especially with the publication of A New Theory of Urban Design, Alexander (1987) started to address to the notions of complexity and organic wholeness of cities. Contrary to the utopian and deterministic blueprints of Modernism, he conceptualized cities as unpredictable emergent wholes showing incremental growth with the interconnection of many individual components.

Following the developments in complexity sciences, Alexander (2002) published his recent holistic study about the incrementalist theory of urban design – The Nature of Order – in which he conceptualized the notion of emergent wholeness with the related term of ‘organicness’ 9. According to Alexander (1987), “every increment of construction in the growing city must be designed to preserve wholeness at all levels, from the largest level of public space, to the intermediate wholes at the scale of individual buildings, to the smallest wholes that occur in the building details” (p.29). By emphasizing the importance of incremental design to achieve complex wholes in a ‘natural’ and bottom-up manner, Alexander criticized the modern attempts to create cities ‘artificially’. He argued that urban planning and design should understand the bottom-up way of urban design of pre-industrial age and develop successful planning and design mechanisms to achieve a slow adaptation of complex coherent wholes (Batty, 2005).

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9 Alexander (1987) explained the term organic as “This feeling of ‘organicness’ is not a vague feeling of relationship with biological forms. It is not an analogy. It is instead, an accurate vision of a specific structural quality which these old towns had... and have. Namely: each of these towns grew as a whole, under its own laws of wholeness... and we can feel this wholeness, not only at the largest scale, but in every detail” (p.2).
2.3.3 Complexity Theories of Cities

Until the expansion of critical approaches against the deterministic models in urban planning, the common perception of city was dominated by a very simple hierarchical structure including a core centrality and sub-centers; a series of highly segregated functional zones and movement channels that bind all of them together. However, according to Batty (2005), the reality is very different from this simple conceptualization which should belong to the times of medieval or industrial city; and, cities are so complex that our traditional assumptions cannot make any sense in the context of contemporary discourse of cities. Therefore, an inevitable need of a new theory of urban planning has emerged to fulfil the expectations of the new understanding of cities: complexity.

The new theory of complexity has originated from the systems approach – but opposed to it by adopting the bottom-up approach – and diverted the debate of non-flexible, deterministic and centralized control mechanisms of Modernism into the studies of non-linearity, emergence, unpredictability and dynamics for the complex systems such as cities. After the introduction of these terms to the urban planning and design agenda, planning problems were started to be defined as ‘wicked’\(^\text{10}\) and the notion of uncertainty has challenged the heart of the planning and design thinking and the issues of rationalization. After this crucial breaking point, according to Batty (2010), it was widely accepted that cities could and should not be treated like machines; “but like living systems with the implication that life, hence city form, emerges from the bottom up following the Darwinian paradigm” (p.103).

Complexity theories has opened up new discussions; introduced a branch of transdisciplinary concepts and notions; and, provided a critical inquiry for urban planning and urban design. According to Sengupta et al. (2016), underestimated and

\(^{10}\) Rittel and Webber (1973) defines the problems of planning as ‘wicked’ and addresses to the impossibility of the concepts of definitiveness, optimality, predictability and resolvability for these problems. (For more, see: Rittel, H. & Webber, M.M. (1973), Dilemmas in a general theory of planning. Policy Sciences Vol.4, 2: pp.155-169).
ignored processes such as temporal dynamics, self-organization, transition and emergence – because of the conceptualization of cities in equilibrium in a highly centralized perspectives – have started to take their places in urban planning and design with the contribution of complexity theories and many scholars studying in the field of complexity theories of cities (CTC) (Allen, 1997; Batty, 2007; de Roo and Silva, 2010; Portugali, 2011; Marshall, 2012). In addition to these, while Frankhauser’s (1994) study of ‘fractal dimension of urban area’ proved the geometric structure of cities’ complex structures; Batty (2013) developed simulation models for the urban complexity such as cellular automata, catastrophe models and agent-based models.

Although, it’s been a long time to understand the message of complexity theories and to translate them into the language of urbanism, as planners and designers, we are just at the threshold of exploring the essence of complexity theories enough to use it as an input for planning and design processes. After embracing the notion of complexity, the settled ideas about ‘the kind of thing a city is’ has been transformed and led to the mind-challenging insights.

2.4 Ongoing Transformation Of “The Kind of Thing a City Is”

Throughout the history of urbanism and its theoretical and practical development, cities have been conceptualized variously in different periods of time. This ongoing change in their conceptualization can be traced easily over the metaphors and models used to describe cities. According to Marshall (2009), these metaphorical expressions for understanding cities have affected directly the way we treat spatial problems and inspired us about the new methods of planning and design. Therefore, it would be possible to summarize briefly the paradigm shifts in urbanism by tracing the metaphorical changes in the description of cities and to give the answer to the vital question of ‘what kind of thing a city is’ in this research’s context before going deep into the subject.

Until the emergence of Modernism discourse at the beginning of twentieth century, cities were seen as a work of art. According to Marshall (2009), early pioneers of town planning such as Raymond Unwin, Arthur Korn and Frederick Gibberd
considered the town planners or urban designers as ‘artists’ and the blueprints as their canvases. In the context of cities, this metaphorical expression refers to ‘a consciously designed object’ which has very definite form and boundaries and represents something finite and stationary. At the beginning of twentieth century, emerging approaches of Modernism started to conceptualize the city as a machine and emphasized its characteristic of ‘functionality’ instead of its visual or artistic effect. In this perspective, what is important is that achieving the functional supremacy with Le Corbusier’s idealization of ‘Machine-Age Civilization’. As similar to metaphor of work of art, city as a machine is again a consciously designed object which has a pre-definite final form.

After the mid-twentieth century, the analogies of cities representing physical systems like work of art or machine has been replaced by the analogies coming from the natural sciences. According to Marshall (2009), the metaphor of city as an organism represents a city which is flexible and responsive to the changes in its environment. Moreover, as we know from the biological systems, organisms emerge with the continuous evolutionary interactions from the bottom-up. Thus, organismic metaphor introduced urban planning with the new notions such as incrementalism, bottom-up design and adaptive changes of the whole in a continuous process. While it resulted in a shift from product-oriented approaches to the ones that are process-oriented, organism analogies similarly have connotations such as optimum and definite size, equilibrium and predictability of the whole based on its individual parts (Marshall, 2009).

After the mid-twentieth century, developments of complexity sciences affected the way cities has been perceived through the analogies of work of art, machine and organism. By adopting the evolutionary perspective, urban theoreticians started to conceptualize the city as an ecosystem (Marshall, 2009; Batty, 2005; Batty and Marshall, 2012). According to this point of view, cities are far-from-equilibrium; they have no definite form and size; and their long-term behavior could not be predicted because of the non-linear processes in itself. Therefore, according to Batty and Marshall (2012), “a city is not an ‘organism’ per se, but an ‘ecosystem’ and its
complexity revolves around the fact that it is composed of many interacting parts that function competitively” (pp.34-35). The shift from the analogy of organism to that of ecosystem also represents a shift from seeing cities as consciously designed, stable and finite artefacts to considering them as emergent bottom-up formations which evolve and change continuously. In this sense, it would not be wrong to argue that cities are so complex and dynamic that considering them as ‘predictable’ systems; and projecting or defining an ‘optimality’ for them would be too simplistic and naïve. Instead, planners and designers should embrace the concepts – such as ‘uncertainty’, ‘disequilibrium’ and ‘non-linearity’ – which are natural results of the complexity.

While the metaphorical expressions for the cities have changed throughout the twentieth century, at the same time, the centralized structures of planning and management mechanisms has also transformed into more decentralized organizations. Top-down and large-scale efforts of planning and design were left; and, the notion that cities emerge from the actions of vast number of individuals and agencies in a bottom-up manner was adopted gradually (Batty, 2005). This presupposition has paved the way for the impossibility of controlling and managing the complex systems from the top-down and legitimated the issue of controlling the whole with micro-scale – or local – interventions.

Radical changes in the means of control and management – from top-down to bottom-up – has also changed the role of planners and their approaches to the problems of cities. Until mid-twentieth century planners were considered as the ‘experts’ for all kinds of socio-spatial problems. The dominant approach in planning was technical-rational planning which assumes that planners could foresee all the consequences of their actions and control the city from the top (De Roo and Rauws, 2012). In the following years, with the increase in critical perspectives to the deterministic planning approaches, technical rationality started to be seen limited (see e.g. Lindblom, 1959; Simon, 1960). Optimistic assumptions about the predictability and certainty of planning processes have been questioned and challenged with the notion of ‘changeability’. Instead of comprehensively pre-considered planning actions, the approach of incremental planning emphasized the importance of ‘process’ composed
of evolutionary and gradual planning actions. After 1990s, with the influence of matured notion of complexity in planning and design, **communicative rational planning** has gained ground. This approach led to the acceptance of complexity and uncertainty in planning and design; and, emphasized the specific planning interventions to area-specific problems with the integration of all planning actors – planners, stakeholders, local authorities – in planning processes.

To sum up, there has been an unceasing transformation about ‘the kind of thing a city is’. Throughout the last century, planning and design approaches has experienced several important transformations with the development of alternative conceptualizations: from the analogy of machine to the ecosystem; from top-down approaches to bottom-up; from technical-rationality to communicative rationality; and **from simplicity and certainty to the complexity and uncertainty**. Marshall (2009) describes this ongoing process of transformation as ‘from creationist paradigms (city as a work of art and/or machine) to developmental paradigms (city as an organism) and to evolutionary paradigms (city as an ecosystem)’. After experiencing all these shifts and transformations, contemporary urban planning and design has generated open-ended answers to the question of ‘what kind of thing a city is’. In that sense, cities can be described as complex eco-systems emerging from the interactions of many individuals in a bottom-up manner, changing their structures dynamically and including uncertainties for their future forms and states.

In the context of contemporary planning and design theory, describing cities as complex systems with an evolutionary perspective requires to understand the emerging notions of complexity, emergency, uncertainty and many others; and, to find their connotations in urbanism. Therefore, in the following chapters, implications of complexity theory will be translated into the language of urban planning and design; possible achievements and contributions of this approach will be revisited; and, alternative ways of dealing with the problems of uncertainty, unpredictability, changeability and dynamism will be quested to open up new discussions for the contemporary urban planning and design agenda.
2.5 Concluding Remarks

History of science progressed not in a cumulative manner; instead, by means of distinctive revolutions representing critical shifts between different paradigms (Kuhn, 1962). These revolutionary turning points have paved the way for radically different understandings and brand-new questions for natural, physical and social sciences. While the scientists and theoreticians were struggling with the mind-shift from the certainties – or predictabilities – of simplistic problems to the uncertainties – or unpredictabilities – of complex problems, the accumulated knowledge about the dynamics, non-linearity, unpredictability, chaos and many more has triggered another paradigm shift: ‘the theory of complexity’.

Complexity theory has constituted a transdisciplinary approach affecting not only natural sciences but also social sciences and studied the ‘complex systems’ and their behavior. Complex systems can be described as the systems involving many components interacting with each other by using the simple rules and generating emergent collective behavior through the evolutionary processes of self-organization without a central control. Inquiries on complexity and complex systems has led to the emergence of new concepts and terms for the contemporary scientific studies such as emergence, uncertainty, unpredictability, self-organization and so on.

As similar to the paradigm shifts in the history of scientific and intellectual thought, history of urban planning and design is full of breaking points and critical shifts related with the approaches to the problems of cities. The deterministic urban planning and design approaches of Modernism – as being the natural outcome of the scientific reductionism’s dominance at that times – have been criticized with the critical perspectives in mid-twentieth century. Large-scale and static blueprints based on the optimistic belief of predictability of the future and top-down efforts to control the urban space have been questioned and challenged harshly. In that sense, Jane Jacobs and Christopher Alexander were hailed as the pioneers of critical approaches within the context of complexity theory. These pioneers and their successor theoreticians
have led to the conceptualization of cities as complex collective ecosystems emerging from the interactions of many individuals in a bottom-up manner, changing their structures dynamically and including uncertainties for their future forms and states. This radically different conceptualization represented evidently a paradigm shift from the deterministic approaches to the complexity based perspectives of urban planning and design. In that sense, according to Batty (2005), while our perspective to the problems of urban space has been transformed from top-down to bottom-up, the conception of the urban spaces has changed from ‘a system which is fully predictable’ to the ‘one which is full of uncertainties’.

Contrary to the comprehensive planning approaches of twentieth century, where the urban space was perceived as a predictable, static and linear system, contemporary urban planning and design conceptualizes city as ‘organized complexity’ whose future form or state cannot be predicted totally. As stated by Marshall (2009), urban space should be considered as a complex, and sometimes even a chaotic place in which the structural organizations and patterns can be found; not as a totally predictable and understandable one. According to Alexander (1987),

“The whole is unpredictable. When this piecemeal growth starts coming into being, it is not yet clear how it will continue, or where it will end, because only the interaction of the growth, with the whole’s own laws, can suggest its continuation and its end” (p.14).

Within this context, theory of complexity has created an awareness of the limitations of predictability and certainty about the consequences of planning interventions and future conditions of urban space. Therefore, within the perspective of complexity, the most vital task in urbanism should be understanding complexity, embracing uncertainty and developing alternative strategies to operate design within this revealed condition.
CHAPTER 3

URBAN COMPLEXITY AND EMERGENT NATURE OF CITIES

3.1 Cities, Planning and Complexity

Through many years of its development, city planning was considered as an action of administration and regulation. It aimed to control and develop urban places to sustain functional efficiency, to create attractive and ‘good-looking’ environment and to provide people with fundamental spatial needs of dwelling, working, transportation and leisure. However, in the light of critical approaches, it has been clear that the stationary approaches of urban planning and design failed to respond to the bottom-up, unpredictable and non-projectable complex problems of the cities. At this critical point, according to Friedmann (2003), “a new way of thinking about planning was needed that would emphasize the relationship between knowledge and action. [...] These ideas [...] shifted the discourses of planning away from planning as an instrument of control to one of innovation and action” (p.8).

By moving away from the traps of reductionism and determinism – which considers cities totally static and in equilibrium – urban planning realized the continuous and evolving dynamism and complexity lying behind the formation of urban spaces. It was the time to grasp that “process rather than product, function rather than form, time rather than space are all important for a better understanding” of cities (Batty et al., 2004, p.16). Comprehension of these notions by urban planners, designers and theoreticians has not been so painless; instead, city planning has experienced cognitive struggles and paradoxical challenges while adopting the complexity thinking and translating its derived notions and concepts into urban planning and design agenda.

The first struggle was about the definitions of complexity referring to various negative connotations for city planning. The pioneers of complexity theories of cities – such as
Jane Jacobs and Christopher Alexander – overcame this problem by translating the concept of ‘organized complexity’ into planning. While the term – organized complexity – was fulfilling the need of being ‘complex’, it was also including the feature of ‘organization’ representing the desire of structure for the urban spaces. The second and most recent paradoxical challenge was about the complexity’s way of coming into existence. After the development of complexity sciences, it was realized that complexity arises ‘naturally’ from ‘bottom to up’: it is ‘emergent’. This realization motivated urban planners and designers to understand the issue of ‘how to operate planning and design within the accepted condition of complexity – which is naturally arisen or emergent’.

Within this context, urban planning and design firstly eliminated the negative connotations of complexity and accepted it as a reality of the urban space; then, translated its certain notions and concepts into the field of study within the framework of ‘organized complexity’; and then, developed alternative planning and design mechanisms to address the emergent nature of cities.

3.1.1 Cognitive Challenges in Translating Complexity into Urban Planning and Design

Complexity is a term that addresses to a transdisciplinary scientific field and it has various definitions and conceptualizations originating from different field of studies. As it is examined comprehensively in the previous chapter, it has been widely confused with the terms like complicatedness, arbitrariness, randomness and chaos. Because of the lack of a common definition of the complexity, comprehending and defining the term fully in the context of specific field of studies has always been difficult 11 – especially while translating it into the scope of social sciences from its natural sciences based origins.

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11 In spite of the lack of a general satisfactory definition, Batty (2005) presents generally agreed understandings of the complexity as “systems consisting of many basic but interacting units” (Coveney and Highfield, 1995, p.7); and, “systems in process that constantly evolve and unfold over time” (Arthur, 1999, p.107). (For more, see: Batty, M. (2005), Cities and Complexity: Understanding Cities with Cellular Automata, Agent-based Models, and Fractals, MIT Press: Cambridge, MA.)
The discipline of urban planning and design has also struggled with the issue of translating complexity into its own agenda and developed various different perceptions. Defining the complexity as ‘a state of being too difficult to manage’ and ‘a disastrous situation’ has always been common within the planning environment which is highly dominated with the Modernism’s deterministic approaches. According to De Roo (2012), at the first glance, the notions derived from the complexity based perspectives – such as self-organization, emergence, uncertainty etc. – seem incompatible with ‘planning and design’ referring to “a rational process which guides actions from an existing situation towards an envisaged future situation” (p.1). It has not been easy for urban planners and designers to get rid of the negative connotations; vague meanings and fuzzy understanding of the complexity.

In that sense, until the mid-twentieth century planners have considered the complexity as a threat to the ‘rationality of planning process’ and conceptualized it as an unmanageable obstacle to the desired and imagined future state of cities. City planning under the influence of modernism considered the ‘traditional’ cities’ organic structures as irrational and chaotic; and, aimed to remove their natural complexity and intricacy. With the well-known catchphrase of “simple is the best”, Modernism’s deterministic planning and design mechanisms imposed a highly strict planned order which represents the ‘simplicity’ of modern cities against the ‘complexity’ of traditional ones. According to Marshall (2012), efforts to reduce the complexity of traditional towns did not result in better outcomes for the urban space: “This is seen in the case of placeless suburbs with bleak, alienating landscapes, disjointed or dysfunctional planned developments or new towns with failed housing schemes or town centres” (p.192). Therefore, it would not be wrong to argue that problematizing complexity – which is the natural state of being for cities – and conceptualizing it as ‘chaotic irrationality’ resulted in ‘failure of town planning’. (Jacobs, 1961; Alexander, 1965). Within this context, after the introduction of critical approaches against modernism’s simplistic and reductionist doctrines in mid-twentieth century, a new challenging task for urban planning and design has emerged: accepting complexity as an intrinsic, natural and inevitable feature of cities rather than seeing it as an unmanageable problem; and, translating it into the discipline’s framework.
3.1.2 Translation of Complexity into Urban Planning and Design: Organized Complexity of Cities

After mid-twentieth century including harsh criticisms and challenging questions about the nature of cities, urban planners realized the fact that city planning and emerging complexity sciences are actually not strangers. It was Jane Jacobs who embraced the message of complexity theories in the first place and conceptualized cities as ‘problems in organized complexity’ by referring to the Weaver’s (1948) tripartite definition of scientific problems – problems of simplicity, problems of disorganized complexity, and problems of organized complexity. According to Jacobs (1961), cities could be understood neither with the Ebenezer Howard’s physicalist approach to two-variable problem of simplicity nor with the Le Corbusier’s approach to the problems of disorganized complexity. Instead, she conceptualized the city as a problem of organized complexity; and, introduced this term’s response in the urban planning field by defining it as a system of variables “all varying simultaneously and in subtly interconnected ways. [...] The variables are many but they are not helter-skelter [...], they are interrelated in to an organic whole” (p.433).

From that point on, organized complexity can be defined as a systematic relationship including large number of variables which connect each other in an organized – not chaotic or random – manner and constituting a complex whole. Such complexity is not created by an intelligent controller or a divine hand; instead, it emerges from the bottom up with the collective intelligence of interactions. Following the Jane Jacobs’ contribution to the planning theory, Christopher Alexander realized the complexity of cities by remarking the failure of modern attempts to create ‘artificial’ cities. According to Alexander (1965), the most essential ingredient missing from these failed attempts is the complexity which refers to a whole including many interaction and emerges spontaneously through the years in cities like Siena, Liverpool, Kyoto and

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12 According to Jacobs (1961), Le Corbusier ‘assumed the statistical reordering of a system of disorganized complexity, solvable mathematically’ and ‘his towers in the park were a celebration, in art, of the potency of statistics and the triumph of the mathematical average’ (p.435). (For more, see: Jacobs, J. (1961), Jacobs, J., (1961), The Death and Life of Great American Cities. Random House: New York).
Manhattan. Moreover, Alexander (1965) emphasized the organized urban complexity’s ingredients of many urban elements and agents; far more interrelationships between them; and, their systematic co-operation to create an organized structure (a whole) by illustrating a set of interactions at a street corner in Berkeley:

“Here is an example. In Berkeley, at the corner of and Euclid, there is a drug store, and outside the drug store a traffic light. In the entrance to the drug store there is a newsrack where the day’s papers are displayed. When the light is red, people who are waiting to cross the street stand idly by the light; and since they have nothing to do, they look at the papers displayed on the newsrack which they can see from where they stand. Some of them just read the headlines, others actually buy a paper while they wait.

This effect makes the newsrack and the traffic light interdependent; the newsrack, the newspapers on it, the money going from people's pockets to the dime slot, the people who stop at the light and read papers, traffic light, the electric impulses which make the lights change, the sidewalk which the stand on form a system - they all work together” (p.3).

Following these pioneering contributions, the relevant understanding of complexity has been translated into the urban planning and design with the notion of organized complexity. It would not be wrong to argue that a city is basically a complex ‘organization’ shaped by the interactions between people; thus, the concept of organized complexity has been considered as appropriate for the condition of cities; and, accepted by the planning and design environment widely. However, according to Marshall (2012), because of the fact that the word ‘organization’ is also naturally associated with the aggregate of ‘organs’ like in biology, it is possible to argue that there are four different kinds of organized complexity with respect to different conceptualizations: artefactual, biological, ecological and system complexity.13

13 Marshall (2012) identifies four kinds of organized complexity based on a matrix including two different dimensions: ‘natural versus artificial’ and ‘systems versus objects’; and, carefully asserts that the boundaries between these different kinds are not that much rigid and clear.
While **artefactual complexity** means the complexity of deliberately designed objects like machines and work of arts which can be complex, but which are fixed entities and in a state of equilibrium and certainty; **biological complexity** refers to the complexity of biological organisms. Contrary to the artefacts, biological organisms are not fixed entities, they are dynamic and have the ability of self-organized evolution. Artefactual and biological complexity can be grouped into the complexity of objects. On the other hand, while **ecological complexity** means the complexity of ‘natural’, open-ended, dynamic and adaptive systems full of non-linear, unpredictable and irreversible trajectories (Brown, 1994); **system complexity** can be identified as the complexity of ‘artificial’ open systems like economic systems, the Internet, legal system, language and cities.

In the light of this overarching conceptualization, it would be fair to assert that the kind of organized complexity cities have is quite different from the artefactual and biological ones; because, defining cities as machines, work of arts or even organisms is pretty problematic. From the perspective of complexity sciences, cities are far-from-equilibrium, they have no definite form and size; they are not static and their long-term behavior could not be predicted because of the non-linear processes in itself. Therefore, the kind of organized complexity cities have is more akin to the ecological and system complexity which addresses to the open-ended, dynamic, adaptable, self-organizing and bottom-up systems. According to Marshall (2009), cities are ‘ecosystems’ possessing a kind of ‘system complexity’ – which includes some fundamental features of ecological complexity, as well. (Figure 3.1).

Conceptualizing the organized complexity that cities have at the interface of system complexity and ecological complexity requires some other consequences and further conceptualizations. In that sense, cities’ organized complexity stands somewhere in between ‘order’ and ‘disorder’. They are ordered systems which points out a whole structure in which all components co-operating together; and, they are also disordered systems because of their dynamic structures tend to be broken, transformed or even

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14 Ibid.

15 Ibid.
collapsed and their great self-organized variety. According to Boeing (2017), **structure** which represents the order of the system and the **variety** that refers to the potential disorder in the system are two fundamental aspects of urban complexity that designers should realize. Thus, urban complexity covers all this grey field between order and disorder; and, structure and variety. It is continuously dynamic and ever-changing between these two contrasting ends.

![Figure 3.1: Kinds of organized complexity and organized complexity of cities (Marshall, 2009)](image)

This argument brings another feature of organized complexity that cities have: **dynamism**. The processes of spatial development in cities cannot be considered as one-way linear changes leading to static, fixed and permanent outcomes. According to De Roo (2012), thinking urban complexity inextricably related with the notion of dynamism requires the comprehension of planning and design issues not only as ‘being’ but also as ‘becoming’. Thus, it would not be wrong to argue that organized urban complexity refers not only to the complexity of planned or designed physical space and its programme; but also to the complexity of planning and design process itself.
From the systematic and ecological perspective, the procedurally dynamic complexity that cities have refers to the continual evolution through adaptation. Cities respond to different contextual and situational changes – such as economic changes, demographic stresses and technological developments – by adopting their configuration and working mechanism continuously (Portugali, 2006). Adaptation arising from the interactions and feedbacks between components in a bottom-up manner is one of the most necessary features of organized urban complexity. According to Salingaros (2015), modernist attempts of precise geometrical ordering is incompatible with the urban complexity which should be achieved with the evolutionary adaptation: “Alignment and repetition, while visually ordered as seen from the air, are actually experienced as random by the users. […] Forget about deliberately generating complexity: the sequence of steps followed in adaptive design will generate it automatically” (p.1).

The adaptive behavior of organized urban complexity is not based directly on linear cause-effect relationships; instead, the collective behavior of the system is emergent – which means the whole cannot be understood simply by analyzing the sum of its parts. According to Rauws (2017), the possibility to understand, control and predict fully a city’s future trajectory is quite limited; because, while some changes are initiated and planned by planners, some others are ‘unplanned’, ‘unpredictable’, ‘autonomous’ and ‘emergent’.

In the framework of above conceptualizations, the organized complexity that cities have should be understood as a kind of system complexity which includes the fundamental features of ecological complexity – such as dynamism, evolutionary adaptation, emergence and unpredictability. Moreover, the organized complexity refers to the required condition of being whole for cities with its hidden potentiality in terms of structure and organization; and, includes the essential feature of high level of variety in the context of complexity. With the help of these conceptualizations and translations from the complexity sciences, complexity theories of cities (CTC) has been recognized as the most explanatory paradigm for urban planning and design by many scholars and theoreticians (Batty, 2007; Portugali, 1999; Partanen, 2015).
3.1.3 Implications and Contributions of Complexity Theories of Cities in Urban Planning and Design

Accepting complexity as an intrinsic feature of cities rather than seeing it as an unmanageable problem; and, translating it into the discipline’s framework offers a cognitive breakthrough leading to the new perspectives and greater understandings about the nature of cities. In that sense, considering the cities through the lens of complexity theory and questing the alternative ways to operate planning and design processes within this condition would lead to influential implications and future achievements for the planning theory and practice. The contributions of complexity theories of cities to the issues of planning and design can be grouped as three main categories: (1) cognitive contributions about new insights and understandings; (2) contributions to fundamental planning and design approaches; (3) contributions to urban space itself.

**Quest for New Insights and Understandings: Cognitive Contributions**

Adopting the complexity based perspective in urban planning has led to the brand-new questions and accordingly new insights and understanding about the nature of cities – which would enrich the field of study with concepts derived from the complexity theories. Most importantly, the terms such as *non-linearity, situatedness and transitions* have started to be used frequently among the planning environment. In the context of cities, *non-linearity* implies that the micro-level behavior of individuals may affect the macro behavior – or state – of the cities unexpectedly in an extreme manner. According to Portugali (2012), “This somewhat counter-intuitive insight sheds new light on the role and importance of the human individual in shaping the urban landscape and its dynamics” (p.49). In a non-linear environment, instead of isolated and static entities or events; dynamic, unstable and fluid situations are encountered: *situatedness*. According to De Roo (2016), all of these situations following non-linear trajectories are not fixed, but continuously in transition from one state of being to another in a co-evolving manner.
These non-linear and transitionary changes should not necessarily represent a completely chaotic environment; but an ‘emergently organized’ one. The phenomenon of emergence defines the process of global scale formation for a city from the local interactions between urban components and agents. After focusing on the emergence, a new understanding on ‘order and disorder’ has been developed by urban planners and designers. It would not be wrong to state that emergence occurs somewhere in between order and disorder – or chaos. Emergence is a disordered process when it is examined in the context of self-organized individuals without any controller; and, ordered process when it is examined in terms of the macro-scale structure that represents a whole or an organization. Positing the emergence between these two contrary ends has led to the further creative thoughts. In that sense, while a strictly ordered environment refers to a resistance to change and so development – ‘dead’ environment – (Lister, 2008), an uncontrollably disordered environment refers to chaos and disaster. According to De Roo (2016), emergence addresses “a potential for development to occur” and “room for creativity” (p.174). After accepting that the order and disorder do not necessarily contrast with each other, urban theorists started to interpret the tension between these two extremes as an opportunity instead of a problem. Complexity based perspective to cities has taught planners that in cities, “beneath the apparent chaos and diversity […] there is strong order and a pattern […]” (Batty, 2008; p.769).

Incorporating these new concepts and notions has clearly changed planning environment’s view of certainty from the ‘Cartesian reductionism’ and ‘Newtonian determinism’; and, paved the way for alternative approaches in the light of ‘complexity theory’. After rejecting the certainty and accurate predictability in non-linear, emergent and transitionary conditions of cities, uncertainty has been accepted as inevitable and undeniable. Urban theoreticians realized that they need to deal with both knowable and unknowable changes; because, while some changes are direct results of planning and design interventions, the others emerge unexpectedly beyond the control of planners and designers (Rauws, 2017). The challenging recognition of uncertainty has led to the considerations about the ‘optimal future state’ of cities. In that sense, a city experiences continuous and uncertain changes which seems familiar to
unpredictable evolution; therefore, cities have no optimal future form which is predictable and knowable beforehand (Marshall and Batty, 2009).

With all above considerations, urban planners and designers has focused on developing alternative strategies and approaches including some other notions such as self-organization, responsiveness, adaptiveness and flexibility to respond both foreseen and unforeseen transitions in urban space. The new perspective based on the non-linearity, emergence, uncertainty and transition has challenged planners to consider cities as an instant moment in an ongoing process. Process based thinking has led to the ‘spatio-temporal’ understandings and time-sensitive perspectives in urban planning and design.  

**Contributions to Urban Planning and Design Approaches**

In addition to the cognitive contributions leading to the new insights and understandings, complexity based perspective has influential contributions to the theoretical and practical approaches of urban planning and design, as well. In that sense, accepting the uncertainty as a reality and realizing the limitations of planning and design interventions to predict the optimality for cities has necessitated alternative approaches in order to deal with the complexity. Broadly, these approaches can be divided into two categories: (1) rule-based planning and design approaches and (2) participative or collaborative approaches in planning and design.

According to Crawford (2016), one of the broadest response in planning environment to achieve a complex order is related with the application of hidden spatial rules or codes consistently. In this kind of approach, the whole system is decentralized to the individuals who are free to act in the urban space as long as their actions are consistent with the universal systematic rules. Moroni (2014) describes these sets of rules as ‘relational rules’ representing ‘urban codes’:

> “Urban codes are based on ... relational

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16 Process based thinking has transformed the main questions of planning action from ‘what and who’ to ‘when and where’. This condition points out that complexity based perspectives have shifted urban planning away from the product-oriented approaches; and, directed it to more action-oriented and process based approaches (Dobrucka, 2014; De Roo, 2003; Rauws, 2015).
rules that are few, simple, generic, end-states-independent, and long-run oriented” (p. 257). Adopting the rule-based approach provide planners and designers with achieving the planned order by defining only generic components – or codes related with them – without using comprehensively specified blue-prints. In that sense, potentiality of creative emergence is sustained, relations between individuals is optimized as far as possible by embracing the uncertainty and the concept of organization is achieved in terms of the whole collective system. Another contribution of complexity to planning and design is adopting the participatory and collaborative approaches. Within the context of this approach, there is no central controller; instead, all of the actors (citizens, local governments, central government, planners, investors and so on) share the responsibility to control the whole by using an intricate feedback system between each other. Thus, system’s capacity to adopt uncertain and non-linear changes and to achieve co-evolutionary development tends to increase in time.

In addition to these general approaches, some scholars have started to adopt ‘hybrid – or mixed – planning and design approaches’ including both conventional planning mechanisms and complexity based alternatives. Marshall (2012) argues for a hybrid planning approach and describes this approach as ‘a system of planning’ involving design, master-planning, generative coding and development control simultaneously. 17 Hybrid planning approaches represents the interface between tradition and innovation and helps to achieve organized complexity in cities in an evolutionary manner rather than a pure ‘design based way of doing’. According to Marshall and Batty (2009), with the contributions of complexity theory urbanists have realized that while planning is learning from existing successful practices of contemporary urbanism, it should also be eager to adopt novel and alternative approaches and models.

17 Marshall (2012) explains this system by stating that: “In this system, design is the primary generative impulse, addressing particular individual needs […]. Coding exerts a proactive contribution on behalf of the public authority planner, acting to ensure basic standards […]. Design and coding together provide a generative system that could be sufficient to give rise to a kind of emergent urbanism, but with no guarantee that any specific outcome would be optimal or beneficial as a whole. Development control can therefore act to ensure that a specific ensemble generated through design (with or without coding) meets public interests collectively […]. this system, collectively, could be capable of delivering functional complexity, of the kind found in traditional (not-wholly-planned) cities” (p.203).
Moreover, complexity has led to the development of new computational and mathematical models – such as agent-based models, cellular automata simulations, network models and so on – in order to understand the emergent formations and dynamics of cities. These crucial advances and enhanced analytical tools have paved the way for understanding role of the bottom-up, self-organized, emergent and evolutionary urban processes to achieve organized complexity in cities. However, according to Portugali (2012), these sophisticated simulation models has dominated the recent complexity based urban studies more than enough; and, made the field of study stuck into the quantitative message of complexity by ignoring the qualitative messages. Nevertheless, complexity theories of cities have a potential to balance the tension between qualitative and quantitative messages; therefore, there are much more to learn from the both sides of the theory by synthesizing these messages carefully.

In the context of these contributions, arguing that the complexity theories of cities have constituted an overarching theoretical basis for the various phenomenon, concepts and approaches in urban planning and design would be fair. By proving their potential to change our understanding about the cities and accordingly our planning approaches and interventions, complexity theories of cities have also generated conceivable benefits related with the urban space’s itself.

**Contributions of Complexity to Urban Space**

Complex urban spaces represent perceptually and visually richer environments in which people feel much more belonging to the place. According to Marshall (2012), complex environment can be described as more aesthetic and psychologically satisfying than the simpler environments, because of the fact that humans evolved by experiencing different kinds of complexities naturally. **Visual complexity and perceptual richness** in urban space should not be confused with the chaotic, jumbled

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18 Portugali (2012) criticizes the simulation models with these words: “The medium has too often become the message; too often complexity theories of cities and cities themselves are seen through the “eyes” of CA/AB models—as theories of cognitively simple interacting agents that in a bottom-up process give rise to cities and systems of cities that are stable and robust” (p.52). Following this criticism, he adds that urban agents are not simple but cognitively complex; and, the cities are ever-changing and dynamic, not static and fixed systems as they are described in simulation models.
and disordered overload on human perceptions. Organized visual complexity represents a balance between order and disorder and a sense of unity in the visual variety (Boeing, 2017). In Ewing and Clemente (2013)’s study about the perceptual qualities of urban space visual complexity is described as “the number of perceptual differences a person is exposed to while moving through the city” (p.6). In that sense, it would not be wrong to argue that visual complexity is highly related with the spatial variety and heterogeneity; which is another contribution of complexity to urban space. Contrary to the Modernists’ simple and clear design schemes including very similar urban components and drawing a homogenous picture of environment, complexity based perspectives offer varied range of urban components, varied arrangement of these elements, many overlaps and interfaces between them and an organic urban fabric as a whole for the city.

High level of variety and heterogeneity in terms of both physical space and the spatial programme ensure the urban environment’s enhanced functionality. With the help of variously specialized collection of urban uses and components, complex urban products can adapt to different circumstances and consequences; in other words, it refers to the increased system resilience through adaptation. Colander and Kupers (2012) defines resilience as “the capacity of the system to absorb and adjust to change by learning from it” (p.199). However, because of the fact that resilience is describing the ability to change according to different situations, this term cannot meet the requirement of being robust in the context of cities. While interpreting the contributions of complexity to urban space, the appropriate term-pair should be robustness (in terms of physical space) and flexibility (in terms of the spatial programme). Complexity theory and complexity based planning and design mechanisms offers an urban space which is flexible and adaptive with the help of its functionally complex programme including various and heterogeneous components; and, that is robust enough to sustain its systemic integrity and adapting its structure to the changing conditions.

The last contribution of complexity is arisen from the notion of emergence which can be basically summarized with the catchphrase of ‘the whole is more or greater or
different than sum of its parts’. Marshall (2009) defines this contribution as synergy which is an ‘added value’ or ‘something extra’ emerged from the generative interactions of system components. Complex urban products have always a potential to generate synergy between the urban components which is not always possible to get just by designing or master-planning holistically. Synergy is a naturally arisen – emergent – contribution of complexity leading to more creative and novel urban formations which are unimaginable and unpredictable at the first glance. 19

To sum up, the main contributions of complexity based perspective to urban planning and design can be grouped into three different categories: (1) it has triggered new understandings and novel insights by focusing on derived concepts from the theory of complexity and challenging our way of considering cities; (2) enabled us to develop alternative urban planning and design approaches embracing these new understandings; and, (3) affected the physical urban space in a positive manner by ensuring certain planning and design measures.

At this recent point – after long years of accumulation of knowledge about the complexity theories of cities, it would be argued that city planning has achieved to deal with the first struggle of understanding the complexity theory, translating its basic concepts and notions into the field of study and realizing its potentials, contributions and implications for urban planning and design. Recently, planning environment has realized that it is time to be aware of that there are new ways to go: how to operate planning and design within this pre-accepted and understood condition of organized complexity which is intrinsically emergent and full of uncertainties.

3.2 Emergent Nature of Urban Complexity

After eliminating the negative connotations of complexity and accepting it as a reality of the urban space, the most recent and challenging inquiry about the complexity’s way of coming into existence – its emergent nature – has started to be observed among

19 Marshall (2009) considers Alexander’s illustration of a street corner in Berkeley as a classic example of synergy. (Please, find this example in this chapter (Chapter 3)). (For more, see: Alexander, C., (1965), A city is not a tree. Archit. Forum. 122(1), pp.1-17).
the urban theorists, planners and designers. Understanding of **emergence**, its key aspects and working mechanisms has helped planners to develop alternative planning and design mechanisms to operate planning and design within the pre-supposed condition of complexity which is naturally arisen or emergent. As it is examined comprehensively in the previous chapter, complex systems are not in equilibrium; they are out-of-balance and dynamic between the two opposite ends of ‘order and chaos’. Complex systems develop adaptive behavior in a self-organized manner according to the changing circumstances; and these behaviors are not defined and controlled by a central authority in a top-down manner. In other words, behavior of the system – which means the macro-intelligence of the system – is *not designed*; instead, this macro-intelligence **emerges** from the micro level relationships between components of the system and it **evolves** continuously. According to Salingaros (2015), it is a certain misconception to assume that urban complexity, or in general meaning organized complexity, is a kind of order which must be designed. 20 ‘Designed’ complexity is “relevant only to visual style not to functionality”; in that sense, the missing part of this kind of complexity is the feature of adaptive evolution according to the changing and variable conditions and circumstances. 21 According to Alexander (2002), “[…] there is a fundamental law about the creation of complexity […] which states simply this: all the well-ordered systems that we know in the world, all those anyway that we view as highly successful, are ‘generated structures’, not ‘fabricated structures’” (p.180). In that context, adopting an evolutionary, adaptive and generative urban planning and design perspective which helps complexity to emerge throughout the morphogenetic process of design should be the main motivation of planning environment. Thus, comprehending the implications of evolutionary perspective on planning and design would help us to conceptualize the concept of emergence and its working mechanism in the framework of ‘design’.

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20 Salingaros (2015) criticizes the point by arguing that “Designed (i.e. invented) complexity cannot automatically produce the useful complexity found in nature […]” (p.2). According to him, the most crucial necessity of a ‘true’ complexity is the system’s ability to evolve in an adaptive manner and to generate emergent and novel formations.

21 Ibid. p.2
3.2.1 Evolution, Planning and Design: Are They Compatible or Not?

In general sense, evolution refers to a gradual process of change and development which is the result of the natural selection among small and gradual variations. Since the introduction of the evolution theory by Charles Darwin, the question of “how did evolution produce creatures with such an enormous contrast between their individual simplicity and their collective sophistication” has remained alive (Mitchell, 2009; p.5). According to heritors of the Darwin and his grand theory, the sophisticated, organized and complex order of beings comes from the very simple rules interacting with each other based on chance, natural selection and enough time. This way of coming into being seems as if it was planned, controlled and designed by a conscious mind – like a ‘watchmaker’ who has a certain target destination and future purpose framed by the planned actions; however, it is nothing but an illusion and misconception. According to Dawkins (1986),

“The only watchmaker in nature is the blind forces of physics [...] natural selection, the blind, unconscious, automatic process which Darwin discovered [...] has no purpose in mind. It has no mind, and no mind’s eye. It does not plan for future. It has no vision, no foresight, no sight at all. If it can be said to play the role of watchmaker in nature, it is the ‘blind watchmaker’ [...] blind because it does not see ahead, does not plan consequences, has no purpose in view. Yet the living result of natural selection overwhelmingly impress us with the appearance of design as if by a master watchmaker, impress us with the illusion of design and planning”. (p.5).

According to Shane (2005), “the shocking part of Darwin’s insight is the removal of a need for any central designer or master-planner of nature. This shock is not just about how biology works, of course, but the interpretation of humanity’s place in the scheme of design” (p.89). Possibility of a ‘design’ in the absence of a ‘designer’ and in the conditions of ever changing dynamism and uncertainty has paved the way for evolutionary thinking penetrating into the fields of spatial planning and design.
With the advent of evolutionary perspective among urban theorists, urban planning and design has started to move away from the stationary sense of producing blueprints of a desired future state. Instead, by realizing that most successful traditional urban developments have occurred even without the conscious efforts of design and control, planners and designers accepted that collective outcome can be achieved through the small and individual interventions in a bottom-up manner without a need for top-down and comprehensive planning mechanisms. In that sense, they adopted process based, incremental and generative planning systems which are more like ‘evolution’ rather than design. After combining the interpretations of Darwinian evolution with the contemporary discourse of complexity theories, cities started to be conceptualized as complex ecosystems which are the natural outcome of an evolutionary, adaptive and emergent series of dynamic, unstable and unpredictable processes.

If it is necessary to re-interpret the message of Darwinism in the context of planning and design, it would be fair enough to argue that planning, design and evolution are not incompatible with each other at all. Indeed, the evolutionary process of planning and design is the only way to generate organized complexity from bottom to up, contrary to the large-scale master planning or settlement-scale design that is the ‘enemy’ of the urban complexity (Marshall, 2012). In that sense, the next question to be answered should be ‘how does urban complexity come about without the usual efforts of planning and design and even without a designer’ and “what enables cities to retain their coherence despite continual disruptions and a lack of central planning” (Holland, 1995; p.1). In order to answer these questions, examining the notion of emergence – which is the key factor lying behind the generation of complex outcomes from the interactions of simplistic interventions without a need for a comprehensive design – would be very helpful.

3.2.2 Emergence: Definitions, Models and Principles

All the complex systems have a distinctive feature which is called ‘emergence’ described by the catch-phrase ‘the whole is more than sum of its parts’. In general sense, emergence can be described as ‘the process of coming into existence from
something else’, ‘arising’ and sometimes ‘creation’. In literature, theoreticians describe emergence as a phenomenon in which global – or macro – behaviors of the complex system arises from the very simple interactions between local parts and individual components. As it is, emergence excludes any conscious, deliberate act of design and control from ‘top to bottom’ by a ‘central designer’. In other words, emergence seems as a ‘designed condition’ in the absence of a ‘designer’: a watch arisen without a watchmaker. Ant colonies exhibiting sophisticated collective behaviors without a central controller, swarm logic of a flock of birds, economic and social systems self-organizing themselves to adapt changing circumstances and many other complex systems are the distinctive examples of emergence. It is acceptable that emergence is behind not only all kinds of complex natural processes and beings but also social, economic and political systems that form basis for human life. Therefore, it would not be wrong to state that all complex systems have an essential feature of ‘emergence’; and, understanding this phenomenon would lead a broad comprehension about the working mechanisms of complex systems.

Holland (1988), defines emergence briefly as “much coming from little” – which is referring to that complex, sophisticated and surprising forms emerge from the application of very simple rules. The most important key point here is that in order to argue that a system, a pattern or a formation is emergent low-level rules should give rise to higher level discernible macro-behavior. Another important point is that in the absence of a central controller a hidden force can manage this movement from low-level to the high one: ‘adaptive evolution’. According to Johnson (2001), “emergent complexity without adaptation is like the intricate crystals formed by a snowflake: it is a beautiful pattern but it has no function” (p.20). Therefore, emergent systems and their behaviors have an ability to evolve according to the changing needs and to be more intelligent throughout the time.  

Last but not the least, emergence contains a kind of surprise in itself which can be generalized as ‘irreducible complexity’. In other

\footnote{According to Johnson (2001), adaptation is not necessarily a compulsory feature of an emergent system. At that point, he gives the examples of tornados, hurricanes as the emergent systems which are not good at all. These systems are emergent but they do not develop any adaptive process to evolve into a better condition, they are destructive not admirable. (For more, see: Johnson, S. (2001), Emergence: The Connected Lives of Ants, Brains, Cities and Software, Penguin: London)}
words, the macro-behavior of the system cannot be predicted from the interaction between individual components; and, there is always an uncertainty that should be embraced within emergent processes. Surprise, uncertainty and irreducibility are the essentials what make a process, a formation or a system emergent.

**Emergence and Self-organization**

In literature, there is a misunderstanding about using self-organization and emergence interchangeably. Defining self-organized systems with respect to their ability to organize themselves without any external and centralized control seems as if these two concepts are substitutes or even synonyms. However, the similarity between emergence and self-organization is limited with that they are both dynamic and ever-changing processes arising over time. While emergence emphasizes the radically novel macro-behavior resulting from the interactions between individual components, “*self-organization emphasizes the dynamical and adaptive increase in order or structure without external control*” (Wolf and Holvoet, 2005; p.13). In other words, self-organization is an internal organizing process aiming to acquire an ‘increased order’ autonomously; and, emergence is a process having micro-macro effect which is full of surprise and unpredictability.

As emergence and self-organization defining the distinctive features of complex systems, most of the time they occur together and co-operate for the systems itself. ‘Increase in order’ as an essential feature makes the self-organization macro-level characteristic; because in complex systems, while micro-level dynamics are very complicated and sometimes even disordered, macro-level is a kind of ordered or organized condition (Wolf and Holvoet, 2005). In that sense, for a complex system, emergence represents the arising process of complexity from the simple components and interactions. On the other hand, self-organization means the organization of this emerged complexity – macro-state of the whole system – autonomously without any external controller. Emergence and self-organization can both exist without each other and also co-operate together for the system (Figure 3.2).
General Working Mechanism and Models of Emergence

Emergence is a deep-rooted phenomenon dating back to the ancient Greeks and later on, to the beginning of Modernism with the concepts of ‘whole before its parts’ and ‘Gestalt’ respectively. However, these conceptualizations have focused generally on the issue of ‘coherent whole’ not on the dynamic and generative processes lying behind the emergence \(^{23}\). After the development of dynamic systems perspective and the systems theory, the notion of emergence has started to be conceptualized within the context of complexity theories by many scholars such as Newman (1996), Schelling (1969), Prigogine and Stengers (1997), Holland (1998), Weinstock (2010), Wolfram (2002), De Landa (2011), and many others. While some of these scholars have developed theoretical perspectives, some others have tried to develop abstract computational and mathematical models that shows how emergence actually operates; in other words, how simple interactive rules between non-intelligent components give rise to collectively intelligent and complex wholes in a bottom-up and surprising manner without a central controller or a designer. Especially the studies of Alan Turing on morphogenesis – “the capacity of all life forms to develop ever more baroque bodies out of impossibly simple beginnings”, recurring patterns of flowers, fractal formations and his computational and mathematical approaches have paved the way for understanding emergence through the dynamic models (Johnson, 2001: p.14).

\[\text{Figure 3.2: Self-organization as an internal organizing process (left); emergence as a process of much coming from little – micro-macro effect (middle); emergence and self-organization co-operating in a complex system (right). (Wolf and Holvoet, 2005: p.10)}\]

\(^{23}\) According to Wolf and Holvoet (2005), “‘whole before its parts’ and ‘Gestalt’ refer to a pre-given coherent entity, whereas emergence is not pre-given but a dynamical construct arising over time” (p.2).
The first and most important model of emergence that demonstrates how an unexpectedly complex order comes from the simple rules is Thomas Schelling’s (1969) checker board style segregation model. In this model, Schelling randomly distributes a population including two different group and defines a simple basic rule: ‘individuals of different groups can live together – side by side – as long as there are enough (at least, equality condition of supporters and opponents) individuals belonging to their preferences’. If the number of opponents is greater than the number of supporters, the individual changes its condition to ensure the first rule. This simple rule defining the interaction between individuals can lead to unexpected outcomes emergently and generate new formations for the system (Figure 3.3).

Figure 3.3: Schelling’s Segregation Model: six changes in homogenous checker board (top-left); emergent pattern according to the rule (top-right); random allocation of individuals with some space to move (bottom-left); emergent pattern according to the rule (bottom-right) (Batty et al., 2004)
According to Batty (2005), this classic model is the most impressive way to show that how simple individual actions based on simple rules can generate surprising, unexpected and organized outcomes. It would be fair to argue that the emergent segregation patterns cannot be anticipated from the simple rules that are known before the application.

Another important model related with the emergence was developed by Stephen Wolfram as an abstract and computational system of cellular automation. In his overarching book A New Kind of Science, Wolfram (2002) described each cell as an individual actor whose behaviors are strongly based on the behaviors of the neighbor cells. In this way, Wolfram demonstrated a grid system in which each row is the outcome of the previous row by relying on the simple two-dimensional patterns. While these individual patterns are too simplistic, the collection of these patterns based on the pre-defined rules is highly complex and sophisticated. Especially, Wolfram’s the 30th rule for cellular automata is a perfect example for an emergent pattern arising from the simple and rule based interactions in a bottom-up manner 24 (Figure 3.4).

![Figure 3.4: Wolfram’s 30th Rule in cellular automata and its complex fractal outcome (Wikipedia, 2018)](image)

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24 Wolfram (2002) believes that the 30th rule is very vital to understand how complex structures and behaviors in nature emerge from the application of unbelievably simple rules.
In addition to these abstract models, a lot of fractal formations such as Sierpinski triangle, h-fractals, c-curves and many others are also good examples for emergent formations which are generated from the iterative application of very simple rules continuously (Figure 3.5).

![Figure 3.5: Fractal formations emerging from the iterative application of simple rules: Sierpinski Triangle (top), h-fractal formation (bottom) (Marshall, 2009)](image)

**Key Principles and General Features of Emergence**

With respect to the discussions above including definitions, models and general working mechanisms of emergence, some fundamental principles about the phenomenon can be listed before re-framing it in the context of urban planning and design. Firstly, and most importantly, emergence is the process of generating a complex macro effect from the usage of simple micro effects – which is defined in literature as ‘**micro-macro effect**’. In that sense, while the complex macro effect of the system represents the coherent whole that maintain some kind of distinctive identity (or a persistent pattern), simple micro effects are highly interrelated with each other with the help of rule-based interactions (Wolf and Holvoet, 2005). Moreover, the relationship between macro and micro levels is bidirectional: simple rule-based interactions between components affect the emergent macro-structure and this emergent structure influences its components by using feedback mechanisms. Secondly, the classic mantra of many theorists – the whole is more than sum of its
parts – is another important principle for emergence: i.e. **more is different**. There is always a surprise factor in emergent formations which cannot be predicted by examining the pre-defined simple rules. The global behavior of the system is radically novel, full of surprise and irreducibly complex. Thirdly, there is **no central controller or designer** for the emergent systems, formations and patterns. However, this does not mean an uncontrollable anarchy or chaos; indeed, emergent systems are rule-based; and, while the interactions between components are controllable, the whole is not directly and totally controllable. Fourthly, emergent systems are full of uncertainties and according to Johnson (2001), “ignorance is useful” to trigger emergent formations (p.77). Embracing the intrinsic uncertainties would encourage random encounters, and radically novel formations and patterns – which is already another necessary principle – in emergent systems. Last but not the least, emergent structures and systems have both **robustness and flexibility** at the same time. Because of the fact that the emergent structure is highly dynamic and composed of large number of individuals, no single entity cannot control the whole and also cannot cause a failure for the system. As stated by Wolf and Holvoet (2005), while individual components can be replaced, evolved or transformed in a dynamic manner (flexibility), the whole or the emergent structure can remain and maintain its identity (robustness).

### 3.2.3 Emergence, Cities and Emergent Urban Order

Until the rise of complexity theories, dominant approaches in urban planning and design was based on the pre-acceptance of controlling the growth, transformation and change of the cities by forming governmental institutions working in a top down manner at different hierarchical levels. However, with the introduction of complexity thinking and its conceptual implications and novel insights, planning environment have realized that, in addition to these dominant top-down understandings, cities are also the outcome of the interactions between individuals operating from bottom to up. According to Batty (2007), “the complexity paradigm simply changes the focus from top down to bottom up, emphasizing that actions are as much local as global but with structure and order emerging as much, if not more, from the bottom” (p.4).
Following the development of complexity approach to cities, urban planning and designed experienced a more sophisticated comprehension which takes its roots from the systems approach’s cliché “the whole is greater than sum of its parts” and argues that the complex system structures emerge from the interaction between individual parts and the whole system is not a direct result of the agglomeration of individual components. By understanding the notion of complexity in the context of cities, urban planning and design has started to shift its focus to ‘design as evolution’ with respect to complexity and emergence and moved away from the mechanistic thinking way of cities. Contrary to the conceptualization of city as singular, separated and fixed structures from their context, environment and people living in there; a new understanding that consider cities as complex material structures having a lifespan, existing with other systems (natural, physical or so) in accordance and developing in an evolutionary manner has emerged (Hensel, Menges and Weinstock, 2010).

As one of the particular examples of complex systems, cities started to be conceptualized as a complex and organized outcome of the emergent process. According to Salingaros (2005), the city as a whole is a product of emergence and this whole is surprisingly different from the sum of urban and architectural components – it represents a unity having its own identity, character and life. In that sense, the emergent order of the cities (especially that of the unplanned or traditional ones) is a product of a huge network of processes in cities (Alexander, 1987); not imposed, planned or designed from top to bottom but arisen (emerged) from the individual actions at micro scale in a bottom up manner. However, it does not necessarily mean anarchic way of creating an order; instead, this complex order emerge spontaneously from the consistent application of implicit, simple and basic spatial rules through a long period of time. There is no comprehensive plan, design scheme or blueprint; just a set of pre-defined, inherent and intrinsic rules and the individuals to follow them. Emergence is the most vital keyword in the context of complexity and cities to help planners and designers understand “how human cities can be unplanned and yet ordered and functional” (Marshall, 2009, p.150).
On Emergent Nature of Unplanned Cities

As a matter of fact, fundamentals of the emergence can be found in the cases of unplanned – or in other words traditional – cities which are generated in the absence of any comprehensive planning and design mechanisms and institutions. While the individual buildings or streets could be designed consciously with some certain motivations, the whole macro form of the city was not designed by a single architect or a planner using the blueprints. Instead, the traditional cities emerged from the application of simple rules in the micro level, appeared spontaneously according to specific contexts and evolved continuously to the changing needs of the society.

According to Johnson (2001), while the imperial cities which were designed by master planners (such as St. Petersburg and Washington DC) are exceptions in that meaning; the organic, traditional and unplanned cities like Florence and Istanbul are final outcomes of the collective behavior of the individuals at the micro level: “They are the sum of thousands of local interactions: clustering, sharing, crowding, trading – all the disparate activities that coalesce into the totality of urban living” (p.109). Although these traditional cities were not planned, controlled and developed by master planners, they seem to have a complex, coherent and functional order unexpectedly. According to Helie (2012), it does not mean that the most successful cities in the history have not been those having the ‘least planning’ but the ‘most enabling plans’ 25. In other words, these traditional settlements had a strong potential to adopt different planning and design rules and to evolve according to emerged conditions. They were not like the imperial cities which are examples of the frozen state of a single designer’s imagination; instead, these settlements and their structure were flexible and open to unexpected circumstances and uncertainties.

25 Helie (2012) argues that the Manhattan plan of 1811 is a perfect example for the condition of ‘least planning’ but ‘most enabling plans’. This plan “provided for the flexible extension of a street grid without interfering in what could be built within the blocks, and so enabled a surge in urbanization that was unmatched in history. Eventually this model reached its complexity limits and a new design for Manhattan was applied (with varying success), such as the building codes that gave us wedding-cake skyscrapers, and the metropolitan transit system of subways and later on expressways”. (For more, see: http://emergenturbanism.com/2007/10/18/emerging-the-city/)
The city of Manchester in England is another important example having an emergent order which was not planned consciously but emerged through the years of industrial takeoff between 1700 and 1850. Actually, until the British government officially recognized Manchester as a city at the beginning of twentieth century, it was run like a feudal estate having no local government and no central authority to plan and control the city. In spite of that, through the chaotic years of population explosion and immense increase in the industrial sectors, Manchester has achieved a strange, unexpected and surprising kind of order: ‘emergent order’. As one of the most intellectual public figures at that times, Engels (1844) summarized this emergent order in his overarching book The Condition of the Working Class by observing the daily life in the city:

“The town itself is peculiarly built, so that someone can live in it for years and travel into it and out of it daily without ever coming into contact with a working-class quarter or even with worker. [...] the working-class districts are most sharply separated from the parts of the city reserved for the middle class. [...] I know perfectly well that this deceitful manner of building is more or less common to all big cities. [...] And yet it is precisely Manchester that has been built less according to a plan and less within the limitations of official regulations – and indeed more through accident – than any other town” (Engels, 1987: cited in Johnson, 2001; p.34).

According to Johnson (2001), the complex and emergent order that Engels realized on the streets of Manchester was really a systematic order and pattern which is not designed with conscious and explicit intention but emerged from the social dynamics of the city to separate different social classes from each other. Emergent order of Manchester was the outcome of individuals’ repeated behaviors in accordance with each other. In that sense, emergent urban order – which is standing somewhere in

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26 Johnson (2001) argues that the local and micro behaviors of individuals resulted in larger movement and eventually a complex order. Basically, “upscale shops dominate the main boulevards, while the working class remain clustered invisibly in the alleys and side streets, the artists live on the Left Bank, the investment bankers in the Eight Arrondissement” (p.40).
between order and disorder, control and anarchy, design and spontaneity – arises from a few simple rules of interaction and repeating behavior patterns.

**Emergent Urban Order as a Rule Governed System**

At the first glance, although emergence in the context of cities seems like a chaotic or anarchic self-organization process within the absence of any controller, designer or manager, it is actually a systematic spatial production process which relies heavily on rules, or agreed patterns. Without following these local rules, there is no chance of achieving a macro-level order – or organized complexity – and a collectively intelligent behavior. According to Mehaffy and Salingaros (2011), application of the simple rules is the key idea behind the emergence of all complex systems and these adaptive rules operate at a fine grain by beginning from the scale of person and going up to that of a family, neighborhood and city. Actually, in that sense, the most vital problem identified via the help of complexity based perspective is related with imposition of these rules at the macro-scale in a top down manner. As the pioneer of urban complexity thinking, Jacobs (1961) emphasizes the importance of ‘streets’ as the most important micro level element to understand how a city works or how the complex urban order can be achieved. Jacobs realized that street level – micro or local – interactions enabled urban spaces to create complex orders; because, according to her, macro scale and collective order and vitality of the cities emerge from the “loose, improvised assemblages of individuals who inhabited those streets” (Johnson, 2001; p.92).

In addition to that, these micro-level rules are flexible, open-ended and adaptive enough both to allow self-organized adjustments at micro-scale and to create a coherent whole at the macro-scale simultaneously. According to Helie (2009), these micro-level rules seems similar to ‘urban planning and design codes’ which are working at local scale; enabling users to make flexible adjustments and achieve diversity; and, integrating individual components into the whole urban fabric coherently. Within this context, it would be fair to state that emergent urban order is generated via the application of simple rules which are working at the micro-level,
evolving according to the changing needs, allowing both flexibility for individuals and robustness and coherency for the whole at the same time. Beyond of that, an emergent urban order cannot be predicted by just analyzing the micro-level rules; it always entails the novelty, surprise and uncertainty in itself. “Emergent behaviors are all about living within the boundaries defined by rules, but also using that space to create something greater than the sum of its parts” (Johnson, 2001; p.181). These relational rules are not about determining the final form or design outcome; instead, they draw a general framework for the design process which will generate the emergent outcome.

**Emergent Urban Order Through Generative Process**

Process is the most essential part of emergent urban order and urban complexity; and, from the complexity based perspective, design is considered as a continuous process not a desired end-state. This continuous, dynamic and adaptive process is called as ‘generative’ and cannot be controlled with conventional master plans, blueprints and comprehensive schemas. According to Mehaffy (2008), urban planning and design must be taken into consideration as a ‘generative process’ from which the complex urban order will emerge without being pre-planned, standardized or optimized in a top-down manner. By differentiating from stationary approaches of urban planning and design, generative design approach concerning the issues of complexity and emergence enable us to understand how complex urban order is emerged through the recursive micro-actions of individuals – based on the rule-governed relationships discussed above – in an evolutionary and bottom-up manner. In that sense, while comprehensively controlled plans or blueprints specifies the complete design product and its desired future-state, ‘recipes’ – which are generative, open and flexible route maps – tell of the key steps required to generate the form.

Alexander (2002) defines the generative process of emergent urban order with the concepts of ‘growing wholes’ and ‘morphogenetic urbanization’. According to him, the whole should grow piecemeal and include a dimension of time; at the end of the process, this whole should be truly coherent – in other words, its parts should be related
with each other in a highly intricate and complex manner; and finally, the whole should be unpredictable – i.e. it should not be clear, fixed, precise or certain about how the form will continue and end. However, in comparison, the modern practice of urban planning and design slices up the land into identical zones and does not develop it piece by piece but instantly, does not produce an unpredictable, emergent and coherent complexity but a highly predictable, static and superficial order.

Moreover, generative processes which are adopted to achieve emergent urban order accepts uncertainties, novelties and surprises by means of its feature of adaptation. This dynamic process includes the evolutionary working mechanism which can be described as ‘adaptive emergence’ (Marshall, 2009). Emergence of the complex urban order is brought about by continuous and adaptive sequence of configurations and transformations at the local level; it is not imposed from above – or created – by a divine hand. In that sense, “generative processes tell us what to do, what actions to take, step by step, to make building designs unfold beautifully, rather than detailed drawings which tell us what the end-result is supposed to be” (Alexander, 2002; p.180). Thus, adopting the morphogenetic process approach in urban planning and design enables emergent urban order to develop its structural coherency; to embrace unexpected cases and uncertainties; and, to develop flexible and adaptive outcomes fitting into various contextual circumstances.

Key Lessons from Emergence for Urban Planning and Design

As the foremost concept and term lying behind the formation of all complex systems, notion of emergence has paved the way for new insights and understandings about the issues of ‘comprehending the urban complexity’ and ‘developing alternative planning and design approaches to operate planning and design within the pre-supposed

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27 According to Alexander (1987), “in each of these growing wholes, there are certain fundamental and essential features. First, the whole grows piecemeal, bit by bit. Second, the whole is unpredictable. When it starts coming into being, it is not yet clear how it will continue, or where it will end, because only the interaction of the growth, with the whole’s own laws, can suggest its continuation and its end. Third, the whole is coherent. It is truly whole, not fragmented, and its parts are also whole, related like the parts of a dream to one another, in surprising and complex ways” (p.14).

28 Ibid.
condition of complexity’. In that context, there are some important lessons derived from the notion of emergence for urban planning and design studies.

Firstly, emergence shows how a complex urban order can be achieved without any controller, designer and their top-down interventions. From this aspect, it challenges our stationary planning and design approaches, criticizes top-down, comprehensive and strict control mechanisms and offer a novel bottom-up urban planning and design perspective prioritizing the interactions between individuals and micro-level and small interventions.

Secondly, although it seems like a chaotic self-organized process because of the fact that there is no central authority, emergence is a rule-governed generative process which is similar to evolution rather than design. Thus, emergence represents a dynamic process in which design product – or macro-state – is emerged from the piecemeal, iterative and continuous application of simple and micro-level rules.

Thirdly, emergence embraces the idea of unpredictability and uncertainty in itself because of its non-linear, highly-dynamic and ever-adapting nature. While the micro-level rules are defined, conscious and purposeful; the emergent macro-effect is not necessarily anticipated, envisioned or intended. In other words, emergent formation processes are so irreducibly-complex that the whole cannot be anticipated by analyzing the micro-level rules or interrelationships. In that sense, emergent urban structures or systems are open to new circumstances or possible uncertainties; and thus, they are both robust enough to sustain their internal structure by means of rule-based complex interactions and flexible enough to adapt arisen uncertainties and unpredictable situations as well.

By relying on these key lessons and derived new understandings, urban theorists developed various approaches – which are based on the notions of ‘organized complexity’, ‘emergence’, ‘generativity’ and so on – to the problems of cities in the revealed condition of complexity. The alternative perspective caring these issues is significantly different from the conventional ideas about urban development, planning
and design. This perspective “is not the same as zoning, which tries to impose fixed rules on development, without regard for the emerging whole. It just isn’t the same as planning, which tries to create the whole by establishing plans, and then filling in slots” (Alexander, 1987; pp.240-241). According to Habraken (1987), this challenging mind-shift mainly deals with how a complex whole can be attained “without imposing uniformity and rigidity where variety and adaptability over time are desirable” (p.3).

3.3 A Brief Review of Contemporary Design Approaches

By relying on the enhanced understanding of urban complexity and its emergent nature, various scholars have developed various planning and design strategies to address the question of ‘how to operate spatial planning and design in the mind-challenging and a kind of unsettling condition of complexity’. While there are so many different perspectives and viewpoints about these issues, they can be categorized in three main groups: (1) rule based design approaches using patterns, types, codes, generic guidelines and grammars; (2) simulation models and systems including cellular automata, agent based models and city games; (3) analytical tools to evaluate design solutions and compare them with acceptable standards.

However, in the context of this research prioritizing particularly spatial ‘designing’ or ‘making’, limiting the scope of the review with the first two categories which are directly used as design and control tools would be more appropriate. The third category of analytical approaches are important as much as the others; because, these evaluation tools – such as space syntax (Hillier, 1996), place syntax (Stahle et al., 2007), route structure analysis (Marshall, 2005) and geographic information system analysis – help planners and designers to enhance awareness about the existing conditions, understand their problems, analyze them with specified indicators and compare these analytical outputs with commonly agreed standards. However, these analytical tools are not directly used in planning and design processes; instead, they are only used after the design process is finished and design product is emerged. Within this context, the first two categories would be examined briefly to understand the contemporary design
approaches by being aware of the fact that the third category of evaluation tools cannot be underestimated at all.

3.3.1 Rule-Based Planning and Design Approaches

According to the scholars, designers and theoreticians adopting rule based approaches in planning and design, historically accumulated habits, traditions and knowledge of people to build their living environment are valuable spatial expressions. In that sense, repetitive patterns, types, codes and grammars offer a strong social agreement on how to live, behave and build (Beirao, 2012). They offer collectively-agreed and various rule-based solutions to certain spatial problems; and, for this reason, rule-based systems produce not only controllable but also flexibly generic spatial outcomes. They are like *recipes* not blueprints, in which, individuals or parts follow simple rules that are open to personally alternative interpretations and applications; but, the whole implies a specific, recognizable and ordered spatial organization.

Alexander’s patterns and organic development rules (1977), process-based and morphogenetic approaches to reach a whole (1975, 2002); Habraken’s generic guidelines and rules focusing on the ‘types’ and allowing individuals to take personal decisions (1972, 1988); urban planning and design codes which are used by especially New Urbanists to support design solutions; and lately, shape grammars developed by Stiny (1980) and urban grammars (Beirao and Duarte, 2009) which is the translation of the term into urban planning and design are the most essential examples of rule based systems in the field of spatial planning and design.

**3.3.1.1 Christopher Alexander**

In the middle of twentieth century, spatial planning and design issues was generally controlled by the policy called as ‘masterplan’. Master plan represents a combination of a map and a set of spatial prescriptions which exhibits the future growth of the city, defines the land uses and prescribes the spatial limits in both qualitative and quantitative manner in order to manage various individual acts of building and to
create an ordered spatial organization and a whole. However, according to Alexander et al. (1975), a master plan can create a totalitarian order and control but not a whole and organic order: “the conventional master plan cannot solve the basic problem, because it is too rigid to do so- and, because, in addition, it creates an entirely new set of other problems, more devastating in human terms than the chaos it is meant to govern” (p.10).

In his book The Oregon Experiment (1975), Alexander et al. criticizes modern built environment lacking a natural and emergent order that exhibits itself in traditional environments built centuries ago. According to Alexander et al. (1975), this emergent order was not planned by a master plan but happened by chance – i.e. by arising from the combination of tacit knowledge, culture-defined agreements and collective actions of people sharing the same rules and principles. Within this perspective, Alexander developed an implementable planning and design process in which a common pattern language was developed by individuals collectively, and then applied in an incremental manner to create a bottom-up growth and emergent order at the campus of University of Oregon. Piecemeal growth approach of Alexander at Oregon was radically different from the notion that spatial planning and design should be controlled by fixed, large scale and comprehensive master plans. Instead, the whole development process of the campus area was managed by developing a series of different projects implemented step-by-step at various scales in different time periods (Figure 3.6).

The immature approach of using patterns and rule-based systems in planning and design has been developed further by Alexander and presented in his overarching work A Pattern Language (1977). In general, the concept of pattern language proposed that common problems of urban environment can be dealt with generic design solutions including 253 spatial design patterns. According to Alexander (1977), these patterns are ordered in a complex systematic relationship which begins with macro level patterns at region and town scale and working down through micro level patterns at neighborhood, building and room scale (Figure 3.7). Pattern language was a quite radical approach at that times because of the fact that it accepts the urban environment
Figure 3.6: Piecemeal growth process of the University of Oregon (Alexander et al. 1975).

as a complex system which cannot be dealt with large scale, top-down and static master plans; but should be generated with the iterative application of simple rules and patterns in a bottom-up manner. By depending on the speculative questions of

“can the structure emerge simply from the spontaneous interaction of the parts?”; “can it be created by a free process, in which the people locally do what they want, and still create the whole successfully?”; “must there be some kind of control, some kind of totalitarian order, imposed from above, which restricts the freedom of the individual acts, and forces them into a large-scale order?” (pp.496-497),
in The Timeless Way of Building, Alexander (1979) drew a comprehensive design framework – a common design language – in which millions of individual interactions will generate an urban space that is truly whole and unpredictable at the first glance: “this is the slow emergence of the quality without a name, as if from nothing” (p.493).

In 1987, Alexander published another influential book emphasizing his theoretical approach – *A New Theory of Urban Design* – in which a radically new urban design experiment was presented. In the book, Alexander (1987) argued that the act of creating a whole in the urban space can only be achieved with the help of a process of urban growth and development which is almost spontaneous and emergent from the individual actions of community.
In order to test this idea, Alexander and his colleagues have defined seven intermediate spatial-formation rules\(^{29}\) to lead the urban growth process at a practical level. Then, they simulated an imaginary urban design process based on these seven rules in a part of the San Francisco waterfront to test this idea. This simulation process was conducted by eighteen graduate students representing different individuals or community groups in the society acting according to the simply pre-defined spatial rules. Within this context, the whole area was emerged by relying on simple urban design rules and a complex coherent whole was achieved throughout the generative process of incremental growth (Figure 3.8).

Following the developments in complexity sciences, Alexander developed further his organic, incremental and process-based urban design approach in his recent magnum opus “The Nature of Order”. In this book, Alexander (2002:2) sees the concept of whole as a result of both unpredictable and emergent process which exhibits complex order beneath the systematic rule-based relationship between its simple parts. According to him, evolution of the complex whole throughout this emergent and unpredictable process is possible by ‘fifteen structure preserving transformation rules’.

Adopting these structure-preserving rules allows generative stages of transformation; and, made the complex whole not only structurally robust but also developmentally flexible throughout the creation process. In that sense, according to Alexander (2002:2), spatial formations which are well-adapted to different conditions, organically various and emergent can be generated by the continuous application of these rules – in other words, by the sequence of unfolding\(^{30}\).

\(^{29}\) According to Alexander (1987), these seven intermediate rules (piecemeal growth, the growth of larger wholes, visions, positive urban space, layout of larger buildings, construction, formation of centres) are actually sub-rules of the one rule: “creation of the complex wholeness”. “Every increment of construction in the growing city must be designed to preserve wholeness at all levels; from the largest level of public space, to the intermediate wholes at the scale of individual buildings, to the smallest wholes that occur in the buildings detail” (p.29). (For more, see: Alexander, C. (1987), A New Theory of Urban Design, Oxford University Press: New York).

\(^{30}\) Alexander (2002) defines the concept of ‘sequence of unfolding’ as similar with the definition of the ‘emergence’. It means the creation of a complex structure easily, nicely, smoothly in a certain order including specified rules. (For more, see: Alexander, C. (2002:2), The Nature of Order, The Centre for Environmental Structure: Berkeley: California, pp. 299-322).
Figure 3.8: Incremental development of the growing whole for the project area in San Francisco (Alexander, 1987).
3.1.1.2 N. John Habraken

Habraken’s general approach to design is about designing basic guidelines including simple generic rules and allowing all actors of the society to interpret these guidelines variously within the limits of the rules. In the book ‘Supports: An Alternative to Mass Housing’, Habraken (1972) introduced the dual concepts of ‘support’ and ‘detachable units’ – while the former represents the structure of the environment which is more stable and robust, the latter addresses to all spatial elements than can be decided by the users which is related with creating enough space for users to change and alter.

By criticizing the dominant role of the designer and emphasizing the issues of ‘distribution of the control of complexity’, ‘allowing change and adaptation to variety of uses on all levels’ and ‘design as slowly evolving and emergent process’, Habraken (1980) argues that “a physical structure has to be designed to allow for individual initiative, and to assure that the whole is more than merely the sum of its parts” (p.23).

In order to achieve this duality of control and flexibility at the same time, Habraken (1988) studied on the concept of ‘type’ and defined the term basically as ‘socio-spatial agreement’ based on architectural values and rules among people. Architectural types reflect basic design rules which must be obeyed throughout the evolutionary process of design; and indeed, these rules are open to different interpretations and self-expressions at micro-level. In that sense, while the micro level rules are well-defined, the macro level effect of the iterative application of these rules are unpredictable and emergent (Figure 3.9). According to Habraken (1988), this rule-based design system allows enough space for a robust and complex structure and millions of flexible and emergent interventions simultaneously – in other words, “the type makes us share its particular values and therefore share a culture, while at the same time it allows us to express ourselves as individuals within that culture” (p.3).
Figure 3.9: Christina Grybojanni’s generic architectural types and derived scheme of the neighborhood in Kessariani, Athens generated by the iterative and derivative application of typological rules (Habraken, 1988)
3.1.1.3 New Urbanism and Form Based Urban Coding

New Urbanism as one of the most important school of thought in urbanism has proposed using the urban design codes\footnote{According to Carmona et al. (2006), throughout the history of cities, different forms of urban regulations have occurred and the use of the design codes could be traced back as far as Roman times with reference to Vitruvius’ Ten Books on Architecture and the detailed spatial prescriptions in it. Moreover, according to him, “a historical precedent for design coding was seen in the rebuilding of London after the Great Fire of 1666” (p.214). However, design coding based on the ideas of New Urbanists represents the most contemporary approach referring to the issue of achieving a complex system by relying on a rule-based system in an emergent manner.} throughout the urban growth processes and represented an alternative approach to conventional master planning. Urban design codes – especially the ones developed by the New Urbanism perspective –

“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 et al., 2003; p.252).

According to the New Urbanist approaches, the conventional master planning tools and ‘modern’ spatial planning and design standards are insufficient to build traditional neighborhoods and urban districts. Contrary to these oppressive ways of controlling urban form, urban codes working at the smallest scales of urban planning and design ensure both variety at the micro scale and harmony and coherency within the whole at the same time (Figure 3.10). According to this broad perspective, design codes should be flexible enough to allow individual expressions; and, by doing so, it should steer the emergent process of complex, intricate and coherent spatial formation.

3.1.1.4 From Shape Grammars to Urban Grammars

Shape grammar means a sequence of very simple shape transformation rules working step by step to achieve a complex language operated by this generative grammar.
Figure 3.10: Typo-morphological urban design codes applied in Montreuil, France including building typologies, plot ratios and typologies and height limitations (Carmona et al. 2006)
Shape grammars were introduced by Stiny and Gips (1972) as the recursive application of simultaneously descriptive and generative set of rules allowing emergent design formations.

According to Beirao and Duarte (2017), in order to produce complex urban order and manage emergent formation processes in urban spaces a new design methodology which is capable of allowing various design solutions instead of a single one is required: using shape grammar approach to develop urban design grammars. This unified point of view, accepts uncertainty and complexity as the most dominant phenomenon in the growth of cities; and, tries to develop a flexible urban design methodology producing adaptable, emergent and complex design outcomes by following the simple rule-based grammars. According to Beirao and Duarte (2009), translating the concept of shape grammars into spatial design and developing urban grammars to produce urban planning and design solutions allow designers to generate alternative solutions containing enough flexibility to embrace various contextual changes and related uncertainties (Figure 3.11).

**Figure 3.11:** Shape grammar rules for producing urban blocks and diversification of the generic design outcomes (Duarte and Beirao, 2011: pp. 890-891).
In the recent years, it would be fair to state that it is possible to understand the simple rules behind the traditional urban patterns and grammars by analyzing their geometries and formation processes within the perspective of shape grammars. Especially, in the article ‘An Urban Grammar for the Medina of Marrakech’, Duarte et al. (2006) demonstrated that it is even possible to generate emergent urban design schemes based on the iterative and recursive application of these grammatical rules (Figure 3.12).

![Figure 3.12: Bottom-up derivation of the Zaouit Lakhdar Zone in Marrakech with the application of shape grammars (Duarte et al., 2006: p.324).](image)

### 3.3.2 Simulation Approaches for Urban Planning and Design

Due to the developments in complexity science and realization of new understandings and insights about the nature of cities, a new generation of simulation models and systems have occurred. According to Portugali (2012), “quantitative urban simulation models are capable of describing, simulating and predicting urban scenarios in an efficient and accurate way” (p.52). The most significant quantitative simulation models are ‘cellular automata’ techniques to simulate urban developments and sprawl; and, ‘agent based models’ to predict dynamic relationship between people and environment (Batty, 2005). The use of simulation approaches enhances the awareness
of the designers about the emergent spatial processes and enable them to develop insights into how different design solutions can be generated for the changing circumstances throughout the time.

In addition to these simulation models, with the advent of participatory decision-making approaches related with integrating all actors of the environment to simulate real-like conditions, ‘city games’ for specific contexts have been developed. According to Mayer et al. (2009), city games replicate the real conditions and rules in the urban space and allow individuals to participate in this simulative planning and design process. Several different strategies related with these ‘serious games’ have been developed by many scholars in the recent years – e.g. (Tan, 2009); (Mayer et al., 2009) and (Venhuizen, 2010).

3.3.2.1 Cellular Automata and Agent-Based Models

According to Batty (2005), spatial order of the cities emerges from the bottom-up and this emergent process can be simulated in two distinct ways: “through cells, which represent the physical and spatial structure of the city, and through agents, which represents the human and social units that make the city work” (p.23). With the first one – cellular automata – the change of the individual cell’s state is defined in reaction to the transition rules and according to the its neighborhood cells. With the help of these rule-based local actions, a spatial recognizable order is generated at global scale. Batty (2005) uses Cellular Automata for simulating processes of urban growth and urban sprawl in order to exhibit how complex spatial patterns emerge from relatively simple rules and to understand the dynamism of the cities that give rise to these emergent formations (Figure 3.13).

The second simulation tool – agent-based models – is used to understand the relationship between the interactional behavior of the agents and spatial outcomes of this interaction. It enables designers to understand how individual level interactions lead to an emergent, unexpected, complex and surprisingly organized spatial outcome, which is exactly the more than the sum of its parts. With agent-based models, for
instance, the spontaneous flow of pedestrians is replicated by the mobile agents on a digital platform, and most likely preferred or shortest routes can be identified.

![Figure 3.13: Urban growth simulation with cellular automata: analyzing urban land-cover and projecting probable growth areas (United States Census Bureau Website, 2018)](image)

Despite their well-known achievements, sophisticated urban simulation models and systems are criticized by many scholars, as well. According to Portugali (2012), the widespread usage of the simulation models in recent years has paved the way for a vital threat: the medium of simulation has started to become the actual message. According to him, while the simulation processes are highly dynamic and complex the results represent a kind of stable and simple environments overlooking the emergent nature and unpredictability of the urban systems. In addition to that, simulation models are criticised for underestimating the qualitative spatial messages of complexity theory and considering cities as if they are just rich databases for testing simulation models.
3.3.2.2 Game Urbanism: Serious Games to Design Urban Space

According to the scholars adopting this approach, cities are complex systems that maintain their organizational structure with the help of continuous interaction between their various urban agents and actors and this complex network of interaction defined with the notion of SIRN (Synergetic Inter-Representation Networks) (Tan & Portugali, 2012; Portugali, 1996). Although city games are quite new interpretations in the context of complexity theories, it is possible to observe similar approaches in the past – e.g. Alexander’s experimental approach in A New Theory of Urban Design (1987) to simulate an urban growth process in San Francisco by following simple rules in an incremental manner, with eighteen graduate students.

Contrary to the simulation systems including cellular automata and agent-based models; in city games, urban agents are not mathematical or digital entities, but real people living in the simulated city. In general terms, a city game is conducted to re-build the defined project area within a specified context. For that purpose, each player is given several mock-up models of existing buildings and asked to place them in the virtual city on the floor or any flat surface wide enough. Throughout the game, players make their move on their own turn according to the simple rules if there are any, examine the virtual city simulated on the floor and observe the development of this virtual model that is created collectively. According to Tan and Portugali (2012), “It is typical in such games that, after a few initial iterations, an observable urban order emerges. The participants internalize this emerging order and tend to locate their buildings in line with it” (p.378) (Figure 3.14 and 3.15).

Simulation games create an experimental, rule-based and interactive environment which allows wide range of urban agents – whether they are professional in planning and design or not – to integrate into decision-making processes (Mayer et al., 2009). In that sense, city games address to the condition of complexity in terms of the plurality of the actors and their dynamic inter-relationships. By means of the easily understood and applied ‘organizational’ rules (not ‘design’ rules), a self-organized, emergent and bottom-up order would be possible within the absence of a central controller.
Figure 3.14: A typical city game: emergent growth process of the model (Tan and Portugali, 2012: p.378).

Figure 3.15: A series of iterations from a city game and observable emergent order (Tan and Portugali, 2012: p.379).
3.4 Concluding Remarks

Moving away from the stationary and conventional approaches by following the emerging paradigm shifts with the complexity theories has not been so easy for urban planning and design. The discipline has experienced cognitive struggles and paradoxical challenges while adopting the complexity thinking and translating its derived notions and concepts into its own agenda.

The first struggle was about understanding the notion of complexity, translating it appropriately into planning and design and accepting it as an intrinsic, natural and inevitable feature of cities rather than seeing it as an unmanageable problem. With the help of the pioneers of complexity thinking in urban theory – such as Jane Jacobs, Christopher Alexander and many others – the term has been translated into planning and design agenda as ‘organized complexity’. These developments offer a cognitive breakthrough leading to the new perspectives and greater understandings about the nature of cities. Considering the cities through the lens of complexity theory has led to the significant contributions: (1) cognitive contributions about new insights and understandings about non-linearity, emergence, uncertainty and so on; (2) contributions to fundamental planning and design approaches – such as development of the rule-based planning and design approaches, simulation systems and models and participative frameworks; (3) contributions to urban space’s itself like perceptual richness, spatial variety and heterogeneity, enhanced functionality and resilience of the urban structure through adaptation.

After dealing with the first struggle by using the accumulation of knowledge in this field, the second and most recent paradoxical challenge has emerged: the complexity's way of coming into existence – its emergent nature. The realization of complexity's arising naturally from bottom-up with the absence of any controller or designer has motivated urban theoreticians to ask the question of ‘how does urban complexity come about without the usual efforts of planning and design and even without a designer’. Understanding of emergence, its key aspects and working mechanisms have paved the way for adopting an evolutionary, adaptive and generative urban
planning and design perspective which helps complexity to emerge throughout the morphogenetic processes of design. By relying on the enhanced understanding of urban complexity and its emergent nature, various scholars have developed various planning and design strategies and approaches to address the question of ‘how to operate spatial planning and design within the mind-challenging condition of complexity and emergence’. Contemporary planning and design approaches developed within the context of this question can be listed as; (1) rule based design approaches using patterns, types, codes, generic guidelines and grammars; (2) simulation models and systems including cellular automata, agent based models and city games; (3) analytical tools to evaluate design solutions and compare them with acceptable standards by using space syntax, place syntax, route structure analyses and geographic information systems.

Based on these cognitive, theoretical, practical challenges and matured accumulation of knowledge discussed throughout this chapter, it would not be wrong to state that cities are complex systems; and, as a natural result of this condition they are intrinsically emergent systems par excellence. The ordered appearance observed in traditional settlements, self-organized spatial formation processes of informal settlements and many other examples represent an illusion of conscious planning and design. Emergence – as the actual reason of this illusion – is the notion that help planners and designers to understand that the actions shaping the urban spaces are “as much local as global but with structure and order emerging as much, if not more, from the bottom” (Batty, 2007; p.4). Within all this revealed context, emergence-based perspective – which considers cities as emergent systems that are spontaneous, self-organized and even random from time to time – has affected the discipline of urbanism which including pretty rationale consciousness and deliberate acts of intervention; and, eventually the role of the planner and designer in that sense.

Contrary to common view, emergent systems do not represent a complete anarchy and chaos even if they do not include any central controller and designer intrinsically. Instead, these rule-based systems represent an evolutionary process which generate considerably organized structures from the collective actions of decentralized
individuals. In that sense, from a designer way of thinking, it would be argued that a controller, a designer or a divine hand does not control and design the macro behavior of the system; instead, all a designer can do is set up the rule-based conditions and relationships between individual components. Thus, idea of a new kind of designer emerges from this mind-shift. Actually, the term cybernetics – as the pioneer thinking of systems theory, complexity and emergence – developed by Norbert Wiener gives clues about the new role of designer. Cybernetics derives from the Greek word meaning “steersman” and addresses to the ‘the science of control, guide and communication for a system’. According to Johnson (2001), in the context of emergent systems, designer has a new kind of hybrid role: a designer controls the micro motives like a programmer-simulator, can have a feeling about the macro behavior like an artist but accepts that this macro behavior has a life of its own and it is out of his/her direct control. Therefore, “great designers like Wright or Resnick or Zimmerman are control artists” – they have a fell for that middle ground between free will and the nursing home, for the thin line between too much order and too little. They have a feel for the edges” (Johnson, 2001; p.189). Moreover, according to (Marshall, 2009), what is needed in urbanism is a different kind of planner and designer: “urban code-writer” – who is building urban form without the need for old-style blueprints and enabling “individual citizens as self-builders to contribute to the generation of urban form through smaller-scale interventions” (p. 163).

Within the context of emergence-based perspective, it would not be wrong to state that while designers have a considerably rule-based control at the micro scale, the macro behavior of the whole system is not directly controllable, full of surprises and uncertainties. Alexander (1979) defines the emergent urban order as more complex than any other kind of order and asserts that this whole cannot be predicted and forecasted by the conventional masterplans and blueprints. The whole and organized complex structure of the cities emerge simply from the interactions between millions of both creative and destructive acts of individuals and it is inevitably unpredictable.

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32 Steer means ‘to direct and control the course (as of a ship or automobile)’ or ‘to pursue a course of action’ (Merriam-Webster Dictionary, 2018).
In that sense, following the first two cognitive challenges and paradoxical debates discussed throughout this chapter, a most recent cognitive challenge would emerge: ‘how can planners and designers can cope with the uncertainty’ which is natural and innate outcome of the complexity and its emergent nature. This question provokes a disruptive feeling for urban planners and designers: “a feeling of directionlessness”. Habraken (1987) criticizes this vague feeling of uncertainty and emphasizes its creative power by arguing that “How can I design if I do not know what the end result will be like? Is a frequent complaint. Why would you need to design if you already knew? Is my response” (p.6). In addition to the challenging tasks of understanding complexity, translating its theoretical perspective into urban planning and design field and accepting it and its emergent nature as intrinsic characters of cities; a new frontier to discover and cross for urbanism has emerged: ‘designing (with) uncertainty’. Therefore, urban planning and design should understand and embrace the notion of uncertainty within the perspective of complexity and emergence; and, suggest alternative and creative responses to be able to operate design within this revealed condition.
CHAPTER 4

DESIGNING (WITH) UNCERTAINTY: TOWARDS A RESPONSIVE URBAN PLANNING AND DESIGN APPROACH

4.1 Uncertainty: Inherent Feature of Complex Urban Formation Processes

The most recent and challenging notions in the world that complexity theories of cities portray are ‘ever-changing dynamism’, ‘unpredictability’ and ‘uncertainty’ of complex urban formation processes. It is inevitably true that continuous change in theoretical understandings, socio-economic variables, design control mechanisms and tools and decision making processes retains urban planners and designers to predict and act for the unexpected circumstances. According to Batty (2012), the unpredictability or uncertainty of the future is originating not only from the philosophical impossibility of prediction as Popper (1959) argued; but also from the simplicity of our models and tools comparing to the complexity of cities itself.

By relying on the theoretical framework of complexity science which is discussed in previous chapters (Chapter 2 and Chapter 3), it can be argued that cities – as an important example of complex systems – are in a state of continuous evolution; and naturally, this process of change and transformation is quite non-linear. Within the non-linear processes of continuous evolution, while a small act can cause a massive effect; a comprehensively big intervention can result in an insignificant outcome. Therefore, uncertainty is an intrinsic and inherent part of the complex urban formation processes. Within that context, before drawing a design framework to cope with uncertainties, revisiting the literature related with the uncertainty in urbanism and more recent interpretation of complexity science – which has valuable implications to enhance our understanding of non-linear change and transitions; and also, related uncertainties – would be fit for the aim of legitimizing uncertainty as an inherent feature of complex urban formation processes.
4.1.1 ‘Wicked Problems’ of Urban Planning and Design: From Obsession with Certainty to Acceptance of Uncertainty

The idea of unpredictability and uncertainty is not that much recent in the urban planning and design theory. Notion of uncertainty in urban planning has emerged within the context of Rittel & Webber (1973)’s remarkable research about the ‘first crisis’ in planning. In their influential study titled as ‘Dilemmas in a General Theory of Planning’, they reflected on the Churchman (1967)’s proposition of ‘wicked and tamed problems’ which are classified according to the difficulty of defining and understanding the scientific problem. According to Rittel & Webber (1973), during the industrial age, planning has been considered as “a process of designing problem-solutions that might be installed and operated cheaply” (p.159) – because of the fact that the problems of industrial age were easier to comprehend and agreed upon their nature. However, especially after the middle of twentieth century, the kinds of problems related with planning has started to changed and moved away from the kind of problems in natural sciences. According to Rittel & Webber (1973),

“The problems that scientists and engineers have usually focused upon are mostly "tame" or "benign" ones. As an example, consider a problem of mathematics, such as solving an equation; or the task of an organic chemist in analyzing the structure of some unknown compound; [...]. For each the mission is clear. [...] Wicked problems, in contrast, have neither of these clarifying traits; and they include nearly all public policy issues – whether the question concerns the location of a freeway, the adjustment of a tax rate, the modification of school curricula, or the confrontation of crime” (p.160).

Within this context, while tamed problems are the ones that can be comprehended,

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33 According to Churchman (1967), “‘wicked problem’ refer to that class of social system problems which are ill-formulated, where the information is confusing, where there are many clients and decision makers with conflicting values, and where the ramifications in the whole system are thoroughly confusing. The adjective ‘wicked’ is supposed to describe the mischievous and even evil quality of these problems, where proposed solutions often turn out to be worse than the symptoms” (p.141). (For more, please see: Churchman, C.W., (1967), Wicked Problems, Management Science, Vol. 14 No:4, pp.141-142).
defined and solved easily, **wicked problems** have no definite and clear formulation. According to Lane and Woodman (2000), while wicked problems have high degree of behavioral complexity – which represents the heterogeneity of different value-based assumptions for the problem’s solution and plurality of related actors – tame problems have relatively low level of behavioral complexity – which means conventional analytical methods and one or several controller/actors are enough for their solution. In that sense, the problems that must be addressed both in theoretical and practical terms are “**wicked and incorrigible**” (Rittel and Webber, 1973, p.167) ones having distinguishing properties that planners should be aware of (Table 4.1).

**Table 4.1:** Ten distinguishing properties of wicked problems (Rittel and Webber, 1973)

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<tbody>
<tr>
<td>1.</td>
<td>There is no definitive formulation of a wicked problem.</td>
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<td>2.</td>
<td>Wicked problems have no stopping rules.</td>
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<td>3.</td>
<td>Solutions to wicked problems are not true-or-false, but better</td>
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<td></td>
<td>or worse.</td>
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<td>4.</td>
<td>There is no immediate and no ultimate test of a solution to a</td>
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<td></td>
<td>wicked problem.</td>
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<td>5.</td>
<td>Every solution to a wicked problem is a &quot;one-shot operation&quot;;</td>
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<td></td>
<td>because there is no opportunity to learn by trial-and-error,</td>
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<td></td>
<td>every attempt counts significantly.</td>
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<td>6.</td>
<td>Wicked problems do not have an enumerable (or an exhaustively</td>
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<td></td>
<td>describable) set of potential solutions, nor is there a well-</td>
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<td></td>
<td>described set of permissible operations that may be incorporated</td>
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<td>into the plan.</td>
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<td>7.</td>
<td>Every wicked problem is essentially unique.</td>
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<td>8.</td>
<td>Every wicked problem can be considered to be a symptom of an-</td>
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<tr>
<td></td>
<td>other problem.</td>
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<td>9.</td>
<td>The causes of a wicked problem can be explained in numerous</td>
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<td></td>
<td>ways. The choice of explanation determines the nature of the</td>
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<td></td>
<td>problem's resolution.</td>
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<td>10.</td>
<td>The planner has no right to be wrong.</td>
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Although the notion of uncertainty has been introduced remarkably into spatial planning theory by Rittel and Webber (1973), potential implications and contributions of the concept has been generally ignored and implicitly remained deep down of the planning theory. However, towards the end of the twentieth century, emerging paradigm of complexity theories has realized the crucial implications of this novel
perspective and rediscovered the wicked problems of planning and the notion of uncertainty in that sense. Especially, Christensen (1985)’s remarkable work addressing uncertainty and complexity within the context of planning has revealed the importance of complexity thinking for leading various planning approaches according to various uncertainties. By accepting that Christensen (1985)’s study raised the notion of uncertainty again, her perspective is much more related with the complexity of a static world, not a dynamic and evolving one (Sengupta et al., 2016).

At that point, complexity theory has portrayed a theoretical framework which puts a question mark and rejects the deterministic notion of predictability and stability and emphasizes evolution of the studied phenomena. According to Moroni (2014), prediction is a very conditional assumption which will happen in the future and highly depended on the recognition and certain validity of existing conditions. However, complex systems are certainly dynamic and ever-evolving; and, for that reason, the assumption for the validity of existing or initial conditions of the system is no longer possible. Therefore, it is impossible to make predictions about the outcomes of the specific intervention and the behaviors of complex systems. In other words, “complex systems are unpredictable, not because of lack of data, but because of their very nature” (Portugali, 2012, p. 213).

Before the realization of complexity science perspective, as uncertainties related with urban planning and design processes are considered as risks or potential failures, the common approach of planning was to control, reduce and prevent uncertainties as much as possible (Abbott, 2009). With the advent of complexity thinking in planning, uncertainties are started to be viewed as an intrinsic and inevitable outcome of complex urban formation processes in contemporary planning and design literature (Abbott, 2009).

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34 Christensen (1985)’s matrix based hypothesis construct the relationship between ‘uncertainty of planning goal’ and ‘uncertainty of planning technology/or mean’. According to Christensen (1985), uncertainties in planning are grouped in two distinct categories – which are correlating with each other and leading to different planning approaches and institutions to cope with these uncertainties: “If people agree on what they want and how to achieve it, then certainty prevails and planning is rational application of knowledge. If they agree on what they want but do not know how to achieve it, then planning becomes a learning process; if they do not agree on what they want but do know how to achieve alternatives, then planning becomes a bargaining process; if they agree on neither means nor ends, then planning becomes part of the search for order in chaos. Each prototype situation suggests a particular range of planning styles”. (p.63).
Acceptance of uncertainty and unpredictability as an inherent consequence of urban complexity raised an awareness about that planners should not ignore the dynamic and non-linear processes of urban change and evolution and should realize that instability is a necessity for development and progress (De Roo, 2010). Therefore, the issue of uncertainty should not be overlooked and the necessary design perspective and operational tools should be developed within the general framework of shifting planning and design perspective (Figure 4.1).

![Figure 4.1: Conceptual shifts in urban planning and design in the context of uncertainty (Adopted from: De Roo, 2010)](image)

### 4.1.2 What Does Uncertainty Imply for Urban Planning and Design?

As the state of complexity implies dynamism and ever-lasting evolution, complex systems like urban spaces are incomplete to some extent. Incompleteness of urban spaces, therefore, connotes to the predictability and knowability level of the system, its key components and actors, and their future state of being. Thus, it would not be wrong to argue that cities which are intrinsically unpredictable complex systems “cannot simply be the built-out product of a creator’s imagination, in the way a building can be” (Marshall, 2012, p.107). This inevitable conclusion leads some certain implications for urban planning and design which are crucially important to develop a novel perspective to cope with uncertainty. According to Marshall (2012), these implications can be grouped in three distinct consequences of complexity: “unknowability of the system as it is”; “unknowability of effects of intervention”; “unknowability of optimal future state” (p.199).
Unknowability of the System as It Is

While for a machine or an organism, even if they are highly complex, most of the parts and their morphology are well known because of the fact that their structure is finite. However, a city, as a good example of complex ecosystem, is not finite at all. According to Marshall (2012), a city should be taken into consideration with its wider scales and issues: “we can’t simply understand a city in terms of what is within the city limits” (p.199). Moreover, unlike a machine or an organism, a city cannot be seen as a product of a single controller or designer; but it should be considered as a collective action of many individuals interacting and competing with each other. Most importantly, Marshall (2012) defines the unknowability of the city with reference to the dynamic relationship patterns evolving unpredictably throughout the time: “There is no expectation that […], the same things will be in the same places doing the same things in relation to each other. The central business district of a settlement could shift unpredictably and irreversibly over time […]” (p.199).

Unknowability of Effects of Intervention

Because of the fact that ecosystems do not follow the same linear trajectories like machines or organisms, their long-term behaviors and naturally the outcomes of the controlling interventions are highly unknowable. While the outcomes of some short-term planning and design interventions seems predictable and quite obvious, when the timescale started to be longer the predictability of the interventions became fuzzier. In spite of our wide and complete knowledge about current population, land uses and values and wider socio-spatial context, our long-term predictions and projections would inevitably fall short to understand the future state of cities due to their dynamic and ever-changing nature (Marshall, 2012).

Unknowability of Optimal Future State

Since an ecosystem includes a wide range of components co-evolving in an interactive manner, it is impossible to talk about a ‘mature or optimal form and state’, (Batty and
Marshall, 2012). With respect to the awareness of the evolutionary nature of urban ecosystems, a city cannot be conceptualized as having an optimal and knowable future state or structure. Marshall (2012) exemplifies this situation by stating that

“In the past, we might have assumed that a town ‘should’ have a town center (in the center), but nowadays it is difficult to be sure what should feature, where. This suggested uncertainty is not limited to recent urban phenomena but can be seen with respect to changing relationships between traditional urban components through history” (p.201).

Within the above context of the consequences of uncertainty in urban planning and design, it would not be wrong to assert that any planning and design act conceptualizing the city as a finite and static product of a single divine hand, trying to predict its future state with deterministic projection mechanisms and designing it with a clear image of optimal form and structure would inescapably fall short to understand the nature of it. Uncertainty, unpredictability and instability are the intrinsic and inherent consequences of complex ecosystems.

However, it does not mean that all kind of planning and design interventions and tools are in vain (Zuidema & De Roo, 2004); instead, it means planning theory and practice should discover and develop a new form of intervention by relying on the derived understandings of complexity theory to cope with uncertainties. Therefore, the question that becomes highly urgent is how planners and designers can embrace the notion of uncertainty and what kind of urban planning and design approach should be developed to strengthen the responsiveness of the urban spaces to cope with uncertainties.

4.1.3 Uncertainty: Paralyzing or Move on?

Traditional urban planning assumed that both planning means and outcomes are known and predictable within the operated context and framework. According to Christensen (1985), “this professional legacy biases planners toward planning
processes that address such conditions of certainty and disguise actual conditions of uncertainty” (p.63). Emerging paradigm of complexity theories and its contribution to planning and design thinking makes this conclusion necessary: ‘uncertainty is a notion that should not be ignored or scared; instead, it should be embraced’. In that sense, uncertainty does not provoke a paralysis effect for urban planning design; instead, it should be valued as an opportunity to discover a contemporary urban planning and design approach which is more responsive to our changing world than ever.

Rather than dreaming about an optimal urban form and structure which last centuries and resist to respond urban change and growth full of unpredictabilities, an evolutionary design perspective should be developed. Basically, this novel perspective entails the idea of ensuring a rule-based design framework which enables the designed urban space to adapt changing circumstances both formally and programmatically. According to Marshall (2012), “planning can be more usefully seen as trying to enable the process of urbanism, a process that to some extent includes design, but is also evolutionary, involving generative, selective and adaptive processes” (p.205). In that sense, the advent of emerging paradigm of complexity and the acceptance of uncertainty as an inherent feature of urban formation processes provokes a dilemma combining the certain design rules (design) with the contemporary notions like adaptability and flexibility (evolution).

In the light of theoretical framework discussed above, it would be fair to express that changing connotations of uncertainty and related inferences of adaptation and flexibility makes it imperative for urban planning and design: ensuring an adaptive urban design framework which allows various possibilities of change and evolution in case of emerging circumstances hard to predict beforehand. Therefore, the delicate balance between controllability and adaptability of design should be addressed by ensuring necessary design structure in which enough choice is provided to enhance adaptive capacity of design for further change and evolution. With that aim, in the next part, the question of what does adaptive capacity mean for urban space would be answered to differentiate the formal principles of urban adaptability (adaptive design) and mechanisms of re-formation, change and evolution (adaptation of design).
4.2 Ensuring Adaptive Capacity of Design for Tackling Uncertainty

Dealing with the notion of uncertainty and unpredictability became one of the most challenging issues in urban planning and design, especially after the critical inquiries of Jacobs (1961), Alexander (1965) and many others questioning the rigid, over-hierarchical and deterministic approaches of modern movement and making “room for the unplanned in planning” (Silva, 2016: p.1040). Until the last years of twentieth century, criticisms were limited with the rigidity of planning and design frameworks that cities have to follow and the inefficiency of simplistic approaches developed with the hypothesis of ‘one-size-fits-all’. With the advent of novel theoretical perspectives and understandings opening up the notions of complexity, emergence and evolution into discussion; contemporary planning problems related with urban growth and change (Sevtsuk, 2011), relationship between form and function with respect to the issue of uncertainty (Sennett, 2008), excessive use of standardized typologies (Shane, 2011) and many others has emerged, as well.

Within this context, while the world’s population is increasing immensely, more than half of the global population is started to be concentrated in urban settlements by presenting both novel and contemporary challenges and promising opportunities. In that sense, the pressure of demographic, socio-cultural, economic and most importantly physical changes bring about a vital need for urban growth and change. According to Sevtsuk (2011), the most urgent need for urban spaces is accommodating both ‘urban growth’ by presenting effective physical design strategies and ‘change’ by enabling settlements to adapt and response to the unprecedented transitions as well. While the expansion of urban settlements and increasing demand for urban growth can mainly be interrelated with the ‘urban form’; unpredictable, emergent and non-linear trajectories of urban formation processes put emphasis on change in ‘functions’ and result in emerging spatial configurations, daily activities and urban land uses. When we take the ever-changing and dynamic interface between form and function into consideration, it would not be wrong to state that the changing and tense relationship between form and function leads critical spatial conflicts and eventually result in destruction, demolition and re-development of the urban spaces continuously.
The main reason of the fragile dynamism between form and function is their over-bounded, fixed and rigid interrelationship which is set up by the conventional and stationary perspectives of urban design and planning. As asserted by Richard Sennett (2008), “The result of over-determination is another paradox, namely that these frozen cities decay much more quickly than urban fabric inherited from the past. As uses change, buildings have to be replaced, since fixed form-function relations make them so difficult to adapt” (p.3). In addition, designing urban space with standardized and inflexible typological solutions give rise to negative externalities on the freedom and control of the end-user, variety and possibility of choice in urban space and capacity of responsiveness for rapid urbanization process and unexpected changes (Shane, 2011). The problem of formal and functional adaptation and responsiveness in urban spaces is because of the common perspective and conventional methodology that dominates urban design and planning by regulating and controlling everything beforehand with fixed objectives in an obsessively certain manner.

Therefore, contemporary urban planning and design need to invent a new and adaptive approach to address uncertainties and unpredictable changes in cities by answering the question of ‘how can we produce the necessary structure for urban space which ensures adaptability and responsiveness for unexpected changes by avoiding from rigidity and over-determination’.

4.2.1 From Fail-Safe to Safe-to-Fail: Why ‘Adaptability’ is Key to Cope with Uncertainty

At the first glance, the effort of controlling the uncertain or unexpected seems an oxymoron; because, while planning and design interventions aim to direct urban development process towards a desired outcome; inevitable uncertainties makes desired outcomes to be restrained. Besides, this paradoxical challenge leaves the question of ‘how planning and design interventions be ready for all possible and unexpected futures’ unanswered. According to Rauws (2015), while being ready for all possible futures is unfeasible; keeping all future paths open certainly undermine the
key objective of spatial planning and design, as well. By being aware of that, urban planning and design should be operated somewhere in between these contrasting ends by providing ‘just enough structure’ which both controls the system and ensures the capacity of responsiveness according to changing conditions. Therefore, the issue of dealing with uncertainty requires a novel and more contemporary understanding about the tense relationships between design and emergence; control and freedom; rigidity and flexibility.

Such an understanding would only be possible by shifting our approach from ‘fail-safe’ to ‘safe-to-fail’. According to Ahern (2011), while the early ideas of achieving stability, control of change and equilibrium by using strict design frameworks is related with fail-safe mentality; more contemporary ideas of change, transition, evolution, uncertainty and adaptability refers to the perspective of safe-to-fail. Contrary to fail-safe system, safe-to-fail system “anticipates failures and designs systems strategically so that failure (or uncertainty) is contained and minimized” (Ahern, 2011: p.1). Safe-to-fail approach advises to develop the system’s responsiveness and recover capacity in case of any change, uncertainty and disturbance; rather than, to control the system’s current and future states in a stable and unchanging manner. Safe-to-fail perspective basically argues that control-oriented and static spatial planning approaches should be substituted with the progressive planning approaches including gradual adjustment, adaptive transition, distributed control mechanisms and self-organization. In addition to this ‘time-conscious’, ‘responsive’ and ‘uncertainty-embracing’ perspective’s contribution, complexity theory and its derived notion of ‘complex adaptive systems (CAS)’ offers a crucial understanding about why ‘adaptability’ is key to cope with uncertainty and unpredictability.

Complex systems like cities are usually defined as complex adaptive systems which respond to changing circumstances by adapting their structural and behavioral characteristics. According to Portugali (2012), adaptability is the most crucial feature of complex systems adapting their structure with respect to the environment in a self-organized manner. Insights depicted from complex adaptive systems offer the
conceptualization of unexpected changes, uncertainties and discontinuous trajectories in urban space as an inevitable and natural part of urban development processes – not as a potential failure or drawback (Tümtürk, 2017). Thus, complex adaptive systems approach contributes the perspective of how urban space can be designed so that it responds to uncertainties and adapts to changing circumstances. According to Rauws (2015), “it provides an argument for planning strategies focused on creating the conditions under which an urban system can develop and redevelop itself, and allow areas to coevolve in response to ongoing changes” (p.129). The notions of safe-to-fail and complex adaptive systems provide urban planning and design with a more responsive perspective to challenge the notion of uncertainty and develop inquiry into issue of ‘why adaptability is key to design (with) the uncertainty’.

Misinterpretation of cities as the pure end-result of purposive planning and design interventions is considered the most crucial problem related with the unpredictability of urban formation processes. As much as cities are conceptualized as the outcome of a master-mind’s creative act; the actual truth is that city’s spatial order arises from not only the interaction between numerous and different plans but also from the inescapable effect of unplanned changes (Alfasi & Portugali, 2007; Silva, 2016). This revealed condition of unpredictability originates from the fact that the complexity of urban life and its ever-evolving nature is above and beyond the relative simplicity of hierarchical organization of form and activities in cities (Alexander, 1965; Alexander et al., 1977). Organized complexity of cities resulting from evolutionary process of gradual changes and non-linear transitions cannot be designed (or invented) by determining and controlling all structural, configurational and compositional details and interrelationships beforehand – it is practically impossible. What is more important, in that sense, is generating urban complexity by using the sequential steps of evolutionary adaptation in order to improve the capacity of urban space to respond uncertainties including various conditional and contextual changes. According to Salingaros (2015), “adaptive design organizes emergent complexity during the design process instead of trying to eliminate it […] organizes existing elements that are responding dynamically to actual and latent human needs” (p.3).
Therefore, the notions of ‘adaptation’ or ‘adaptive capacity’ in the context of urban planning and design offers important contributions to cope with the issue of uncertainty. In terms of design perspective, it paves the way for a more time-sensitive (time-conscious) approach (Prigogine, 1997) considering cities as the collective outcome of an evolutionary process. Thus, this time-conscious approach addresses to the issue of uncertainty by taking the concepts of non-linear transition, urban change and evolution. Moreover, in terms of design strategies, adaptive design perspective emphasizes the importance of allowing urban change and adaptation by providing enough structure to organize urban space and by ensuring wide range of choices to respond changing conditions and related uncertainties in an incremental manner. Thus, it allows to generate an interface between relatively contrasting concepts of ‘design and ‘emergence; ‘top-down’ and ‘bottom-up’; ‘control’ and ‘freedom’ and so on. For that reason, understanding the related notions like adaptation, adaptability and adaptive capacity, investigating what do they mean for urban planning and design and drawing a general framework which entails the fundamental indicators of spatial adaptability would be the most significant objectives of the following part.

4.2.2 Adaptation and Adaptive Capacity of Urban Space

Conceptualization of cities as complex and dynamic systems has paved the way for an understanding of ‘change’ in the theory of urban planning and design and urged the urban planners and designers to think about developing design conditions which are responsive to change and transition. The notions of change and transition without which a city cannot be thought necessitate another crucial concept to cope with the dynamic and ever-evolving conditions of cities full of surprise, unexpectedness and uncertainties: ‘adaptability’. In that sense, what is more important than the question of ‘how to achieve a good design’ is that of ‘how to achieve adaptability’: “or the structural disposition of spaces to change by welcoming changing needs in time” (Porta and Romice, 2010: p.7).

Etymologically, the word ‘adapt’ originates from the 14th century Latin word ‘aptus’ which means ‘suited or fitted’ and takes its most broad definition as ‘to fit something
for some distinctive objectives’ (Harper, 2001). On the other hand, its contemporary
definition seems slightly transformed into “ability or willingness to change”
(Cambridge Dictionary, 2018) or “the quality of being able to adjust to new
conditions” (Oxford Dictionary, 2018). Adaptability then, means both remaining fit
for a purpose and being able to change to respond transition conditions, as well.
According to Habraken (2008), the notion of adaptability has various contradictory
and overlapping definitions in literature – which makes it impossible to define the term
in an overarching manner. Kostourou and Psarra (2017)’s bibliographic research about
the term demonstrates the diversity in the key notions related with the
conceptualization of adaptability (Table 4.2). While some of the definitions are
related with the idea of ‘change over time’, some others address to the issue of
‘longevity or maintaining the structure/state of being’. This definitional duality can be
observed within the context of spatial planning and design. The notion of adaptability
refers to considering design products as evolutionary systems changing their form and
structure in a continuous flux and being fit to contextual transformations. According
to Schmidt III et al. (2010), “achieving adaptability then demands a shift away from
the current emphasis on form and function in response to immediate priorities,
towards a ‘context’ and ‘time-based’ view of design” (p.2). In addition, from the
perspective of complexity theories of cities, Alexander (2003), defines the adaptability
both as a generative process including a series of incremental transformations and
changes; and also, as a state of harmonious and balanced appearance embodying a
geometrical cohesion.

By relying on the inferences in literature, the most appropriate definition of urban adaptability would be a synthesis of two contrasting ends: ‘the capacity for change

35 According to Harper (2001), the definition of ‘being fit’ for the word adaptability has changed subtly into an analogous definition which implies change and transformation: “to make suitable to requirement or conditions; adjust or modify fittingly” (Random House, 2010).

36 Kostourou and Psarra (2017)’s bibliographic research reveals two contradictory definitions of adaptability: “In some cases, adaptability is described as the ability of a system to receive or respond effectively to changes in order to avoid obsolescence. In other cases, an adaptable system is one that resists changes and endures over time” (p.73.3).

37 According to Alexander (2003), adaptability is fundamentally related with what kind of design control enables the generative process of change: “How this walk is controlled: what are the rules of the walk, that make it lead to good adaptation?” (p.19).
Table 4.2: Contradictory definitions of adaptability related with capacity for change and remain fit for purpose (Retrieved from: Schmidt III et al, 2010 and Kostourou & Psarra, 2017)

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Definition</th>
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<tbody>
<tr>
<td><strong>Capacity for Change</strong></td>
<td></td>
</tr>
<tr>
<td>Schmidt III et al. 2010; Druot, Lacaton &amp; Vassal, 2012; Engel and Browning, 2008; Li et al. 2008</td>
<td>Adjust or modify fittingly to suit new conditions</td>
</tr>
<tr>
<td>Kronengburg 2007; Gibb et al 2007; Wilkinson et al 2009; Carroll et al 1999</td>
<td>Respond (readily) to changing needs of the users</td>
</tr>
<tr>
<td>Leaman et al 2004; Groark 1992; Schmidt III et al 2010; Vaughan et al 2013; Kruger 1981</td>
<td>Receive (long-term) changes of use: Reuse, allocate a variety of uses</td>
</tr>
<tr>
<td>Koch &amp; Miranda 2013; Vaughan et al 2013</td>
<td>Receive physical changes of configuration</td>
</tr>
<tr>
<td>Brand 1994; Kasarda et al 2007; Bon 1972; Steadman 2015</td>
<td>Evolve, grow</td>
</tr>
<tr>
<td>Douglas 2006; Schmidt III et al 2010; Kruger 1981; Steadman 2015</td>
<td>Capable for change (size, use, capacity, function, performance)</td>
</tr>
<tr>
<td><strong>Remain Fit for Purpose</strong></td>
<td></td>
</tr>
<tr>
<td>Juneja 2007</td>
<td>Endure (quick) transformations</td>
</tr>
<tr>
<td>Pearce 2004; Bullen and Love 2010; Cooper 2001; Balaras et al 2004; Graham 2005</td>
<td>Avoid decay, obsolescence or demolition, sustainability</td>
</tr>
<tr>
<td>Harper 2001; Friedman 2002; Blakstad 2001; Ridder et al 2008; Slaughter 2001; Schmidt III et al 2010; Torma et al 2017</td>
<td>Remain fit for purpose</td>
</tr>
</tbody>
</table>
and transition’ and ‘remain fit and robust against changes’. In that sense, drawing a framework which synthesizing both change and permanence would be appropriate to understand what adaptability means for urban planning and design.

**Adaptive Capacity: Synthesis of Permanence and Change**

The ability of cities to maintain their character and morphological structure throughout the dynamic formation and development processes constitutes the most important feature of successful places (Carmona, 2010). On the other hand, these places are also capable of growing gradually, changing their structure incrementally and evolving into unexpected conditions with the collective interventions of related actors and especially end-users. Therefore, both permanence and change – or transformation – of the urban space are the essential and non-negligible concepts for cities. According to Habraken (2006), “Good architecture, we instinctively believe, is the stone in the midst of running water. The common environment, however, is the running water and change by way of adaptation over time is essential for its continued existence” (p.36).

Cities’ capacity for change and their tendency to endure their structure is strongly parallel with the conceptualization of adaptability with the interaction between capacity for change and remaining fit for purpose. Therefore, it would not be wrong to define adaptive capacity of urban space as the synthesis of these terms. According to De Roo and Rauws (2012), adaptive capacity of a spatial system is related with the robustness – or resilience – and flexibility simultaneously; besides, robustness and flexibility can be achieved together by ensuring coherence and diversity concurrently. As spatial cohesion means the harmony between internal components of the system and refers to the control and order of the structure; diversity addresses to the ever-changing and evolutionary mode of the urban space and refers to the change, transformation and transition. Therefore, the robustness can be achieved by ensuring both cohesion and diversity in form and function in case of changing circumstances. Thus, it also paves the way for flexibility by increasing the pluripotential of the space to create diverse opportunities.
Consequently, it would not be wrong to state that while robustness and resilience means the ability to maintain coherence in case of conditional change by means of diverse set of choices; flexibility – as the outcome of robustness and resilience – defines the capability of change in urban space. While the former is related with the permanence and availability of enough choice, the latter is associated with change and transition. In that sense, adaptability or in more specific terms ‘adaptive capacity of urban space’ is the synthesized interface between order and chaos; control and freedom; coherence and diversity; rigidity and dynamism; robustness/resilience and flexibility. Within this framework, caring about the adaptive capacity of urban space would enable urban planners and designers to create places which have the ability to maintain their structure and character in a coherent way (robustness/resilience) as well as to respond and adapt changing circumstances in a flexible manner (flexibility). Accordingly, in the following parts, the question of how to ensure the necessary spatial conditions by design in order to generate adaptive capacity for urban change would be essential to develop the core argument of the research. With that aim, examining the notions of robustness/resilience and flexibility and finding their spatial and morphological principles would be fit for this purpose.

4.2.3 Resilience and Robustness: Offering Diverse Set of Choices

Resilience, as an essential characteristic feature to maintain the structure and character of cities, is basically related with the capacity of space to endure change and survive in the face of unexpected transitions and transformations. According to Porta and Romice (2014), resilience of an urban space depends on the capability to maintain its own identity when combined into a whole from its individual parts – i.e. to adapt both expected and unexpected conditions emerged from increasing and changing levels of complexity. In definition, basically, resilience represents the capacity of the system to respond to change without modifying its basic structure (Walker and Salt, 2012); or, to absorb change by learning from its emergence (Colander and Kupers, 2012).

In spite of its potential, until the advent of complexity perspective in urban design, the notion of resilience remains recessive in terms of its contribution to the urban form
and morphology. In the last decade, recent studies integrating the term resilience with the form and space (Porta and Romice, 2014; Romice and Porta, 2015; Tarbatt, 2012; Feliciotti et al. 2015) offers an initial step to understand and re-interpret the concept in terms of urban morphology. With respect to the aforementioned inferences related with the unpredictability of cities, the concept of resilience and its spatial implications open up a novel perspective to understand the issue of urban change and to develop a responsive framework addressing to the adaptive capacity of urban space. In that sense, resilience defines the spatial components and relationships between them remaining throughout the process of urban change. According to Romice and Porta (2015), the survival capacity of a spatial system is highly depended on its diversity potentiality in terms of its adaptation to emerging conditions and circumstances by relying on “relatively small components that can adapt, assemble and reassemble” (p.1). While it is arguably true that the diversity of an urban space can be achieved through an evolutionary process including both expected and unexpected formations, it can also be ensured by design to be developed further throughout the post-design process. Therefore, the most essential property for spatial resilience is ‘ensuring the enough diversity in form and function which offers sufficient amount of choice in space’; and – owing to existing choice variety – ‘paves the way for adapting future changes and transitions’.

In their seminal book, ‘Responsive Environments’, Bentley et al. (1985) proposed the notion of ‘choice’ for urban design and architecture agenda by focusing the issues of responsiveness, robustness, resilience and the like. According to Bentley et al. (1985), a responsive environment which is resilient to the dynamic processes of change should provide the end-users with wide range of choices available in the space. Key design qualities like variety of uses offering diverse choices of experiences; permeability offering alternative flow and movement choices; and personalization enabling individuals to put their own stamp on a designed place are the essential

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38 Bentley et al. (1985) developed inquiry about how does design affect choices the users can make and proposed a responsive design framework that offers diverse set of choices in terms of form, function, accessibility and sensory experiences. In that sense, they covered the key issues in making a place responsive, such as permeability, variety, legibility, robustness, visual appropriateness, richness and personalization. (For more, see: Bentley, I. et al. (1985), Responsive Environments, Elsevier: Oxford).
features of a responsive space. Beyond of them, the quality of robustness, according to Bentley et al. (1985), is the most inclusive term which affects the capacity of a space for responsiveness and adaptability: the degree of a place to be used for diverse set of purposes owing to the offered choices without limiting the user to a fixed single use. In that sense, the notion of robustness, as similar to the resilience, defines the capacity of a space to maintain itself through the process of change by using the available set of choices to respond emerging needs. Actually, these two terms – resilience and robustness – refers to analogous definitions to some extent, as well: durability and maintenance of a system.

In addition to their basic similarity in definition, comparing the concepts of ‘robustness with increased choice’ (Bentley et al. 1985) and ‘urban resilience’ (Ahern, 2011) reveals that it would be possible to draw a more common and broad framework to identify related urban design strategies and principles. Resilience studies emphasize the acceptance of uncertainty as an inherent feature of urban space and urge planners and designers to develop design strategies for ensuring the ability of a system to adapt and maintain itself through non-linear trajectories of urban change.

According to Ahern (2011), multi-functionality and diversity as the most important principles of urban resilience means integrating various functions simultaneously and providing diverse set of choices in size, form and use. As having both physical and socio-economic dimensions, diversity also requires presence of a wide range of user groups and actors in the urban space in addition to the intensification of various form and functions. Redundancy refers to the multiplicity of choices or options to choose (Folke, 2006), complements the principle of diversity by increasing the user choice, and it is achieved “when multiple elements or components provide the same, similar or backup functions” (Ahern, 2011: p.342) to prepare the system for a prospective

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39 While resilience means “the capacity to recover quickly from difficulties; toughness”, robustness means “the ability to withstand or overcome adverse conditions or rigorous testing” (Oxford Dictionary, 2018).

40 Ahern (2011) identifies five urban planning and design strategies to develop urban resilience: “multifunctionality, redundancy and modularization, diversity, multi-scale networks and connectivity, and adaptive planning and design” (p.1).
change. It ensures the continuity of the spatial structure by providing the buffer capacity with the enhanced variability in form, function and user group. As complementary to redundancy, modularity describes the degree of system components to be distributed across sub-scales and sub-systems (Ahern, 2011). The fact that while modules are structurally independent from each other, at the same time, they are also interdependent with each other in the whole system by relying on relatively loose rules. According to Feliciotti et al. (2016), these complementary features enable modules “to aggregate to form new higher-scale wholes without ever losing their individual identity” – which means both to maintain character and identity; and, to generate new formations to adapt changing circumstances. Therefore, modularity controls the interaction between different scales and components of urban form, allows to distribute design control and development (Habraken, 2006) over individuals41, provides the necessary pre-condition to generate diversity in choice and represents an essential principle to achieve urban resilience. Moreover, resilience capacity of a system is closely related with the “redundant circuitry that maintains functional connectivity” (Ahern, 2011: p.7). Basically, connectivity defines the degree of flow in a system and affects the efficiency of movement and intensity of spatial program. Enhanced connectivity not only helps to increase contact points and exchange interfaces in the urban space, but also provides the essential structure carrying the diverse and redundant set of choices; and, frames the modular configuration of morphological components.

In the light of abovementioned theoretical frameworks, it would be depicted that Bentley et al. (1985)’s responsiveness and robustness principles and Ahern (2011)’s urban resilience principles share some similar and overlapping attributes related with the notion of urban resilience (Figure 4.2). In that sense, resilience seems as a matter of providing enough set of choices in terms of form, function, use, movement and design control to provide urban space with the capability of adapting emerging

41 According to Habraken (2006), the concept of ‘distribution of design control’ is crucial for urban change through evolutionary and gradual process of adaptation: “For everyday environment to be alive and healthy, such control must be dispersed, allowing different parties taking care of things on different levels in the environmental hierarchy” (p.37).
conditions of change. As adopting the principles of diversity, redundancy, modularity and connectivity, resilient design approach helps to produce urban structures “complex enough to support modern life as an efficient, interconnected, multifunctional system [...] adaptable enough to withstand and react to change [...] versatile enough to respond in different contextual and cultural manners to similar pressures” (Romice and Porta, 2015: p.1).

However, by relying on the notion of adaptability’s two-fold descriptions – resilience and flexibility, permanence and change, design and evolution – it would not be wrong to state that urban adaptability is not only achieved by design operations but also requires the evolutionary process of transformation and change. Emergent nature of urban complexity and adaptation requires an understanding of evolutionary process including gradual and incremental micro interactions between urban agents which generates a collective macro-behavior and flexible formation for the urban space. These micro interactions between urban agents generate novel emergent conditions; increase the diversity in choice and resilience of the urban space; and, enhance the adaptive capacity of the whole system through time.

![Figure 4.2: Overlapping attributes of resilience theory (Ahern, 2011) and responsiveness/robustness (choice) theory (Bentley et al., 1985)](image-url)
As it is investigated and expressed before, resilience and flexibility are the two sides of the same coin: adaptive capacity. Therefore, while the implications of resilience and robustness (offering enough choice) draw a framework entailing the structural, compositional and formal properties of the urban space achieved by ‘design act’; a complementary approach based on the notion of flexibility (leaving room for change) constitutes the other side of the coin focusing on the mechanisms of urban formation, re-formation, change and evolution.

4.2.4 Flexibility: Leaving Room for Change

Flexibility, as a complementary notion to define adaptive capacity with the concept of resilience, refers to the ability of a system to respond changes and unexpected circumstances\textsuperscript{42}. In the last decades, the notion of flexibility has stemmed from the fundamental question of ‘how to design cities if they are quite complex, evolutionary and unpredictable systems’ and used interchangeably in literature with the concepts of adaptability, resilience, responsiveness and so on.

Until the 1960s, the time in which the critical approaches emerged in urban planning and design literature, the notion of flexibility had various negative connotations threatening the rationality of planning and design such as chaos, disorder and lack of design control. Following this period obsessed with certainty and rigid control in urban space, the literature focusing on the concepts of incrementalism, complexity and project-led development has started to use flexibility by referring to the contemporary notions of adaptation, openness, responsiveness and change. According to Tasan-Kok (2008), the concept of flexibility “helps in achieving as much certainty as possible in a world in flux by accepting uncertainty and applying consideration to cope with it” (p.183). While flexibility is used in engineering systems design as the capability of a system to cope with uncertainty (Gupta and Goyal, 1989); it also is taken into consideration in the literature of architecture and urban design with reference to the issue of dealing with the uncertainty and change by procedural, incremental and rule-

\footnote{In definition, flexibility means “the ability to be easily modified” or “willingness to change or compromise” and basically refers to an act of change (Oxford Dictionary, 2018).}
based adaptation – e.g. Supports (Habraken, 1972); A Pattern Language (Alexander et al. 1977); Shape Grammars (Stiny and Mitchell, 1978); Design for Change (Friedman, 1997); Urban Grammars (Beirao and Duarte, 2005); Game Urbanism (Venhuizen, 2010). In that sense, flexibility in urban design refers to an unfinished process of change and responsiveness to various – both expected and unexpected – emergencies in urban space. According to Beirao (2012), flexibility can be addressed on three distinct levels within the context of urban design: the first is related with the flexibility of design process, the second is about the multiplicity of design scenarios, and the last emphasizes the flexibility of post-design process in terms of adapting new conditions:

“(1) The first considers the capacity of the design method or process to adapt to changes [...] (design flexibility). (2) The second considers the design of systems of solutions rather than one single solution (multiplicity – the design of systems; flexible design). (3) The third considers the design of solutions which are capable of adapting even after the implementation is finished (flexibility of the design)” (p.2).

By accepting that a most ideal perspective should include both the flexibility of design process and design product, to define the adaptive capacity’s other side – in addition to the notion of resilience – flexibility can be defined as the ability of a design to adapt changing situations even after the implementation: capability of allowing the change and transition. Therefore, flexibility refers to the concept of ‘changeability’ and means possibility of change and transformation into new conditions (Ardeshiri et al. 2016). In that sense, flexibility (leaving room for change) is a complementary notion for the concept of resilience (offering enough choice) to define the adaptive capacity of an urban space – while the former refers to post-design process, the latter addresses to the design process itself. In order to achieve flexibility, a system of design needs some prerequisites investigated in the context of resilience – such as diversity, modularity, redundancy and connectivity. Hence, as a relatively depended concept to resilience, flexibility of design can only be possible if the urban space offers enough diversity in choice; and, gives the various potentials and rights of selection among them to the urban agents. Owing to the diversified set of choices and options available
in the urban space, implemented design would be capable of adapting to change; and so, flexibility of design would be achieved eventually.

Schmidt III et al. (2010), describes the flexibility as an act of change – from one condition to another – and defines the term with a series of ‘ables’\(^{43}\) (Table 4.3). These ‘ables’ and related types of change is basically categorized under two distinct groups: versatility refers to the change of form – i.e. physical layout or structure; convertibility refers to the change of function or use (Schmidt III et al., 2010).

**Table 4.3:** Changeability types related with the notion of flexibility (Adapted from: Schmidt III et al. 2010)

<table>
<thead>
<tr>
<th>-ables</th>
<th>Types of Change</th>
</tr>
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<tbody>
<tr>
<td><strong>Change of Form</strong></td>
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</tr>
<tr>
<td>versatile</td>
<td>change of space</td>
</tr>
<tr>
<td>scalable</td>
<td>change of size</td>
</tr>
<tr>
<td><strong>Change of Function</strong></td>
<td></td>
</tr>
<tr>
<td>convertible</td>
<td>change of function</td>
</tr>
<tr>
<td>adjustable</td>
<td>change of task</td>
</tr>
<tr>
<td>refitable</td>
<td>change of performance</td>
</tr>
</tbody>
</table>

Therefore, it would not be wrong to state that flexibility is related with the level of changeability of urban form and function to adapt to new conditions; and, complements the notion of resilience to draw a unified framework for ‘adaptive capacity of urban space’. While flexibility is related with “allowing change to occur with reduced intervention at a later stage” (Friedman, 1997: p.1), resilience and its spatial design implications constitute the necessary prior-condition for adaptation to start and continue through time.

\(^{43}\) According to Schmidt III et al (2010), the notion of flexibility covers “a spectrum of possibilities from how the space was defined physically to how the space was being used functionally” (p.5). In that sense, a series of ‘ables’ – adjustable, versatile, refitable, convertible, scalable, movable – are defined and matched with a series of types of change – change of task, space, performance, function, size and location.
4.2.5 Critical Remarks on the Synthesis of Resilience and Flexibility: Adaptive Capacity of the Urban Space

Adaptive capacity, as an overarching concept, emerges from the synthesis of two vital notions – resilience and flexibility. While the former refers to the degree of spatial permanency by relying on diverse set of choices in the space, the latter is related with the capacity of spatial change through gradual adjustments in order to accommodate both foreseen and unforeseen circumstances. Spatially, a resilient urban structure which is diverse, modular, redundant and connective – in other words, a structure which offers enough choices for use, experience, flow and design control – enables urban change in form and function to occur via a series of incremental adaptations and transformations. In that sense, resilience constitutes the necessary pre-condition for flexibility to occur and continue; and so, adaptive capacity of an urban space cannot be considered without one of these concepts. In fact, the notion of adaptive capacity can be found somewhere in between resilience and flexibility; and, achieving adaptive capacity is related with ‘offering enough choice to leave room for change’. From this complementary perspective, it would not be wrong to state that adaptive capacity puts forth a unified framework to understand relatively contrasting – but at the same time mutually complementary – notions and to operate design for coping with urban change (Figure 4.3).

While the notion of resilience refers to the conditional qualities by relying on structural or formal principles (diversity, redundancy, modularity, connectivity), the concept of flexibility identifies mechanisms of formation and types of change (formal change and functional change). Therefore, while resilience is related with the spatial properties (e.g. modularity) which can be achieved by physical design operations (e.g. fine-grain subdivision of ownership pattern) (Feliciotti et al. 2016); flexibility refers to the processes of change which cannot only be controlled with design – instead which emerges from the collective interaction of many individuals and transforming contexts over time in an evolutionary manner. In that sense, formal principles derived from the concept of urban resilience define what kind of structure and configuration allows adaptation to occur; and, behavioral or operational mechanisms (related with
With reference to the dependent relationship between resilience and flexibility mentioned above, it can be expressed that adaptive capacity is an inclusive term which addresses to both design process and post-design process, as well. Within this context, it is unavoidably true that adaptability is associated with existing form (design) as much as it is related with formation (re-formation) (emergent transformation) phase. According to Schmidt III et al. (2010), “[...] adaptability could take place before the building was occupied through the pre-configuration of initial design choices [...] or after the building is occupied through the re-configuration of the building for subsequent changes in use” (p.3). Therefore, it is possible to argue that enhanced capacity of adaptability offered by design would generate and contribute to the further adaptation through post-design process.
In addition, the notion of adaptive capacity makes possible to discuss the contradiction between two contrasting terms: **design and emergence**. This inherent contradiction is inevitable for urban planning and design agenda from the perspective of complexity theories. Rationally, cities need to be designed and controlled with purposeful and conscious interventions, but on the other hand, they are quite complex, naturally unpredictable and emergent eco-systems to be controlled. According to Romice et al. (2017),

“Such contradiction, [...] is only apparent: if we look at the most successful historical parts of our cities we will find that most of them [...] had been masterplanned at least to some degree, at some point in time, and yet have evolved constantly and restlessly, adapting to changing conditions and new opportunities along the way” (p.1).

In the context of this inherent contradiction, the notion of adaptive capacity offers an interface to understand what can be offered and controlled by **design**; and, how it can **evolve** in the face of changes and transitions through a series of adaptations. In parallel with this, the notion of adaptive capacity as an interface between resilience and flexibility, enables us to understand the tense relationship between **planning** and **self-organization**. As accepting that cities are not only planned and controlled systems of organization but also an emergent outcome of self-organized interaction between agents, it could be argued that the notion of adaptive capacity builds an integration between control and freedom. While the principles of resilience draw the boundaries of planning and design interventions, change mechanisms of flexibility addresses to the self-organized process of change mostly depended on the distribution of design formation and development over end-users. In that sense, rather than to investigate which approach (planning or self-organization) is best fit to achieve ‘good city form’, adaptive urban design approach asks the right question of “**what planning is best fit to set the right spatial structure for future change and adaptation**” (Porta and Romice, 2010: p.8). Thus, adaptive urban design approach also builds an interface between **top-down** or **bottom-up** perspectives by integrating the notions of design and evolution, control and freedom, planning and self-organization and so on.


4.2.6 Key Principles of Adaptive Urban Design Approach

Adaptive urban design approach basically emphasizes the need for urban spaces to have capacity to cope with uncertainty and to adapt to foreseen and unforeseen change and transitions responsively. Rather than turning back to dynamic process of change and trying to eliminate uncertainties, from the perspective of complexity theories, contemporary urban design should redirect its focus to generate necessary conditions which are capable of responding urban change (De Roo, 2016; Rauws, 2017). In that sense, adaptive urban design offers a slight transition from place-making to condition-making by offering the principle of ‘allowing necessary conditions under which urban spaces have the possibility to transform into novel configurations and structures and – by doing so – to adapt emergent conditions of change’. This fundamental shift does not refer to a ‘counter-design’ argument undermining the rationality of urban planning and design; instead, it offers novel insights to comprehend the necessity of addressing to uncertainty and adapting to possible changes and transformations in urban space. As similar, Marshall (2012) also rejects the pointless discussion of ‘designing or not designing’ in urban design agenda by expressing that “any settlement or built environment will feature design somewhere, at some level; and so, the question becomes an argument of scale” (p.220). In that sense, briefly pointing out key principles of adaptive urban design approach would be essential to draw a general framework for enhanced adaptive capacity for the urban space and its formation process, as well.

**Ensuring Enough Choice to Leave Room for a Possible Change**

By moving away from the obsession of certainty and over-deterministic control mechanisms, urban planning and design re-discovered the contemporary notions of change, time, transition and evolution within the perspective of complexity theories. In that sense, the notion of adaptive capacity offers a complementary approach to integrate the contrasting concepts of control and freedom, top-down planning and bottom-up emergence, design and evolution and so on. Thus, adaptive urban design approach enables urban planners and designers to answer the question of ‘what gives
necessary permanence and certainty by leaving room for further changes in urban space’ in a responsive manner. With respect to the complementary notions of resilience and flexibility, arguably it is true that a responsive and adaptable urban space is both robust to absorb the externalities arisen from change processes and also flexible to re-configure and re-programme over time. According to Campbell (2011), “as such, it looks to put in place a new top-down discipline that is more ‘open’ to bottom-up responses from a range of actors. It also looks to limit choice but still allow infinite possibilities” (p.48). Within this context, the most essential inference of adaptive capacity for urban design agenda is ‘to ensure enough and diverse set of choices to leave room for a prospective change’. Therefore, creating the right conditions to entail wide range of choices is key to generate the possibility of change to adapt and respond emerging circumstances.

**Rule-Based Design Framework Allowing Open-endedness**

Complexity perspective offers an understanding about establishing simple rules can generate complexity by allowing diversity in choice and ensuring coherence simultaneously. According to Moroni (2014), framework rules introduce a form of ‘abstract coordination’ and they are open enough to ensure wide range of choices rather than insisting on a comprehensive end-state. Without covering all possible options or scenarios, a rule-based design framework constitutes a ‘carrying structure’ which is robust enough (Alexander et al., 1987) and which guides the evolutionary process of urban change, as well. Therefore, rule-based design framework is key for the synthesis of resilience and flexibility to develop adaptive capacity of urban space – in other words it defines “freedom within constraints” and limits the possible choices “which give rise to infinite possibilities” (Campbell, 2011: p.61). To have a set of well-defined, abstract and relational rules pave the way for an open-ended design and evolution process to adapt and respond to uncertainties and urban change. However, open-endedness does not mean an ‘anything goes’ or ‘laissez faire’ approach; instead, it enables preferred developments (according to the rule-based

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44 Habraken (2008) defines the open-endedness in relation to the notion of ‘incompleteness’ and ‘incomplete form’: “an architecture planned so that it can be added to, or more importantly, revised internally in the course of time as the needs of habitation change” (p.10).
framework) more likely to emerge (Rauws, 2017) and allows adaptive capacity to be developed and continue through time.

**Incremental Design Through Small-Scale Interventions**

For the notion of adaptation, time dimension is crucial; because urban complexity emerges and develops incrementally over time – through a series of adaptive and evolutionary adjustments. Incremental design approach provides various opportunities to respond emerging contextual changes and enables the design framework to adapt both predictable and unpredictable spatial transitions. In that sense, “a mosaic of self-sufficient small-scale plans is preferable to large-scale plans as it assumes fundamental uncertainty in future development paths” (Rauws, 2015). Contrary to large-scale and comprehensive plans, small-scale design interventions are less dependent to the viability and success of the other interventions; in other words, possible failures in any part of the system can be recovered with the small-scale actions in an incremental and gradual manner. Thus, small-scale and incremental design interventions would both contribute to the long-term spatial resilience and allow flexible transformations and adjustments to respond changes – i.e. would eventually enhance adaptive capacity of the urban space.

The above-mentioned principles of ensuring enough choice to leave room for a possible change; developing rule-based design frameworks allowing open-endedness and incentivizing incremental design through small-scale interventions constitute the fundamental basis for adaptive urban design approach and help to strengthen adaptive capacity of the urban spaces. From this point on, urban planning and design should develop the necessary design-control tools and frameworks depending on the morphological components of the urban space to allow adaptation to emerge, develop and continue through urban formation processes.

**4.3 Steering Urban Adaptation: Plot-Based Urban Design**

Our reflection on the key research notions – like urban change, adaptive capacity,
resilience, flexibility and so on – paves the way for a general understanding of ‘urban evolution through time’ instead of a conventional design and planning approach caring to control urban space in a static manner with fixed objectives. According to this evolutionary perspective, the quality that makes cities to adapt changing circumstances and to maintain their own being is their generative power emerging from the collective actions of individuals through time. According to Alexander (1979), “this quality in buildings and in towns cannot be made, but only generated, indirectly, by the ordinary actions of the people, just as a flower cannot be made, but only generated from the seed” (p.xi).

Therefore, it would not be wrong to state that what is equally important as much as ‘design’ is how it would be generated by seeding it from bottom to up (i.e. steering) and how it would respond to changing circumstances (i.e. adapting) through time. Adaptive urban design approach offers the necessary perspective that answers these crucial questions by integrating the notions of resilience and flexibility, design and evolution, permanence and change. In order for an urban space to be adaptable, the necessary minimum structure must be ensured by design (by offering enough choice) – which will eventually steer the emergence and continuity of urban adaptation (allowing change) through time. According to Porta et al. (2011), while urban design actually is the act of designing right structure; urban adaptation is the process shaped by “the restless activity of ordinary people doing their own ordinary business, […] that we term informal participation” (p.1).

Therefore, from urban design perspective, the most essential task is to find how to establish the right structure in an urban space which will enhance the adaptive capacity and steer urban adaptation over time. This perspective does not make us to fall into the trap of ‘counter-design’ or ‘anti-design’ approach; instead, it offers valuable potential to answer the long-sought question of “can cities be at the same time planned and emergent?” (Kropf, 2009: p.106). In that sense, investigating the essential morphological components, design control tools and mechanisms that give life to the necessary structure – which will enable urban adaptation – is crucial. The notions of ‘plot’ and ‘plot-based urbanism’ gaining importance lately in contemporary urban
design agenda offer promising opportunities for these objectives of the research.

4.3.1 ‘Lost Art of Subdivision’: Plot as the Most Suitable Design-Control Tool for Urban Adaptation

The plot, defined as the smallest morphological component of the urban space, has started to be considered as the most meaningful unit of urban development in the last decade. According to Tarbatt (2012), individual plot is the most reliable ‘spatial scale’ to conceptualize the notions of urban change, incremental adaptation and spatial evolution, because: “it represents the smallest expression of undivided ownership, and therefore decision making, within the townscape” (p.23). According to Campbell (2011), any spatial formation inevitably starts with the plot and its interaction with the building mass and the street; and, this makes plot “the smallest and the most achievable unit of delivery” (p.77). In addition, from the perspective of complexity theories, if a city is a complex organized system – in other words, a whole which is greater and different from the sum of its parts – plot is the basic part that generates this collective and complex interaction between individuals.45

As stated by Tarbatt (2012), especially in traditional urban spaces, there was a tendency to subdivide large pieces of land into smaller plots which leads to a diverse urban form apparently as ‘character-full patchwork’ and ‘rich-tapestry’. However, these dense and diverse urban patterns, which are neither wholly planned nor wholly unplanned, started to be lost as a consequence of over-deterministic design interventions aiming to control large pieces of urban land without distributing design-control over various individual plots. Because of the emerging trend towards single-use, monolithic and segregated developments on larger pieces of urban land, individual plots started to be amalgamated; and, close-grain and diverse patterns of ownership in urban spaces started to be lost eventually (Figure 4.4). Correspondingly, from the perspective of complexity theories, it would not be wrong to argue that ‘the possible emergence of the collective and complex spatial outcome from the interaction of

45 According to Romice and Porta (2015), plot is “a reliable component of greater wholes” and represents the most abstract part of a complex system (p.1).
Figure 4.4: Changes in plot configuration of London and Dublin illustrating the ‘loss of plot’ (Tarbatt, 2012: p. 13, 39).
various small interventions has been lost, as well. In addition, loss of fine-grain urban pattern offering diversified set of choices, enabling the distribution of design-control and allowing adaptation to emerge and continue in an incremental manner led to a decrease in the adaptive capacity of urban spaces and made them more vulnerable to uncertainties.

Loss of plot and close-grain urban pattern has provoked urban planning and design community to re-consider the diverse, multi-functional and fine-grained development patterns as viable alternatives to the mono-functional, uniform and coarse-grained urban patterns laid out on large plots. In that sense, discovering the ‘lost art of subdivision’ (Campbell, 2011) is essential to achieve fine-grain and diverse compositions of individual plots which are inherently more resilient (by offering enough choice) and more flexible (to allow change and adaptation in an incremental manner) in the face of urban changes and uncertainties.

By relying on the recent perspective of complexity thinking, evolutionary approaches in urbanism and the importance of plot and fine-grain development, ‘Plot-Based-Urbanism’ is emerging in the contemporary urban planning and design agenda. According to Romice and Porta (2015), plot-based strategies in urbanism “is not only conducive to incremental growth and mixture of land uses and tenures, but is also resilient to economic risks, encourages informal participation” (p.3).

4.3.2 Plot-Based Urbanism: What Makes ‘Plot’ Key for Steering Urban Adaptation?

In the last two or three decades, an observable tendency has emerged in urban planning and design agenda conceptualizing the ‘urban block’ as the most operable unit of design. According to Samuels et al. (2004), from the evolutionary perspective of urban morphologists, use of the urban block as the most achievable unit of design results in missing the essence behind the formation process of an urban fabric – which is blocks are essentially made of the plots and their interface with the streets. The nested hierarchy in this complex series of relationship starts with the plot, continues with the
building mass on top of it which creates the necessary interface (street front) to define streets, and eventually forms the urban block made by the interrelation between plots, street fronts and street network (Figure 4.5).

Figure 4.5: Nested hierarchy starting with plot and forming street block, block and urban pattern respectively (Adapted from: Campbell, 2011: p.76).

Actually, contemporary research on the evolution of cities in history shows that urban patterns have never developed block by block (Mehaffy et al. 2010); instead, “street fronts (on top of plots) are built up on both sides of central streets and keep on growing, step by step, on the sides of successive streets as they emerge. Blocks, [...] are the resultant formation of a dynamic construction whose homogeneous and typical unit of development is the street front” (Porta et al. 2011: p.8) This fact is revealed not only from the self-organized formation processes of traditional towns but also from the development process of well-designed and planned part of the cities (Figure 4.6). Therefore, urban blocks alone are not enough to generate the complexity of the urban space without really understanding and operating with their sub-structures – such as plot configuration, plot frontage (street face) composition and street network itself.
As contrary to the natural formation processes of urban spaces, while block-based approaches are becoming prevalent in urban design agenda; the level of functional complexity in urban fabric decreases, urban structure becomes more homogeneous lacking the necessary quality of diversity and modularity, and eventually, urban space’s capacity to address and adapt to change is lost gradually. In that sense, ‘plot-based urbanism’\(^{46}\) (Porta et al. 2011; Tarbatt, 2012; Porta and Romice, 2010; Campbell, 2011) offers more appropriate approach to achieve a responsive form of

\(^{46}\) According to Porta and Romice (2010), “Plot-Based Urbanism […] as an appropriate, responsive and sustainable form of development, […] is versatile and capable of minimizing and spreading risk in conditions of adverse economies, it is conducive to informal participation, capacity building development of local capital, it has proven to be the most resilient form of urban development in time, and it is respectful to local character” (p.34).
development by emphasizing the importance of ‘plot’ and ‘fine-grain’ urban fabric in generating the capability of adaptation. It enables planners and designers to achieve a more resilient (i.e. which is more diverse, modular, redundant and connective which offers enough set of choices) and flexible (i.e. which is capable of change) urban space to adapt both expected and unexpected transitions over time. Plot-based urbanism basically argues that plot is the smallest key component of the urban space to steer urban adaptation; however, it does not mean that any spatial composition consisting of small and many plots is just fine. Instead, it means “*not everything needs to be small, but larger things should start from an agglomeration of the small. [...]*, once we have a plot we can combine this into a lot, a block or even a whole phase of development, but we can always go back to the plot” (Campbell, 2011: p.88).

**What Makes ‘Plot’ Key for Steering Urban Adaptation?**

As being the most viable morphological component to operate design in revealed condition of complexity, plot offers valuable contributions to fostering spatial diversity/modularity/redundancy, controlling design process incrementally and making urban space to adapt processes of change and uncertainties efficiently. First of all, subdivision of the land into small pieces of plots allows design control and development to be distributed over various developers and users⁴⁷, and thus, enables diversity to occur in terms of user profiles, functions and formal expressions. Therefore, smaller plot subdivisions “*provides an opportunity for independent timelines and introduces the possibility for individual responses – the preconditions for richness, variety and uniqueness*” (Tarbatt, 2012: p.77). In addition to the diversity, smaller plot subdivisions mean increased modularity for urban space and generate robustness by means of diverse set of choices available for the users. Secondly, plot subdivisions provide both urban designers and other urban agents with controlling the design process in an incremental and adaptive manner. According to Alexander (1987), if the grain of development is small enough, wholeness can emerge easily from the piecemeal design interventions and individual transformations over time. Thus, it

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⁴⁷ According to Tarbatt (2012), fine-grain development leads to an increase in the amount of area which can be controlled by various actors: “*Close grain development also opens up the market to a wider range of smaller developers and investors [...]*” (p.63).
would not be wrong to state that smaller plot subdivisions contribute to the piecemeal growth characteristic of the urban space and help urban adaptation to occur and continue in gradual manner.

Last but not least, most of the morphological studies in literature shows that single buildings change faster than plots and plot configurations; but as similar to this, plots change faster than urban blocks and streets (which are the most enduring spatial elements structuring the city) (Conzen, 1969). Therefore, fine-grain subdivision of land into plots increases the capability of urban space to change and transform according to different circumstances, enables incremental growth through and after design process, and enhances the adaptive capacity of urban space. All in all, plot and accordingly plot-based design approach offers a novel perspective and operational design framework to create necessary pre-conditions for urban adaptation to emerge, develop and continue over time in an evolutionary manner.

4.3.3 Learning from International Plot-Based Urbanism Examples

In order to draw a clear and overarching framework to understand the contributions and achievements of plot-based urbanism for the concept of urban adaptation, revisiting some past and contemporary plot-based urbanism examples would be worthwhile for the objectives of this research. To that end, three international case-studies would be examined to infer fundamental lessons about the importance of plot and plot-based development for enhancing the adaptive capacity of the urban spaces: (1) Edinburgh, New Town (Scotland) by James Craig; (2) Barcelona – Eixample (Spain) by Ildefons Cerda; and, (3) San Francisco – Alamo Square (USA).

4.3.3.1 The New Town – Edinburgh

Edinburgh – New Town, renowned as one of the most successful examples of city planning, is an important example of plot-based urbanism which offers many fundamental lessons for contemporary urban planning and design agenda. In mid-1700s, the emerging problem of overcrowding and decrease in living standards in the
Old Town necessitated to build a new residential area for the upper classes. For this purpose, a design competition was organized by Edinburgh’s Town Council in 1766, which was won by James Craig – who designed “a simple grid of rectangular blocks with a broad, central main street linking two garden squares at either end” (Carley et al. 2015: p.8). In this perfectly ordered grid-based plan, James Craig offered a good street hierarchy emphasized by identical perimeter blocks and a series of mews and subdivided these blocks into a large number of individual plots (Figure 4.7).

Figure 4.7: James Craig’s plan for the Edinburgh – New Town, 1767 (Retrieved from: National Library of Scotland – Town Plans/Views 1580-1919)

The New Town, which was initially imagined and designed as a wealthy residential suburb consisting of large townhouses, has accommodated both formal and functional changes and evolved into a dense and mixed-use city core of Edinburgh (Figure 4.8). According to Carley et al. (2015), although the New Town was designed with an extremely regular and rigid grid-layout including uniform composition of identical perimeter blocks, it “evolved successfully over an eighty-five-year construction period and more than two centuries of occupation” and adapted to the unpredictable processes of urban change (p.30). In that sense, investigating the key spatial qualities coming from the New Town’s original design which enables it to change, transform
and adapt over years is quite essential to understand the hidden power lying behind its accommodation of formal and functional change.

Figure 4.8: The aerial view of the New Town, Edinburgh (Source: Google Earth, 2018)

Close-grain plot configuration of the original layout was the most significant precondition which steers adaptation and evolution of the New Town. The explicit modular subdivision of individual plots in feu plan, allowed the development to proceed gradually by the actions of various actors ranging from aristocrat citizens (end-users) to wealthy entrepreneurs (speculative builders). Over time, each individual plot was interpreted in a distinctive way – but in line with the fundamental development rules of James Craig – and these genuine and complex ownership regulations has given way to “a flexibility and a capacity for architectural sophistication far beyond anything envisaged by Craig” (Carley et al. 2015: p.46). Through the first phase of construction, the modular and homogeneous plot configuration was transformed with basic operations of plot amalgamation and subdivision (Figure 4.9); and, design variety in plot sizes and coverages, building typologies (townhouses, tenements, mews housing and so on), building widths and heights was achieved incrementally (Figure 4.10). In addition, the emerged configurational and compositional variety within a harmonious spatial structure led to diversity in functional programme of the space and variety of end-users or dwellers.
In combination with the close-grain plot configuration, New Town’s hierarchical and grid-based street network carrying diverse set of entrances (i.e. plot frontages) offers good potentialities to adapt changing needs in urban space. Highly connective and permeable street network composed in close-relation with the diverse set of frontages prepared a ground for the emergence of retail and commercial activities in the New Town48. According to Carley et al. (2015),

48 Chambers (1825) describes the gradual adaptation process by stating that: “All the houses in this square, [...], were at first occupied by people of distinction. About six noblemen possessed then their own houses in it at one time, besides various Lords of Session, gentlemen of fortune: but, of late years, since fashion has retreated northwards and westwards, the greater part of the houses have been converted into shops and offices; and the time does not appear to be far distant, when this square shall become the chief commercial mart in the city, - a purpose for which it seems to be well adapted” (p.184).
“The simple - even naive - idea that every plot would carry a large town house occupied by a prosperous household did not take long to break down: builder-developers, following real-world commercial imperatives, created a rich mix of tenements and town houses capable of supporting a wide variety of residential and commercial uses (p.198).

In spite of its fairly rigid original design, disjointed development and design over the years has contributed to New Town’s evolution and increased its adaptive capacity owing to the individual and incremental modifications of plot subdivision, plot amalgamation, building extension (both vertically and horizontally) and the addition of annex masses to increase density. In that sense, it is fair enough to express that the continuous change in form and function has resulted both from the design qualities of original layout (such as modular plot subdivision, low plot coverage ratios for further extension, permeable street layout enabling plot frontages to be active for various uses) and from the collective actions of individuals over years. The combination of these key features has made the New Town an adaptable urban space withstanding continuous change.

Today, the New Town is a highly vibrant, dense and hybrid city core which is a synthesis of diverse set of uses and a dynamic community including people from all strata. Although it was initially envisaged as a residential suburb composed by uniform townhouses, the New Town achieved to transform into an intricate urban space including diverse building masses in different sizes, widths, heights, functions and even formal expressions within a coherent and harmonious urban structure (Figure 4.11). This evolutionary change can also be traced from the transformation of highly uniform and simple plot configuration into a heterogeneous and complex one including various range of sizes and forms (Figure 4.12).

As stated by Mumford (1961), like it was two-hundred years ago, the New Town is still a living space having buildings robust enough to adapt change and transitions: “Their spaciousness, their very anonymity, their lack of functional exactness, have prolonged their life; for they serve almost equally well as apartments, hotels, offices,
While its general structure entails the design qualities of order, hierarchy and coherency, the individual components are still in flux – changing from one state to another without breaking the whole. According to Casey et al. (2015), “the New Town has characteristics both of predicted form, […] but also of the unpredicted metamorphosis found in the organic city” (p.221).

Figure 4.11: Rose Street revealing the intricacy of the New Town with diverse building sizes, forms, styles and functions (Retrieved from: Google Maps – Street View, 2018).

Figure 4.12: The current plot configuration of the New Town (Canmore – National Record of the Historic Environment Scotland, 2018)

To sum up, the New Town offers worthwhile lessons about the concept of ‘urban adaptation’ through close-grain subdivision of land by integrating the notions of top-
down and bottom-up, design and evolution, permanence and change, resilience and flexibility. The feuing plan which is defined as “a loose framework of plots with a fine grain” (Casey et al. 2015: p.228) allowed the development of each plot with high level of variety in an incremental manner and ensured the considerable amount of entrances through street network. In that sense, the fundamental features of (1) fine-grain plot subdivision; (2) close relationship between plot and street via plot-frontages; (3) gradual development and transformation of the plots with disjointed design formation are crucially important to comprehend why plot and plot-based urban development is key to steer urban adaptation over time. By relying on the fact that the New Town is a successful urban space in terms of urban adaptation, contribution of the fine-grain plot configuration and plot-by-plot development to adaptive capacity of the urban space is undeniably significant – it constitutes the necessary pre-condition for adaptation to emerge and continue through time.

4.3.3.2 Eixample – Barcelona

Eixample, which means ‘extension’ or ‘expansion’ in Catalan, is the core part of today’s Barcelona designed by Ildefons Cerda in 1859 – after the demolishment of medieval city walls surrounding the old town. The arisen problems of overcrowding and hygiene with the advent of Industrial Revolution, made it necessary to create a new city extension which would offer a more livable environment for the increased population in Barcelona. In that sense, Cerda’s plan for the Eixample is not only a successful spatial solution to the emerging problems of the city, but also “a pioneering work in modern urban development history” in various terms. (Basquets, 2014: p.122).

Cerda, by referring to the contemporary spatial planning mechanisms and design tools for the first-time ever, created one of the most successful examples of modern urbanism enduring its structure, responding transformation gradually and withstanding change over 150-years. The egalitarian and orthogonal grid system constructed by highly connective mobility network and the proposed urban blocks having various open spaces in and between them are the most distinct characteristics of this seminal urban fabric (Figure 4.13).
Actually, before completing his design proposal, Cerda conducted comprehensive researches on the urban form and plot-based formation processes of various cities like Edinburgh – New Town and New York – Manhattan Island to understand their block typology (Figure 4.14). By relying on these studies, he proposed three different block types – “building blocks forming an (almost always) 90-degree angle, two parallel lines, or ‘u’ shape” (Fernandez, 2008: p.65) – and weaved the whole Eixample fabric with the combination of these blocks (Figure 4.15). Even if Cerda’s plan has been mostly recognized by its urban block typology in urbanism literature, as stated by Sola-Morales (1997), block formation is the last stage of his design proposal which is arisen after the subdivision of the land into individual plots and structuring this ownership pattern with extensive street network: “the process of production of the new urban fabric for Barcelona can be understood in three distinct and sequential levels: Parcelling, Urbanization, and Construction” (p.3). According to the author, Cerda firstly worked on achieving a close-grain plot configuration by parceling the agricultural land with aggregation and subdivision operations (parceling), then reticulated the whole fabric with grid street mesh (urbanization) and obtained eventually these renowned urban blocks (construction). In that sense, it would not be
wrong to state that plot subdivision and its relationship with extensive street layout have an important role to play in Cerda’s design proposal and its adaptation and evolution through time.

**Figure 4.14:** Cerda’s research on the block typologies of Edinburgh – New Town and New York – Manhattan Island (Basquets, 2014: p.126).

**Figure 4.15:** Three different urban block typology offered by Cerda and their various compositions in Barcelona – Eixample (Projective Cities – AA School of Architecture Website: Yuwei Wang, 2012).

Before Cerda’s plan, the area was a large farmland comprised of many small plots scattered through the land in an unrestrained way – which would most likely lead speculative transactions while the planning process was proceeding. In order to
prepare the site, before anything else, Cerda drafted different plans of fragments both to preserve the close-grain plot configuration of the Eixample and to establish the precise relationship between property borders, street lines and building blocks (Figure 4.16).

![Figure 4.16: Two distinctive plot-division plans for two different street blocks in the Eixample (Basquets, 2014: p.137,139)](image)

Throughout the planning process, Cerda meticulously designed the plot subdivision of the whole area by caring the tense relationship between regular plot division and preserving the former grain of the area. According to Basquets (2014),

“there was often a contradiction between the perfect form of the octagonal matrix of the street blocks and the erratic or geographical layout of former farmland. Cerda fought to regularize the form of plots by means of re-division, and in a few cases, he managed to do so: the form of buildings and their gable ends still illustrate this contradiction” (p.138).

This explicit contradiction between conscious design act to regularize plot divisions and inherited irregular ownership patterns paved the way for the combinations of various fine-grain plot configurations. In that sense, this quite regular and controlled plan unexpectedly allowed design variety in building typologies (corner buildings, row houses and singular buildings) and building sizes; and, enabled diverse set of functions to be generated in the Eixample over time (Figure 4.17).
In addition, as asserted by Basquets (2014), the initial low plot coverage (defined by Cerda as 50% at most) gave chance for further expansions of the building footprints or even heights incrementally and allowed the Eixample to adapt changing conditions of densification. Like it was in Edinburgh - New Town example, highly modular and diverse plot configuration allowed individuals from different classes with different aims to participate in construction process. Thus, the Eixample was generated through a piecemeal form of development – plot by plot – and the increased modularity of plot subdivision “enabled minimal interventions in order to enhance the areas that offer greater adaptability to the new uses and functions” (Leote, 2015: p.2).

In addition to close-grain plot configuration, Cerda payed attention to the relationship between plot and street to increase mobility and continuity through the Eixample. By relying on the fact that Cerda’s plan drawings were supported by a detailed list of the individuals owning each street block, it would not be wrong to express that street formation is the most elementary form of development to control the relationship between plots (both side-by-side and face-to-face) and to develop the fabric in an
incremental manner – street-by-street. According to Fernandez (2008), Cerda thought that grid-based street structure can solve many problems about gradual construction process, traffic and mobility, topology and administration of ownership. Owing to the well-established intersecting formation of hierarchical streets, high level of permeability and connectivity was achieved; and, it allowed the clustering of various mixed-uses along plot-frontages like the combination of “rented apartments, single family and artisan houses, warehouses, workshops and detached houses with gardens” (Basquets, 2014: p.148). As one of the most innovative solutions developed by Cerda for the relationship between plot-frontages (facades) and street network, ‘chamfered corners of the blocks’ both created the renowned octagonal shape of the grid layout and helped to increase the interface (shared surface) between street and plot. These chamfered corners triggered the appearance of various functions relatively different from residential uses and allowed the emergence of diverse public squares.

The enhanced adaptive capacity of the Eixample sustaining over years is not only resulted from the design qualities of Cerda’s plan but also emerged from the collective actions of individuals through an open and evolutionary process to respond changing circumstances: i.e. from disjointed design formation over centuries. In that sense, while it is true that the maintained and well-adapted overall structure of the Eixample owes its adaptive capacity necessarily to the design qualities related with plot and block configuration, street network and many others; the effect of collective actions like modification, transformation and re-interpretation by individuals without altering the structure is also undeniable (Guardia and Nadia, 2018). Indeed, even Cerda himself, was open to possible modifications throughout the design and construction process: “The Cerda project was established and began to be developed, but it did not predetermine and does not predetermine that this plan should be free from the need to undergo major reforms as the times unfold, times in which [...] peoples demand imperative modifications” (La Vanguardia, 25/01/1887). According to Guardia and Nadia (2018), in terms of adapting historical transformation and responding modifications, Cerda’s plan and its structure offered a flexible framework in which “the plot was a key piece in the functional articulation of the new city” (p.8). Therefore, it is possible to express that the configurational design aspects of the
Eixample (such as fine-grain plot configuration, grid-based extensive street network, enhanced relationship between streets and plot frontages) allowed the incremental transformation and development with distributed design formation over years; and steered the urban adaptation to emerge and continue through time (Figure 4.18).

![Figure 4.18: Evolution of a sample block in Eixample: representing gradual change in plot sizes, plot coverages, building widths and heights (Basquets, 2014: p.301)](image)

Today, the Eixample is the most vibrant part of the Barcelona entailing various urban functions and it is “an ongoing laboratory of architectures that has room for the most diverse styles and trends, all within the general coordinates of alignment and ground levels established almost at the very start” (Basquets, 2014, p.299). It is a very vital mixed-use and dense civic core entailing commercial, residential and public uses simultaneously (Figure 4.19). The morphological and programmatic adaptability of the area can also be traced from the transformation of relatively uniform plot configurations into more heterogeneous and diverse ones including various range of plot sizes, plot forms and plot frontages (Figure 4.20).
It is clear that today’s Eixample is relatively beyond of what Cerda imagined and designed. The Exiample’s enduring macro structure and its evolving pieces through adaptation represents that it is actually a successful synthesis of design and evolution, permanence and change, resilience and flexibility which offers valuable
understandings about the concept of urban adaptation. It would not be wrong to state that not only the configurational and structural design qualities of the area which constitutes the pre-conditions of adaptation (modularity, diversity, connectivity, redundancy) but also the collective actions of individuals (modification of form and function) enabled the Eixample to respond changing needs, maintain its vitality and adapts to unprecedented emergencies. In that sense, as aforementioned case study – Edinburgh, New Town – does, Cerda’s Eixample offers valuable understandings about the contribution of fine-grain plot configuration, plot-street relationship and plot-by-plot development and modification to adaptive capacity of the urban space.

4.3.3.3 Alamo Square – San Francisco

Alamo Square is one of the historical neighborhoods of San Francisco which is close to the city center and includes diverse urban uses and various user groups living in quite different architectural typologies. Origin of the Alamo Square dates back to the mid-nineteenth century when it was planned as a suburban residential area subdivided into fine-grain plot configuration within rectangular urban blocks and having a large public open space at the center of the neighborhood (Figure 4.21).

![Figure 4.21: Gridiron block-layout of the Alamo Square in San Francisco (Moudon, 1986: p. 4).](image)

According to Lischewski (1978), the most distinctive feature of Alamo Square is its characteristic close-grain plot subdivision which is platted by the municipal authority
to provide private sector and many individuals with the highly accessible property rights. Since it has been built at 1850s, Alamo Square experienced several physical and social transformations and evolved into a heterogeneous neighborhood including different building traditions ranging from Victorian houses to the contemporary architectural solutions and variety of mixed-uses and functions simultaneously. In terms of the procedural spatial change and adaptation to emerged conditions in the city, Alamo Square – as similar to many early twentieth century American neighborhoods – “had recently proved able to adapt successfully to rapidly changing lifestyles, economic circumstances, and technological breakthroughs” (Moudon, 1986: p.1). In that sense, examining the key morphological features of the neighborhood by focusing on the process of urban change and adaptation would offer substantial insights about the importance of distinctive configurational principles on adaptive capacity of the urban space.

At the beginning of its development, around 1899, Alamo Square’s plot configuration was not that much matured and diversified as it can be understood from the relatively homogenous distribution of property lines within the gridiron structure of the neighborhood. Alamo Square’s fabric was based on the modular configuration of 25-varas\(^{49}\) (approximately 21 meters) identical components, in which each urban block (100 by 150 varas or 85 by 130 meters) was subdivided into six large lots of 50 by 50 varas (42 by 42 meters) which would be further subdivided into small plots when it was necessary (Figure 4.22). Up until the beginning of 1900s, buildings on the neighborhood were identically narrow and small – except the corner parcels having relatively large buildings – and designed with the analogous architectural expressions which eventually represents quite homogenous urban space (Figure 4.23). As stated by Moudon (1986), fine-grain land subdivision in Alamo Square “acted as a chessboard” which regulates the position and composition of the buildings, defines the relationship between building mass and hierarchical structure of the grid street network, and, allowed both the continuity and change of this remarkably adaptable urban space (p.51).

\(^{49}\) Varas is a traditional measurement used in Spanish colonies which approximately equals 33 inches – i.e. 50 varas approximately equals 42 meters.
Figure 4.22: (a) the grid structure and an identical urban block composed of 25-varas modules; (b) a typical urban block subdivided into 6 identical lots – indicated with yellow line; (c) different subdivision examples of lots into individual plots (Moudon, 1986: p.52-53).

Figure 4.23: Alamo Square at the beginning of twentieth century; representing the uniform composition of identical buildings with the exception of corner parcels having larger buildings (Moudon, 1986, p.21).

After 1930s, on the one hand, while vacant large lots in the neighborhood started to be subdivided into small plots; on the other hand, some of the plots aggregated to build
larger buildings which eventually led to the appearance of coarser-grain parts in Alamo Square. While the structural network and general configuration of the neighborhood was preserved, larger modern apartment buildings started to be emerged in addition to Victorian single-family houses as a result of the gradual increase in density. In addition to the changes in plot coverages, plot sizes, building sizes and styles, some small commercial and industrial uses started to appear along several major streets such as Divisadero and Fillmore – which contributed to the variety of the neighborhood. Following this period, after 1970s, some urban renewal projects started to be developed at the north-east part of the neighborhood; and, it resulted in emergence of larger size of the buildings occupying large plots without creating a strong relationship between the plot frontages and street network. While the fine-grain plot configuration and strong interaction at the street level has been preserved in most of the Alamo Square, “in the urban renewal blocks, the cellular characteristics of the earlier fabric were eliminated as the result of the wholesale aggregation of land” (Moudon, 1986: p.23). Contrary to the most of today’s Alamo Square – which is composed of fine-grain plot configuration, mixed uses and heterogeneous composition of user groups and architectural expressions – this contemporary urban renewal area having a coarse-grain plot configuration was solely reserved for residential uses; and, since from its early development it has been open to dispute because of its incompatibility with the general character of the neighborhood. In spite of these recent developments leading negative externalities on Alamo Square’s urban fabric, the neighborhood successfully preserved its distinctive character and noticeable physical qualities through ages; and, adapted to changing circumstances by both modifying its individual components and sustaining its spatial coherence simultaneously. The pre-conditions of fine-grain cellular configuration and its combinatory use with the gridiron street structure established “the cohesive and unifying system of blocks, streets and lots” (Moudon, 1986: p.56) and allowed the incremental change, transformation and adaptation of the space to occur without altering the macro structure (Department of City Planning, 1978) (Figure 4.24). Procedural adaptability of the area can also be traced from the transformation of relatively uniform plot configurations into more heterogeneous and diverse ones indicating the adaptation of form and function to respond urban change (Figure 4.25).
Figure 4.24: Gradual change of the plot configuration and building footprints in Alamo Square from 1899 to 1931, and to 1976 (Moudon, 1986: p.14-15).

Figure 4.25: Variations in plot configuration in 1931 evolved from relatively homogeneous distribution of plots in 1899 (Moudon, 1986: p. 55).
In addition to its physical qualities arising from the original design, adaptive capacity of the Alamo Square is also related with the collective and continuous modifications of individuals leading to the evolution of the neighborhood over time. Especially, the small size of individual plots which were available at the beginning of 1900s paved the way for the participation of many end-users and speculative developers into development process and steered the various interactions between them. In spite of the fact that Alamo Square’s design principles and configurational features seem rigidly controlled and uniform at the first glance, the area achieved to experience the evolutionary process of transformation into a diverse, mixed-use and vibrant urban space and adapted to the emerging needs without losing its general structure and character. According to Moudon (1986), the unprecedentedly emerged variety of Alamo Square sprang from “the individuality of the settlers and their desire and ability to express themselves through the building of their environment” which is a direct result of the fine-grain ownership configuration including small and many plots and allowing the distribution of design formation effectively (p.94). In that sense, it is explicit that the importance of plot and plot-by-plot (i.e. incremental) development is undeniable for both creating the pre-conditions of adaptation and allowing it to continue over time with the help of distributed design and development control. Accordingly, Vance (1977) argues that the process of morphogenesis and transformation of the urban space is a series of incremental changes defined by the negotiations between individual plots – which are the key spatial components in which change and adaptation would take place. Within this context, it would not be wrong to state that Alamo Square’s original plot configuration and ownership pattern allowed multiple, continuous and relatively disjointed increments through time, made the neighborhood responsive according to arising contextual changes by allowing variety of spatial choices and enabled the area to preserve its structural and characteristic coherency.

Today, Alamo Square is a vibrant and mixed use neighborhood composed of the co-existence of diverse spatial structures having various plot sizes, building forms and uses simultaneously (Figure 4.26). Its explicit evolution from a residential suburb having relatively homogenous plot configuration and architectural style into a collage
representing the spatial hybridity and including diverse set of urban grains is the most striking evidence for the adaptability of the neighborhood (Figure 4.27).

Figure 4.26: Aerial view of Alamo Square, San Francisco (Source: Google Earth, 2018)

Figure 4.27: Sample section-cut from Alamo Square representing the co-existence of various urban grains (fine, medium and coarse) and accordingly the diversity in plot sizes, building widths, heights and styles (Moudon, 1986: p.140).

Throughout its procedural evolution, the gridiron structure and fine-grain plot configuration has always been the most permanent characteristic features of Alamo Square and prepared the ground for incremental changes by individuals to respond and adapt both expected and unexpected circumstances. In that sense, according to
Moudon (1986), close-grain plot configuration has always been the most important spatial feature – which affect the form and function of the buildings, variety in their design and potentiality of change – and steered the urban adaptation, enabled Alamo Square to respond changes through different periods of time thanks to the emerged variety of the available choices in space; because, “the smaller the increment of land ownership, the more variety created in the environment” (p.141). Though it was not planned for that purpose specifically (i.e. for change and evolution), Alamo Square had necessary pre-conditions for adaptation to emerge and continue through time: fine-grain plot configuration and gradual development and transformation of the plots with disjointed design formation over time. In that sense, as similar to the aforementioned case studies of New Town in Edinburgh, Eixample in Barcelona, and Alamo Square in San Francisco constitutes a remarkable example for successful urban change and adaptation, and, offers priceless insights about the importance of plot-based urbanism approach for the adaptive capacity of the urban space.

4.4 Overlapping the Key Lessons of Plot-Based Urbanism and Principles of Adaptive Capacity of Urban Form

It is explicit that “there are urban forms that appear ‘inherently’ more resilient to change over the long run than others” (Davis and Uffer, 2013: p.11) because of both their physical characteristics coming from the design and the way they experience the post-design process of evolution. The examined case studies in the current chapter shows that even if these urban spaces were not planned consciously to be adapted into arising circumstances and resisting to time by responding change, they have some common characteristic features contributing their adaptive capacity. Most importantly, these case studies emphasize the importance of ‘plot’ and ‘fine-grain plot subdivision’ through ‘plot-based urbanism’ for enhancing the adaptive capacity of urban spaces to respond change over time and help us to re-discover the knowledge of ‘urban adaptability’ in the context of design and evolution, permanence and change, and resilience and flexibility. In that sense, the key lessons of (1) fine-grain plot

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50 Moudon (1986) describes the notion of ‘adaptation’ by referring to the term ‘resilient environment’. According to the author, it is “any environment that can be adapted to major change without major modifications” but incremental adjustments extended over time (p.158).
configuration; (2) enhanced plot-street relationship and increased interface between them via grid-based structure; and (3) disjointed (or incremental) development/formation through time are substantial points derived from the common characteristic features of these case studies. These derived lessons are strongly parallel with the recently developed principles\(^\text{51}\) of ‘plot-based urbanism’ by many scholars pointing out the importance of plot in spatial responsiveness, adaptability and capacity of change (Porta and Romice, 2010; Campbell, 2011; Tarbatt, 2012).

As the first and most important principle, **fine-grain plot configuration** is crucial to enhance the adaptive capacity of urban space. It means subdividing the land into many small plots that would allow to distribute ownership regulations into various individuals which would eventually lead to the further disjointed development in time and ensure the emergence of diversity in form and function (Figure 4.28).

**Figure 4.28**: Aerial view of fine-grain townhouses, Steigereiland, the Netherlands (Tarbatt, 2012: p. 128)

\(^{51}\) According to Porta (2010), small plots, street centrality (emphasizing the relationship between plot and street), 400-meters rule and informal participation (incremental development by individuals) are the distinctive characteristic features of urban spaces planned and designed with plot-based urbanism approach.
Moreover, according to Moudon (1986), “many property owners slow down the rate of change by making large-scale real estate transactions difficult” and thus make the urban space more resilient to change and transitions (p.188). In that sense, as the smallest and the most controllable (or achievable) morphological components of the urban space, small plots are the key “to foster the characteristics of older close grain places that we value – diversity, variety, adaptability – while also putting in place the frameworks necessary to achieve all the other objectives of urban design” (Tarbatt, 2012: p.154). In addition, from the perspective of complexity theories, plot is the most fundamental component – or sub-part – of the complex urban fabric which controls the relationship between individuals and the form of the physical space. In that sense, simple operational rules at plot scale would certainly generate complex results by allowing the diversity in form and function, various spatial choices and end-users and would steer the urban adaptation to emerge and continue through time. Therefore, fine-grain plot configuration refers to the necessary pre-conditions of urban adaptation like modularity, diversity, variety of choice and paves the way for incremental development through time.

As another complementary principle, enhanced plot-street relationship is important for the adaptive capacity of the space. According to Porta (2010), by relying on the fact that the most resilient historical spaces (some of them were revisited in case studies part; like Edinburgh – New Town) developed and transformed street by street and plot by plot; not block by block, it is evidently true that ‘street front’ or ‘plot frontage’ “should be taken as the coding units of a new generation of form-based codes” that would pave the way for incremental emergence of adaptability (p.30). Moreover, the enhanced relationship between plot and street constitutes the vital interface between public and private space; and, allows the emergence of new urban uses apart from residential facilities and contributes to the mixed-use, diverse and hybrid character of the space by providing enough choice – which is key for adaptability. According to Tarbatt (2012), fine-grain does not only refer to the plot subdivision but also to the size of blocks: “the greater the number of blocks and streets over a given urban area, providing a more permeable urban structure overall” allows various choices of flow in space and triggers the agglomeration of various functions.
through distinctive axes (p.28). In that sense, enhanced plot-street relationship and increased interface between them via grid-based and close-grain network provides the necessary resilient structure in which flexible operations can be made by using the modular composition of plot subdivisions – which is the answer of why the most adaptable and resilient urban spaces investigated as case studies are the ones structured by close grain, extensive and permeable gridiron street network.

Lastly, incremental development via disjointed design formation is crucial for the adaptation of urban space by responding to change and transitions in an evolutionary manner. Disjointed development defines the gradual process of adaptation without the central coordination of any controller; but according to the collective agreement on simple rules. According to Porta (2010), “small plots must be coupled with disjointed development, i.e. plot control assigned plot-by-plot to different subjects, in order for informal change to start and keep happening” (p.30). In that sense, discrete development process by relying on simple rule based relationships allows urban space to adapt changing circumstances by the collective actions of individuals and enables the distribution of design formation and control. As being reverse of the comprehensive, centralized and ‘instant city’ approaches, incremental development leaves some ambiguity in design process; allows variety of spatial choices, genuine personal interpretations and emergence of diversity in space; and, enhances the adaptive capacity of urban space to accommodate changes (Moudon, 1986).

While the first two of these derived lessons – fine grain plot configuration and enhanced relationship between plot and street – refer to the formal principles of adaptive capacity which would be achieved by design; the last one – disjointed development – points out the post-design process in which the design would be re- configured, transformed and evolved into something different. In that sense, the key principles of plot-based urbanism derived from the literature and sample case studies are strongly parallel with the principles of adaptive capacity defined in previous part – in terms of referring both to the formal principles (modularity, diversity, redundancy, permeability) and formation mechanisms (change of form and function), design phase and post-design phase, design and evolution, resilience and flexibility, permanence
and change (Figure 4.29). This overlapping relationship represents that the adaptive capacity of investigated plot-based urbanism examples does not only originate from their physical characteristics coming from design but also depends on the disjointed, relatively self-organized and gradual process of evolution in time. Accordingly, the same relationship is valid for the concept of ‘adaptive capacity’ which is a combinatorial effect of design and evolution. Therefore, synthesizing the conceptual and relatively abstract principles of adaptive capacity with the key lessons of plot-based urbanism would enable us to define a more operational and tangible design framework focusing on the morphological and programmatic characteristics of an adaptable urban space. By doing so, it would be possible to define the formal (design) principles of adaptive capacity and formation (post-design/evolution) mechanisms of the adaptation.

Figure 4.29: The joint framework of the adaptive capacity of urban form through ‘plot-based urbanism’

4.4.1 Formal (Design) Principles of Adaptive Capacity of Urban Form

As it was mentioned before, adaptive capacity is an overarching concept which is related not only with permanence and resilience; but also with change and flexibility. Therefore, both the formal principles of any design and also its procedural reformation (emergent transformation) over time defines its adaptive capacity. The first
part of this bipartite synthesis is the formal (design) principles of adaptive capacity which are derived from the theory (modularity, diversity, redundancy, permeability). Within this context, these relatively abstract concepts would be re-visited by relying on the formal principles derived from the plot-based urbanism examples (fine-grain plot configuration and enhanced relationship between plot and street).

**Modularity**

According to Batty (2013), urban systems are characteristically modular and they are composed of smaller and independent but highly interacting components which are eventually aggregating at various scales and forming distinctive wholes. Within this nested-hierarchical relationship, plots are the most fundamental units representing the modules of the urban space and their configuration and composition generates the other components like streets, urban blocks and urban patterns respectively. In that sense, while the modules (plots) and their configurational rules are simple, the emerged formation arising from their relationship is highly complex and sometimes unprecedented. According to Feliciotti et al. (2016), “modularity is important for resilience because it helps spread innovation through interdependency, while limiting the damage caused by failure of individual components” (p.71). From a morphological perspective, the notion of ‘urban grain’ is the most appropriate term that refers to the level of modularity. Tarbatt (2012), defines the urban grain as “a metaphor for the density of subdivision of plots and blocks” (p.28) and states that fine-grain (or close grain) urban fabrics having a lot of individual small plots are functionally and formally more complex and more resilient to change than the medium-grain or coarse-grain ones (Figure 4.30).

![Figure 4.30: Enhanced modularity of the urban space via the subdivision of the land into many small individual plots (left: coarse-grain, middle: medium-grain, right: fine-grain) (Tarbatt, 2012: p. 90)](image)
Therefore, fine-grain plot configuration representing highly modular characteristic feature is important to increase the complexity level of the system, to allow enough choice in space, to enable more individuals to participate in development process and to increase the adaptive capacity by relying on the diverse set of spatial choices. In that sense, ‘small plots’ are key to steer adaptation; because, their functional and geometrical simplicity controlled by many disjointed individuals generates the necessary functional complexity which will increase the resilience and capacity to respond change (Habraken, 1998; Moudon, 1986; Porta and Romice, 2010; Panerai et al., 2004). In other words, modular subdivision of the land constitutes the first necessary basis on which the other vital principles of adaptive capacity will be planted and developed.

**Diversity**

Jacobs (1961) defines the ‘diversity’ as one of the most essential features of a successfully evolving city and identifies the necessary pre-conditions for its being developed as follows: small urban blocks having many entrances (fine-grain configuration of individual buildings and plots), high level of concentration (density), the variety of functions, building styles and sizes (mixed-use). Diversity is crucial for both resilience and flexibility – i.e. adaptive capacity – of an urban space; because, it allows the availability of various choices in space which will both increase the stability in different conditions and enables to accommodate changes simultaneously (Ahern, 2011). The notion of ‘spatial capacity’ introduced by Marcus (2000, 2010) points out that the fine-grain configuration of plots increases the number of individuals in the area and triggers the emergence of different end-users having different strategies and diversity of functions and formal expressions (Figure 4.31). According to Tarbatt (2012), “diverse range of close-grain uses” developed on wide range of plot sizes enhances the capacity of spatial adaptation; because in diverse urban spaces “no single part is too big to fail” (p.15).

Diversity of plot sizes, building forms, uses and individuals offer “various ‘experiential’ choices” in space which is defined as the key for any ‘responsive
Redundancy

Redundancy refers to the availability of the multiple choices more than it is needed (Cambridge Dictionary, 2018) and complements the principles of modularity, diversity and permeability. Therefore, redundancy is related with the duplication of similar spatial components used for the same function in different forms, sizes and styles to enhance the backup capacity of the system in case of any failure or change. Feliciotti et al. (2016) illustrates the term by giving the example of “fine-grained ground floor retailing, department store and commercial center appropriately contained in a mixture of plots of different sizes” and points out the importance of modular configuration of diverse range of plot sizes assigned for the similar functions.

Because of the fact that redundancy also means the inclusion of overabundant amount of any service or good even if it is not necessary, it is associated with the generous plot

Figure 4.31: Illustrative diagram of the notion of ‘spatial capacity’ (Adopted from: Bobkova et al. 2017: p.47.4).
sizes having low plot coverages. Availability of larger plots with low coverages facilitates the densification process of the area and “generous dimensions will facilitate the appropriation of space for a variety of activities” gradually (Moudon, 1986: p.188). Moreover, in addition to its contribution to the diversity and emergence of various set of choices in plot configuration, redundancy contributes to the street network by offering ‘alternative pathways’ and complements the principle of permeability.

**Connectivity and Permeability**

Permeability is “the extent to which an environment allows people a choice of access through it [...] is a key measure of its responsiveness” (Bentley et al., 1985: p.12) and it defines the amount of various and alternative choices of flow in the space. An urban space composed of smaller blocks offers more choice of flow than the one having relatively larger blocks (Figure 4.32).

![Figure 4.32: Permeability at structural scale: comparison of small and large blocks in terms of the permeability – i.e. available choice of flows (Bentley et al., 1985: p.10,12)](image)
Illustrated by distinctive plot-based urbanism examples in previous part, as one of the most traditional and rooted models, gridiron urban pattern has always been the most adaptable one which is both allowing change and maintaining its character in a resilient manner. According to Campbell (2011), “the geometry of the open hierarchical grid has long been advocated as providing the necessary framework for urban variety” (p.63) and contributed to the evolutionary process of development and change.

Permeability is interchangeably used with the notion of connectivity in literature; because high level of permeability directly contributes to the accessibility and connectivity of the space. Connectivity increases the level of encounter between individuals and facilitates the intensification of certain activities through particular segments even if it is not planned and designed for that purpose (Hillier, 1996). By relying on the fact that increased interactions and emergence of unexpected encounters among individuals paves the way for increased level of complexity and diversity (Jacobs, 1961), permeability and connectivity are key principles to enhance adaptive capacity of the urban space. Moreover, in terms of the relationship between fine-grain plot configuration and street network, high level of permeability and connectivity leads to an increase in the total amount of shared-surface or interface between plot-frontages and streets and triggers the development of active plot frontages (Figure 4.33).

**Figure 4.33:** Permeability within urban block: emerging mews lead to an increase in available plot-frontages and enhances their relationship with movement (Campbell, 2011: p.79).
These interfaces are important to respond changing circumstances by being activated with the emergence of different functions like commercial and retail activities which prefers to be in a closer relationship with the public space. Therefore, “smaller blocks generate a more flexible grid and permit more frequent linkages, visual and pedestrian connectivity, and a greater degree of activity on the street” (Tarbatt, 2012: p.102).

4.4.2 Formation and Re-formation (Post-design) Mechanisms of Adaptation: Change of Form and Function

While the derived lessons of (1) fine-grain plot configuration and (2) enhanced relationship between plot and street overlaps with the formal principles of adaptive capacity (modularity, diversity, redundancy, permeability); another key lesson of (3) disjointed (incremental) development refers to the formation or re-formation mechanisms of adaptation related with the change of form and function through post-design process. Therefore, design characteristics of an urban space can only constitute the necessary basis for change and transformation; but it is not enough to ensure adaptation. For the notion of adaptation, time dimension is crucial; because it emerges and develops incrementally over time – through a series of evolutionary adjustments by various actors. According to Schmidt III et al. (2010), “[...] adaptability could take place [...] through the re-configuration of the building for subsequent changes in use” (p.3). Therefore, it is possible to argue that potential of adaptability offered by design would only be activated by the incremental, disjointed and discrete actions of change by individuals through post-design process.

As it is mentioned before (see Chapter 4.2.4) the notion of urban change basically can be categorized under two distinct groups: **change of form** – i.e. physical layout or structure; and **change of function** or use (Schmidt III et al. 2010). In terms of the change of form, plot configuration is important as the most fundamental component of urban form; because plot is the basic determinant of form and function by relying on its capacity to respond change in time (Moudon, 1986). According to Kropf (2001), the incremental and disjointed changes in individual plots through time leads to an “aggregate effect” on a larger scale and allows adaptation to different circumstances.
As it is illustrated by the plot-based urbanism examples, the basic change mechanisms at the plot scale can be listed as: amalgamation of individual plots, subdivision of larger plots into smaller ones, increase or decrease in plot coverages, increase or decrease in the height of building mass or expropriation of a part of plot for public use like roads, open spaces or public services.

In addition to the changes in form, functional changes are another important part of post-design adaptation. In the case of arising contextual changes and by relying on the emerging needs of inhabitants, an adaptive urban space can experience functional transformations by maintaining its structural coherence (e.g. one of the pre-investigated case studies – Edinburgh, New Town – was designed as an upper-class residential suburb; but it has experienced a gradual functional transformation and evolved into a mixed-use civic core thanks to its design characteristics and disjointed actions of individuals). Hence, it is possible to argue that certain formal principles of an adaptive urban space – like fine-grain plot configuration, diversity of formal expressions, uses and end-users, redundant plot coverages allowing further densification and permeable street network interrelated with the modular plot layout – allows the formation or re-formation process even after the design is implemented and enhances the adaptive capacity. Therefore, all in all, formal principles of adaptive capacity (*modularity, diversity, redundancy, permeability*) and formational mechanisms of adaptation (*change of form, change of function*) are two different sides of the same coin – the notion of adaptive capacity cannot be thought without taking both of these into consideration.

**4.5 Concluding Remarks**

Before the realization of complexity science perspective, uncertainties related with urban planning and design processes were considered as risks or potential failures; and the common approach of planning was to control, reduce and prevent uncertainties as much as possible (Abbott, 2009). The problem of formal and functional adaptation and responsiveness in urban spaces is because of this common perspective and conventional methodology that dominates urban design and planning by regulating
and controlling everything beforehand with fixed objectives in an obsessively certain manner. With the advent of complexity thinking in planning, uncertainties are started to be viewed as an intrinsic and inevitable outcome of complex urban formation processes in contemporary planning and design literature. Therefore, the question that becomes highly urgent is how planners and designers can embrace the notion of uncertainty and what kind of urban planning and design approach should be developed to strengthen the responsiveness of the urban spaces to cope with uncertainties. In that sense, the notions of ‘adaptation’ or ‘adaptive capacity’ in the context of urban planning and design offers important contributions to cope with the issue of uncertainty.

By relying on the inferences in literature, the most appropriate definition of urban adaptability would be a synthesis of two contrasting ends: ‘the capacity for change and transition’ and ‘remain fit and robust against changes’. Within the framework of this definition, caring about the adaptive capacity of urban space would enable urban planners and designers to create places which have the ability to maintain their structure and character in a coherent way (robustness/resilience) as well as to respond and adapt changing circumstances in a flexible manner (flexibility). Within the context of this chapter, the notions of robustness/resilience and flexibility and their spatial and morphological principles are examined. While the former (resilience) refers to the degree of spatial permanency by relying on diverse set of choices in the space, the latter (flexibility) is related with the capacity of spatial change through gradual adjustments in order to accommodate both foreseen and unforeseen circumstances. Spatially, a resilient urban structure which is diverse, modular, redundant and connective – in other words, a structure which offers enough choices for use, experience, flow and design control – enables urban change in form and function to occur via a series of incremental adaptations and transformations. In that sense, resilience constitutes the necessary pre-condition for flexibility to occur and continue; and so, adaptive capacity of an urban space cannot be considered without one of these concepts. So, while the notion of resilience refers to the conditional qualities by relying on structural or formal principles (diversity, redundancy, modularity, connectivity), the concept of flexibility identifies formational mechanisms and types of change (formal change and functional change). From this complementary perspective, it would not be
wrong to state that adaptive capacity puts forth a unified framework which can be defined as offering enough choice to leave room for change.

In addition to drawing this theoretical and conceptual framework, from urban design perspective, the following task of this chapter is to answer the question of how to establish the right structure in an urban space which will refer these conceptual principles, enhance the adaptive capacity and steer urban adaptation over time. In that sense, as being the most viable morphological component to operate design in revealed condition of complexity, plot offers valuable contributions to fostering spatial diversity/modularity/redundancy, controlling design process incrementally and making urban space to adapt processes of change and uncertainties efficiently. Within the second half of this chapter, in order to draw a clear and overarching framework to understand the contributions and achievements of plot-based urbanism for the concept of urban adaptation, some historical case studies of plot-based urbanism are revisited. To that end, three international case-studies are examined to infer fundamental lessons about the importance of plot and plot-based development for enhancing the adaptive capacity of the urban spaces: (1) Edinburgh, New Town; (2) Barcelona, Eixample; and, (3) San Francisco, Alamo Square. These examined case studies demonstrate that even if these urban spaces were not planned consciously to be adapted into arising circumstances by responding to change, they have some common characteristic features contributing their adaptive capacity. Most importantly, these case studies show the importance of ‘plot’ and ‘fine-grain plot subdivision’ through ‘plot-based urbanism’ for enhancing the adaptive capacity of urban spaces to respond change over time. In that sense, the key lessons of (1) fine-grain plot configuration; (2) enhanced plot-street relationship and increased interface between them via grid-based structure; and (3) disjointed (or incremental) development through time are substantial points derived from the common characteristic features of these case studies.

While the first two of these derived lessons – fine grain plot configuration and enhanced relationship between plot and street – refer to the formal design principles which would be achieved by design; the last one – disjointed development – points out the post-design process in which the design would be re-formationed, transformed and evolved into something different. In that sense, the key principles of plot-based
urbanism derived from the literature and sample case studies are strongly parallel with the principles of adaptive capacity defined in previous part – in terms of referring both to the formal principles (modularity, diversity, redundancy, permeability) and formational mechanisms (change of form and function). Integrating the theoretical conceptualizations of adaptability and derived lessons from historical case studies enables to draw an overarching framework about the morphological and programmatic characteristics of an adaptable urban space.

By relying on these understandings, contemporary urban planning and design need to invent a new design model to improve the adaptive capacity of urban form by asking the very question of ‘how can we produce the necessary structure for urban space which ensures adaptability and responsiveness for unexpected changes by simultaneously avoiding from rigidity and over-determination’. To that end, in the following chapter, a responsive design model would be proposed by critically evaluating two different contemporary urban planning and design projects with respect to the derived lessons and insights about the notion of adaptive capacity.
As it is illustrated in the previous chapter, the notion of urban adaptability is a synthesis of two contrasting ends: ‘the capacity for change and transition’ and ‘remain fit and robust against changes’. That makes adaptive capacity an inclusive term established upon the relationship between resilience and flexibility, permanence and change, order and chaos, coherence and variation, top-down and bottom-up, design and emergence. In addition to the identification of ‘morphological and programmatic characteristics of an adaptable urban form’ (in Chapter 4) by relying on the first research question of this research, the second and complementary research question of ‘what kind of design approach enables to create defined morphological and programmatic characteristics of adaptability by avoiding from rigidity and over-determination’ need to be responded, as well. In that sense, examining distinctive contemporary urban design practices which demonstrates these characteristic features would offer substantial insights to develop a new model approach to improve the adaptive capacity of urban form by design. Even if it is hard to find out a full-fledged contemporary urban planning and design practice responding to the revealed context of urban adaptability, two important case studies are worth to examine in detail and seem promising to extract new knowledge about improving adaptive capacity of urban form by design: (1) IJburg, Amsterdam (the Netherlands); and, (2) Middlehaven, Middlesbrough (United Kingdom).

IJburg is a contemporary urban development project extending towards to the east of the city of Amsterdam and it was built innovatively on the IJmeer Lake (Figure 5.1). It is a very accessible location connected to the city center with a 15-minute tram ride. The whole design layout consists of seven artificial islands establishing a close-knit
relationship with both each other and the water as well. It is projected to be completed within two phases. The first phase consisting of Haveneiland, Rieteilanden, and Steigereiland islands was completed and it includes more than 8000 homes within a dense and mixed use living environment. When the whole project would be completed, it will host approximately 45000 inhabitants (Gemeente Amsterdam, 2018). In addition to the wide spectrum of housing opportunities in the area, IJburg includes wide range of uses contributing to the lively character of the neighborhood like schools, sport areas, varying retail and commercial facilities, a beach and two marinas. This large scale urban development project is intended to be realized with an innovative public-private partnership allowing wide range of design parties to be involved in design and development process.

Figure 5.1: Aerial view of IJburg Urban Development Project area and its immediate surroundings (Google Earth, 2018)

Middlehaven is an ongoing urban development and regeneration project intended to be designed as a lively mixed-use urban extension to city of Middlesbrough. The project site covers a large vacant area at the north of the city center which was former dockland and harbor area of Middlesbrough (Figure 5.2). The main objective of the project is to create a new neighborhood including “a wide spectrum of housing, including family homes with gardens, live-work units, urban styles apartments, student and sheltered housing” (Middlehaven Development Framework, 2012: p.31);
different character areas and wide range of uses; and regenerated industrial landscape including various open spaces and a revitalized river. Middlehaven is one of the most inspiring examples of UK’s recent innovative approach to create living environments by relying on the collaboration with private market mechanisms. Although it seems such a large-scale project area need to be controlled with comprehensive planning and design mechanisms; Middlehaven demonstrates a quite different design approach which allows urban space to be generated from the independent and incremental actions of various individuals in a coherent manner.

Investigation of these two contemporary urban design practices would offer substantial insights to support the revealed conceptual framework of adaptability with an operational framework. IJburg is a perfect urban development example to understand the relationship between coherent structure at macro scale; and, flexible diversity and availability of multiple spatial choices in micro scale. The design approach and acquired morphological and programmatic characteristics contribute to the first part of the adaptive capacity – offering enough choice as pre-condition of design. As complementary to the IJburg case, Middlehaven presents innovative design strategies allowing further change and transformation of the area in addition to the diverse set of spatial choices proposed within the context of project. Thus, it complements the first
part by addressing to the notions related with the second part of adaptive capacity like change, transition and incremental adaptation – leaving room for change.

5.1 IJburg, Amsterdam, The Netherlands

The end of twentieth century is the era in which the Dutch planning and design authorities started to question large-scale planning interventions due to the arising economic recessions and also the role of public governments using the strict regulation mechanisms in spatial planning. Especially in Amsterdam, the planning authorities and scholars started to agree upon the idea of “more with less (meer met minder)” and proposed that “the new form of Amsterdam planning should be ‘organic’” (Savini, 2017: p.157). By emphasizing that conventional planning and design mechanisms with detailed, prescriptive and strict rules discourages the individual creativity and spatial flexibility, municipality and the other planning authorities adopted a more ‘enabling’ role instead of an ‘authoritatively controlling’ one.

IJburg is the biggest and the most strategic contemporary urban planning and design example in the city of Amsterdam – started to be built in the 1990s and still continuing to be developed today incrementally. The fundamental strategic idea behind IJburg is developing an urban expansion with the character of true ‘urbanity’ by referring to the relationship between control and flexibility; and, cohesion and variation.

5.1.1 Planning and Design Process

The initial ideas about the Amsterdam’s expansion towards IJburg date back to 1960s when the city suffered from impoverishment and decline of the city center. In 1965, Van den Broek and Bakema developed a visionary urban expansion scheme – called ‘Pampus Plan’ – which is a linear settlement on the Lake IJmeer. According to Lupi (2008), Pampus City was the representation of high level of urbanity including dense living spaces along with various working and leisure functions and proposed a

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52 According to Savini (2017), “organic is used to identify a type of transformation made with small-scale, nonlinear and gradual steps, driven by small scale, or even individual, entrepreneurial developers” (p.158).
radically new kind of community life within a compact neighborhood for the city of Amsterdam (Figure 5.3).

![Figure 5.3: Pampus City plan developed by Van den Broek and Bakema in 1965 (Buurman, 2005)](image)

Even if this visionary plan could not be implemented, its general perspective and conceptual framework inspired the planning ideas developed for the subsequent population growth of the Amsterdam. In 1996, Frits Palmboom of Palmbout Urban Landscapes – by collaborating with H+N+S Architecture and Amsterdam DRO (Physical Planning Department) – prepared a spatial plan which was conceptually defining the project as seven artificial islands (archipelago) developed incrementally on Lake IJmeer and comprised 18,000 homes along with commercial facilities, as well (Figure 5.4).

![Figure 5.4: Palmbout Architecture’s archipelago plan for IJburg on Lake IJmeer (Palmbout Urban Landscapes, 1996)](image)
By relying on Palmbout Architecture’s general planning decisions, the first phase of the development of IJburg was identified as Haveneiland and Rieteilanden; and municipality (Amsterdam DRO) has formed a complex cooperation including both the municipal authorities and three important consortia in the market: *Waterstad IJburg, the IJburgermaatschappij CV and the IJdelta Onwikkelings vof Consortia* – which are including various development agencies, housing corporations and project development and real estate companies. Asserted by Claus et al. (2001), “the municipality would be responsible for the main structure of the various islands as well as the inclusion of structural works, while the consortia would be responsible for the development of the zones created by the municipality” (p.83). Within the context of its development model and land release strategies, IJburg was a radical and substantial example in terms of opening up the planning and design process to a large group of consortia without trying to develop the whole spatial scheme at once with a central master-mind. With the coordination of this collaborative public-private partnership, Frits van Dongen of the Architekten Cie., Felix Claus of Claus & Kaan Architecten Amsterdam and Ton Schaap of Schaap & Stigter were invited to prepare a detailed urban design scheme. The design of these important figures of planning and design in Amsterdam is based on an extensive urban grid structure through which the diverse composition of the buildings was distributed over various blocks having different sizes and typologies in a coherent manner (Figure 5.5).

According to Lupi (2008), the most fundamental aim of this very abstract and conceptual design scheme is to ensure diversity in form and function within a coherent grid structure strengthen the sense of ‘urbanity’. This illustrative masterplan was supported with an urban design guideline (*Design for IJburg – Ontwerp voor IJburg, 2006*) which is relatively flexible and defines the specific design codes and requirements for certain parts of the area. According to Paul Kierkels (2018), “the design guideline was flexible enough to make individual and creative interpretations by the architect – that is actually part of our job. We had a complete freedom through the design process of our block33”. Even if the masterplan is developed by

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33 Excerpted from the interview with Paul Kierkels from Orange Architects – the design office responsible for Block 42A in IJburg and single standing building called ‘Jonas’ on it.
abovementioned three important architects/urban designers collaborating with in a large consortia, IJburg was not a pre-determined dream of a single person, but the emergent result of the various individual and collective planning and design interventions of ‘millions-hands’ through time. After the masterplanning process, each different block was entrusted to a different coordinating architect and these coordinating architects invited some other architects to operate design process within these urban blocks – which are subdivided more into various ‘lots’ to be designed in a diversified manner. This approach paved the way for an extreme amount of diversity not only in physical space but also in the profile of designers having different design solutions within the limits of the same masterplan and design guideline.

Figure 5.5: Illustrative masterplan of IJburg 1st phase – Haveneiland and Rietilanden West by Claus, Van Dongen & Schaap (Claus et al. 2001: pp.86-87)

As part of this research, in addition to examining planning and design process of the IJburg, a series of interviews have been made with the representatives of four different architecture offices who have participated in the design process and produced different design solutions in typological terms; and with two of the authors of the Masterplan of the IJburg – Felix Claus and Ton Schaap (Figure 5.6). While identifying the
correspondent designers, it was aimed to cover each different design parties – masterplanner, coordinating architect and architect – in the design process of Ijburg.

In that sense, while the two masterplanners Felix Claus and Ton Schaap provided inside information about the masterplan process and fundamental logic behind it; four different architecture offices evaluated their own architectural design process and product within the limits of masterplan decisions. These four architecture offices were chosen consciously as they provided different typological solutions in flexible manner.

Figure 5.6: Interviewed design offices and correspondent designers responsible for different urban blocks in Ijburg
in the scope of same masterplan and design guideline. The correspondent designers and masterplanners have been informed about the specific research questions and the general context of the research beforehand; and they have been provided with open-ended and qualitative interview questions (See Appendix A: Interview Questions). The interviews have been conducted preferably over Skype – face to face. In addition, some of the respondents has chosen to answer questions over e-mail due to their busy schedule. These architects and urban designers provide inside-information about their design process, and help to understand:

(1) the level of flexibility/open-endedness in design process;
(2) roles of different parties in terms of dispersed design formation;
(3) the design parameters for achieving diversity and coherence;
(4) adaptive capacity of design by relying on its merits and deficiencies.

Throughout the interviews, it was expected from each correspondent person to evaluate the masterplanning process by relying on the notions of flexibility and control; and to identify their varying roles in the design process and conceptualize the organizational relationships both allowing flexibility and constraining their decisions. Within this general context, each correspondent person provided distinctive design parameters – both in the whole masterplan and in their assigned urban blocks – which are totally open to individual interpretation of the designers and the ones controlled in a relatively strict manner to ensure the unity in diversity. Moreover, it is expected from these interviewers to self-criticize the urban blocks in terms of allowing adaptation and change to the emerging circumstances in IJburg – like arising need of intensification, transformation of urban uses and so on. The collection of this valuable knowledge would be referred often in the following parts of the study in which adaptive capacity of IJburg would be evaluated by relying on adaptability in urban form and formation process.

The involvement of various designers and other parties throughout the design process and the flexibility of abstract masterplan and design guideline – which is not working as a conventional blueprint but as an illustrative model to indicate general
characteristics – led to an increased amount of diversity in urban form and function; and, unexpected and emergent spatial outcomes without disturbing the coherence of the site. According to Lupi et al. (2007), “IJburg has chosen a different approach and tried to attract many potential developers for the realization of the plan. This has resulted in that the physical structure became different than expected and ensured more diversity in the design of residential blocks” – which means there has never been a strict pre-defined direction for the development of IJburg (p.10). In addition, as it is expressed by Pero Puljiz (2018), “while the masterplan organizes the general layout including public and private spaces, water and land surface; everything in between was left to designers which created unpredictable variety.”

Today, IJburg is a dense urban extension of the city of Amsterdam which is both entailing various architectural design solutions and rich tapestry of formal expressions; and simultaneously, illustrating a coherent urban layout as if it is controlled by a single hand (Figure 5.7).

Figure 5.7: Aerial view of IJburg – Haveneiland, Amsterdam (City of Amsterdam and Bureau Palmbout, 2015).

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54 Excerpted from the interview with Pero Puljiz from De Architekten Cie – who is one of the coordinator architects in IJburg responsible for Block 23.
According to Ton Schaap (2018), one of the masterplanners of the project, “IJburg is an experiment – a model of urbanization” based on “incremental design of variety of form and functions”. As it is stated in Design for IJburg (2006), fundamental aspects of the plan like ‘loose design plan’, ‘incremental development’ and ‘high density within compact construction’ helped IJburg to achieve a diverse spatial character and mixed composition of form and functions piece by piece through time – which would eventually enable it to respond unexpected changes in the market. In that sense, IJburg is a contemporary urban development project where elements of flexibility (in micro scale) and control/coherence (at macro scale) would be integrated in a successful manner (Savini, 2017).

5.1.2 Evaluation of the Adaptability in Form

As it is always stated in the official planning and design documents and by the masterplanners of the site (Claus et al. 2001), variation and coherence are the most important key words that defines the IJburg. According to Felix Claus (2018),

“the spatial programme of IJburg was determined by the municipality as very restrictive in a mathematical sense (a very much detailed requirement of the housing to be realized; both in numbers - 8200 housing units, categories - 40% social housing, 30% middle income, 20% expensive - and in typologies - 40% low rise minimum). However, since the ‘market led’ urban design process asked for a certain degree of freedom of development for the individual developers, we came up with a more or less neutral system of a grid”

to offer certain amount of flexibility to subdivide land into developing lots and blocks. While the planning process was started with a masterplan – the most common way of initiating a spatial planning and design process – ‘flexibility’ has always been emphasized throughout the design and development process in order to prevent a rigid layout and to enable a certain amount of ‘spatial chaos’. This fundamental vision

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55 Excerpted from the interview with Felix Claus from Felix Claus and Dick Van Wageningen Architekten – who is one of the masterplanners of IJburg and responsible architect for some of the urban blocks in Haveneiland.
affected the physical characteristics of the IJburg and resulted in a balanced urban space “between permissiveness and rigid frames” (Lupi, 2008: p.92).

**Modularity and Diversity: Creating Fine-Grain Spatial Configuration**

In IJburg, it is explicit that the general urban pattern is based on a close-knit grid structure which is formed by the extensive network of streets, open spaces and waterways; and, rectangular urban blocks (Figure 5.8). According to Claus et al. (2001), this simple spatial structure “creates the necessary conditions for a characteristic balance between order and chaos, cohesion and variation”, because; while the grid puts a few restrictive conditions in terms of the relationship between public and private and controls the relationship between street and block; it simultaneously leaves room for the diversity within modules – the blocks – in terms of both formal expressions and types of uses (p.84). Therefore, the grid – as the most successful system of spatial relationship in terms of modularity – allows achieving a cohesion and integration structurally; and, paves the way for a flexible diversity within each different modules – i.e. it creates the most fundamental and abstract pre-condition of design to increase ‘choice’ in space. Moreover, the modular spatial structure of IJburg has made it possible for various group of designers and developers to work together within this ordered grid system. For that reason, different design parties – ranging from large scale corporations to the individuals interested in self-build housing – found a chance to express various design solutions with a great freedom within defined boundaries. As it is stated in Toelichting op Ontwerp-Uitwerking (Explanatory Notes on Design Execution) (2000), “the grid is a well-proven and appropriate structure which creates the right conditions for the realization of the diverse program by a large number of private parties and allows to further develop various urban sub-plans in time” (p.14). In parallel with this intention, modular macro-structure of the IJburg has enabled designers to obtain varying sizes of grid solid blocks by scaling the uniform modules of the grid to up and down – which would eventually lead to a diverse composition of single-family homes, apartments and commercial facilities with varying forms and styles; and a certain level of flexibility to respond to the changing circumstances (Stedenbouwkundig Plan – Haveneiland en Riteiland Oost, 2004).
Figure 5.8: Grid-based spatial structure of IJburg Plan (De Architekten Cie, 2018)
Thus, while the initial grid composed of approximately 20 meters wide streets constitutes a homogenous distribution of 175 meters wide urban blocks throughout the site; the varying depth of the blocks (decreasing from 90 meter to 70 meters towards the shorelines), subdividing blocks into various lots to be designed by different architects and imposed network of waterways add a further level of complexity and helps to achieve a heterogeneously modular structure in IJburg (Figure 5.9).

Figure 5.9: Evolution of the proposed grid structure in masterplan and its capacity of change (Campbell, 2012).

According to Campbell (2011), the uniform and simple grid structure of the masterplan has evolved successfully into a new and highly complex spatial structure – which
proves that the abstract modular system of IJburg is highly scalable (up and down), modifiable and flexible: “Nothing complicated here: simplicity giving rise to complexity” (p.87). Therefore, it would not be wrong to state that the modular spatial configuration in IJburg is highly important to increase the complexity level of the system; to enable more parties to be involved in design and development process; and, to increase adaptive capacity of urban form by relying on potential diversity which would be generated on this flexible spatial framework. Within the above-mentioned context of modular grid-layout, IJburg was organized into diverse urban blocks, each subdivided further into distinct lots to be designed by different architects. In that sense, while some spatial elements were fixed to achieve the structural coherence, the others were considered as flexible to allow “versatile use of both living and working space” (Savini, 2017: p.165).

Because of the modified and complex grid structure lying behind the spatial programme and eventual differences in size and location of the blocks, all of the urban blocks and subdivided lots are unique in IJburg. As it is stated by Ton Schaap (2018),

“the whole grid-based and differentiated spatial program was divided evenly over the blocks. Every block had a variated program as a consequence. So, we achieved a plan that encourages variation – the contrast between the strict grid and the variation in architecture has worked well".".

According to Claus et al. (2001), “the dimensions of the blocks are such that standard zoning of housing in these blocks is impossible. The blocks differ in size so that the block designs will each be different from the others” (p.91). Moreover, the total programme of living units and other spatial amenities like retail facilities and schools were carefully scattered through the grid structure – that means there was no strict zoning regulations for each group of uses. In principle, each urban block has more or less equal level of density and mixed-use programme in itself entailing various typological solutions (such as single-family houses, detached houses, multi-layered

56 Excerpted from the interview with Ton Schaap who is one of the masterplanners of IJburg and senior urban planner and designer in the Municipality of Amsterdam.
apartment complexes and courtyard dwellings) and different uses (commercial units, offices, schools and playgrounds). In fact, it is possible to observe typological variations not only from block to block but also from lot to lot within the same urban block in a cohesive manner. In that sense, co-existence of various building typologies in each urban block ensures increased amount of spatial choice and represents a “successful mix of architectural individuality within an overall feeling of a cohesive neighborhood” (Paul Testa Architecture, 2018) (Figure 5.10).

In addition to the formal and functional diversity within blocks, it is possible to trace the coexistence of diverse and close-grain street-facades along with the streets – which represents both the differentiation and integration of the various life-styles (urban and suburban) and increases the perceptual richness of the urban space (Figure 5.11).

Figure 5.10: Uniqueness of each urban block in IJburg: explicit typological diversity of the building blocks – varying from fine-grain plot-based family housing to courtyard dwellings, point blocks and detached houses – within a coherent urban structure (Google Earth, 2018).

Figure 5.11: Houses (suburb) and apartments (urban) mixed in the street-facades (De Architekten Cie, 2018)
Moreover, residential environments in IJburg were not characterized by specific financial categories; instead, a varied choice of price levels was offered: %30 social housing, %10-20 luxury housing in higher price category and %40 medium price category. This programmatic variation also leads to a social diversity and makes IJburg accessible “for various categories of income, age, household types, cultures and lifestyles from Amsterdam and the regions” (Projectbureau IJburg, 1995: p. 19).

In addition to the programmatic and typological mixture, the design guideline – Design for IJburg (Ontwerp voor IJburg) – which was released in 2006 to support masterplan defines distinctive design parameters to control the diversity within urban blocks in a coherent manner. In that sense, one of the most-referred parameter to ensure diversity is the building heights. The design guideline does not prescribe directly the building heights for each individual block; instead, it defines certain intervals to ensure vertical diversity within boundaries. According to the official document - Stedenbouwkundige Planvorming 2000, (Urban Plan Formation) – each building block would be at least three-storeys and at most six-storeys high by allowing exceptions according to the design vary up to at most eight levels. Therefore, in addition to the variety of block and building sizes, façade compositions, building typologies and functions, a diversified volumetric composition of the buildings could be achieved in IJburg – which would ensure diverse set of densities throughout the whole site.

Contrary to the flexibility of building height parameter, built-line of the buildings – which is defined as ‘1.2 meters margin strip between building and the street’ in the design guideline – is another control parameter for building blocks which both allows coherence in structural terms and also ensures diversity in compositional terms. According to this parameter, while the perimeter of the building blocks could be aligned to achieve a macro-level coherence, the built coverages – i.e. extensions into interior courtyard – of the building has remained flexible to allow the emergence of diverse building composition. According to Felix Claus (2018), “while the outside of the blocks, the facades to the streets were subject to supervision, the ’soft’ insides of
the blocks are much more free and adaptable\textsuperscript{57}. Thus, this parameter allowed to achieve a balance between ‘formal exterior’ and ‘informal interior’ for each urban block; and, paved the way for the integration of extremely diverse building blocks (Figure 5.12).

Figure 5.12: Formal exteriors (fix) and informal interiors (flexible) of urban blocks (Adopted from: De Architekten Cie, 2018)

When the characteristic features of modularity and diversity in IJburg are taken into consideration, it is possible to observe a diversified and mixed urban grain which is a natural result of the diverse spatial composition built upon a simply modular structure. As it is discussed in the previous chapter (Chapter 4), fine-grain plot configuration is crucial to enhance the adaptive capacity of urban space; because it increases the amount of choices in terms of ‘ownership’, ‘design control’, ‘form and sizes’ and so on. Therefore, the level of spatial resolution (granularity) refers to the pre-conditions of adaptive capacity like modularity and diversity and steers incremental adaptation mechanisms in the following period. In IJburg, the initial modular subdivision of spatial grid (which was very coarse-grain at first) could be subdivided into various lots to be designed by different parties and it increased the level of spatial resolution by dispersing design development and formation variously. Even if the urban blocks are big enough to represent a block-based approach, further subdivision of these blocks allowed many designers, individuals, collectives and corporations to be involved into design process as similar to the plot-based/or lot-based urbanism approaches. In addition to the blocks and subdivided lots, some parts of the

\textsuperscript{57} Excerpted from the interview with Felix Claus from Felix Claus and Dick Van Wageningen Architekten – who is one of the masterplanners of IJburg and responsible architect for some of the urban blocks in Haveneiland.
IJburg (especially the Rieteiland West and East and the opposite shore in Haveneiland) were platted with a fine-grain configuration (plots of approximately 9 meters wide and 50 meters deep) and allowed an increase in the choice of plot-based and self-build housing developments, as well (Figure 5.13).

In that sense, it would not be wrong to define IJburg as a ‘mixed-grain’ living environment variously composed of fine-grain, medium-grain and coarse-grain urban fabrics within a harmony. The complexity and diversity in grain is a natural result of the initial design approach which is very flexible and open-ended and creates a basis for different grains and compositions to be generated in the urban blocks simultaneously (Figure 5.14).

The innovative approach in IJburg – which is allowing a certain degree of spatial uncertainty by increasing the freedom of choice and controlling the diversity within a coherent structure – is its most important strength in terms of the improved level of adaptive capacity. According to Adams, Tiesdell and Weeks (2011), diversity in urban grain, building typology and functions in IJburg would most probably allow incremental development in time and the place would adapt and respond to changing circumstances successfully.
Figure 5.14: Various possible urban-grain strategies to shape the interior of the urban blocks (Adopted from: Claus et al. 2001: p.90).

**Redundancy: Back-up Capacity**

Redundancy is a complementary principal to improve adaptive capacity of urban space in addition to the modularity and diversity; and, it refers to the availability of multiple spatial choices more than it is needed. In that sense, duplication of the similar spatial components in different sizes, forms and typologies and supplying more than the actual need enhance the backup capacity of the system. In IJburg, the strategy of taking each block programme into consideration within individual blocks to achieve certain supply level enhances the redundancy of the space. In each individual block, it is possible to
observe residential units in different sizes, various price categories and diverse typologies. Moreover, in terms of use, IJburg offers a high degree of mixed block programme – which makes possible to offer multiple choices in each urban block. Because of the availability of commercial spaces, playgrounds, schools and other public buildings in different sizes, forms and typologies within different blocks, it would not be wrong to argue that IJburg’s spatial programme is highly redundant. As it is expressed in the previous chapter (Chapter 4), in spatial terms, redundancy is also associated with generous plot or block sizes having relatively low built ratios to facilitate the intensification of the area gradually when it is needed. In IJburg, while the block and subdivided lot sizes are generous enough, most of these urban blocks were designed and covered at maximum rates in order to supply sufficient number of dwellings and other uses for the pre-defined spatial program effectively. Because of this limitation, it seems hard to extend buildings or make some additions for most of the urban blocks in the area; and, to some extent, it decreases the IJburg’s adaptive capacity in terms of further intensification and compositional change.

**Permeability: Enhanced Plot-Street Relationship andChoice of Movement**

In spatial terms, permeability defines the amount of various and alternative choices of flow in the space and contributes to the adaptive capacity of urban form. IJburg’s gridiron urban structure and modular composition of urban blocks enhances the level of spatial permeability and increases the visibility of diverse spatial choices in the neighborhood (City of Amsterdam and Bureau Palmbout, 2015). In addition to the permeability at structural scale, each urban block in IJburg has a distinct level of permeability, as well. According to Urban Design Plan *Stedenbouwkundig Plan* (2004), while the intentionally closed corners of the buildings direct pedestrians through the long edges of the block, multiple accesses along these edges invites movement flow into the block and enhances the permeability. Moreover, urban blocks in IJburg are large enough to allow various mews and open spaces to be generated flexibly. Because of the fact that most of the urban blocks were subdivided into various lots to be designed by different architects, it is possible to observe diverse inner-block configurations in terms of the formation of mews and open spaces. While these mews
and open spaces contribute to the permeability of the site, at the same time, they also make it possible to achieve more fine-grain plot configuration – which would eventually help to modify, re-built and re-programme each individual plot when it is necessary without being dependent to the other components of the urban block. Therefore, for IJburg, permeability is a spatial quality contributing the level of spatial resolution (i.e. modularity) and it helps to enhance adaptive capacity of the individual urban blocks (Figure 5.15). In terms of the relationship between fine-grain plot configuration and street network (which is explained as ‘enhanced plot-street relationship’ in Chapter 4), high level of permeability in IJburg leads to an increase in the total amount of interface between plot-frontages and streets; and, triggers the development of active building-facades. It refers to a positive merit for the adaptive capacity; because, these interfaces can potentially respond to changing circumstances by being activated with the emergence of different functions like commercial and retail facilities which mostly prefer to be in a closer relationship with the movement. Therefore, the urban blocks permeable enough are the ones which would most probably be re-configured and adapted to the arising needs in terms of prospective formal and functional change in IJburg.

\[\text{Figure 5.15: Block-17 (left) - Block-30 (right)}\] permeability of the blocks contributes to the capacity of adaptation–by offering diverse set of choices for movement, contributing plot-configurations (modularity), building typologies (diversity), allowing various sub-spaces (Google Maps, 2018)
5.1.3 Evaluation of the Adaptability in Formation

The physical characteristics of urban form – which is described with the notions of modularity, diversity, redundancy and permeability – is highly essential to create pre-conditions of design to offer enough spatial choice. While these characteristic pre-conditions prepare the ground for incremental adaptations to emerge and continue through time; they are not enough to improve adaptive capacity of the urban space and they should be complemented with the mechanisms of urban change and transformation. The real ‘adaptive capacity’ can only be generated if an urban space having these pre-conditional characteristics responds to the ever-changing needs of the users and emerging circumstances in the space. IJburg, as an incremental urban development project achieved by the collective actions of various designers, offers valuable lessons to leave room for formal and functional change; and, to disperse design formation for achieving flexibility in formation process.

**Formal and Functional Change**

In IJburg, ground floors of the buildings have been given additional heights – at least 3.50 meters by referring to the concept developed in masterplanning process: ‘multifunctional ground floors’. This additional floor height was consciously offered to allow the possibility of emerged multi-functional activities on ground floors in future – like retail facilities, offices and other public amenities. Leon Thier defines this design feature as one of the important characteristics that contributes adaptive capacity of urban space: “It helps to remove the border between living and working which is not so hard anymore in the Netherlands”. According to City of Amsterdam and Bureau Palmbout (2005), this quality “encourages the organic growth of social and commercial initiatives rooted in the area and organized by the residents”; prepares a ground for prospective functional changes for each individual block; and, improve adaptive capacity of urban space to respond emerging needs and circumstances. According to Felix Claus (2018), “with respect to the concept of ‘adaptivity’, the

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58 Excerpted from the interview with Leon Thier from Atelier PRO – who is the leading architect responsible for Block 6 in IJburg.
ground floors to have 3.50-meters floor height was major requirement – so that it would always be possible to change from residential to commercial in the future\textsuperscript{59}.

Moreover, masterplan also offers some multifunctional single-standing buildings called ‘solids’ illustrating both the flexibility in use and resilience in structure (Figure 5.16). Solids are designed to respond any unprecedented functional change in the urban space; and, because of their open-plan layout these buildings can accommodate not only residential units, offices and retails but also sport and leisure facilities and even a little factory if it is necessary (City of Amsterdam and Bureau Palmbout, 2005).

\textbf{Figure 5.16:} Block-1 (left) and Block-18 (right) as typical examples of solid typology in IJburg (Inbo Architecture and Varende Makelaar, 2018).

These loft-like structures can be freely modified and increase the diversity of spatial programme by offering various choices. Moreover, according to Claus et al. (2001), “these solids […] can be further filled in with a limited amount of housing or elements that go beyond the standard programme package of an urban expansion area. Thus, the solids are \textit{reserved space for the future}” (p.88). Therefore, solids in IJburg create freedom of choice for individual design, allows functional adjustments by increasing the urban diversity, and improves the adaptive capacity of urban space.

The ‘time factor’ and the notion of \textit{incremental development} played an important role in the planning and design process of IJburg and the relationship between fixity

\textsuperscript{59} Excerpted from the interview with Felix Claus from Felix Claus and Dick Van Wageningen Architekten – who is one of the masterplanners of IJburg and responsible architect for some of the urban blocks in Haveneiland.
and flexibility has always been in the agenda. The economic crisis in the Netherlands’ construction sector emerged at the beginning of 2000s necessitated both minor and radical changes in the spatial development. Because of this economic recession, development of some of the urban blocks in Haveneiland is delayed and these vacant lots (which are supposed to be built as residential blocks) created various opportunities for local people to generate green spaces, playgrounds, community centers and other public land uses. In that sense, “the adoption of diverse development approaches and use of small parcels allow an incremental development to take place. Undeveloped spaces are being used temporarily by residents, which enables more spontaneous urban practices to take place in this planned community” (Smart Cities Dive, 2018). Stated by Savini (2017), “today, inhabitants have already claimed nine out of seventeen vacant blocks for activities relating to urban gardening, education for sustainable living and recreational facilities for children” (p.165).

Therefore, it is possible to argue that the current spatial form and programme of the IJburg relatively emerged from these unprecedented actions as much as it was also designed consciously. The main reason for that IJburg was designed as a coherent and diverse living environment incrementally – whose modular and diverse spatial framework would enable ‘freedom of choice’ and increase ‘flexibility in formation process’ to adapt changing circumstances. The authorities responsible for the development of IJburg’s following phases took lessons from these arising situations and started to propose some innovative ideas – “like reserving 'grey' spaces for temporary uses and allowing time to explore options before deciding how best to develop them in response to the needs of the new community” (Adams, Tiesdell and Weeks, 2011: p.133). Today, the Centrumeiland which is the first self-built part of IJburg-2nd Phase Urban Development Project, started to be developed with these innovative approaches by leaving the urban blocks relatively less pre-determined in terms of both form and programme to steer emergent outcomes in a more flexible manner.

Contrary to its adaptive capacity in terms of possible functional changes and emergent outcomes through incremental development process, IJburg shows a relatively limited
**adaptive capacity for physical changes of the space (formal change).** While some of the modular urban blocks composed of mixed-grain plot configurations in Haveneilanden and self-built residential units designed by fine-grain plot configurations in Rieteilanden seems potentially adaptive in terms of formal change; reconfiguration, intensification and modification of the most of the dense urban blocks in the central part of the neighborhood is very hard.

The most important reason for this incapability of formal change is that most of these urban blocks were designed and covered at maximum rates (low redundancy); and, it makes hard to extend buildings or make some additions for most of these urban blocks in the IJburg. In parallel, Leon Thier expressed that as similar to the most of other urban blocks, their design projects (Block 6) does not allow extensions, additions and so on; because of the building density and the high level of built coverage in the block. In that sense, in the following phases of IJburg, planning authorities decided to use “more smaller apartments (fine-grain) to prolong the life of the housing and their flexibility capacity: buildings must be assembled and/or split, can be partially extensible and change their function” (Stedenbouwkundig Plan – Haveneiland en Riteiland Oost, 2004: p. 9).

**Disjointed Design Formation**

Although IJburg is a large-scale urban development project initiated and controlled by a central authority, it also achieved to open design and development process to the contributions of various parties in a collaborative manner. Especially at the beginning of the construction process when a serious economic recession has emerged, this collaborative design strategy was questioned with the proposals about fewer designers having control over more units. However, “this would conflict with desires to have a fine urban grain and a diversity of developers” (Adams, Tiesdell and Weeks, 2011: p.129). Throughout the development process of IJburg’s 1st phase (Haveneiland and Rieteilanden), a large number of public authorities, private market entrepreneurs,

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60 Excerpted from the interview with Leon Thier from Atelier PRO – who is the leading architect responsible for Block 6 in IJburg.
housing corporations and also individuals were involved into the process; and, helped to reduce the risk in case of a market failure and enabled incremental development.

Urban blocks in IJburg was designed by a variously different group of architects within the coordination of one ‘coordinating architect’ for each different block. As it is stated by Shaya Fallahi (2018), “coordinating architects do not take any design decisions but guides the whole design and development process by representing a kind of quality controller of the local authority.\(^6\)”. Coordinating architect is the one who subdivides the urban blocks into ‘lots’ to be designed by these different architects and supervise the design team to meet the programmatic and physical standards of the masterplan and ensure that each different design proposal could integrate each other coherently. This inclusive design process is a perfect example of distributed design formation; and, “it also demonstrates how careful planning and a robust delivery mechanism can allow the build-out of an area with many different designers and development models, producing a rich variety of built environment than is normally expected in a newly created neighborhood” (Adams, Tiesdell and Weeks, 2011: p.132). More than 60 different architecture offices were participated into the design process of IJburg–HAVeneiland and Rieteilanden; and, their various design solutions provided a highly complex and diverse cityscape including wide range of spatial choices in terms of form, function, typology and style in a coherent manner (Figure 5.17).

In addition to the diversity of professional designers, IJburg reserved enough room for individuals who want to develop their own houses in an individual and collective way. Self-built plots in Rieteilanden “are being built on by private individuals who are working with an architect of their choice, without a supervisory architect and without any aesthetic control by the municipal inspectorate” (IJburg Neighborhood Website, 2018). This creates not only a diversity in architectural expressions but also helps to disperse design control to individuals from a central authority – that paves the way for an incremental and independent process of formal and functional changes in each plot and improves capacity of spatial change.

\(^6\) Excerpted from the interview with Shaya Fallahi from VMX Architecture – the design office responsible for Block 23B in IJburg.
The notion of disjointed design formation is a complementary principle for the incremental adaptation of urban space and improves the capability of change in a positive way. Moreover, it contributes to the diversity in urban form which is a key to enhance adaptive capacity and responsiveness. According to Adams et al. (2013),

“the fewer the number of actors involved [...] the more uniform the built product. If [...] a single designer is responsible for all the parcels [...] the process will be simplified but the urban form may have little variety. Increasing the number of designers and/or developers makes the process more complex but has the potential to produce a richer and more diverse urban form” (p.465).

5.2 Middlehaven, Middlesbrough, UK

Middlehaven is a contemporary urban regeneration project located on the partially vacant area of former Middlesbrough Dockland (Figure 5.18), and it is the most impressive example of UK’s current innovative approach to generate a mixed use and attractive neighborhoods. The innovative spatial framework was developed for the incremental regeneration of the area by Urban Initiatives Studio on behalf of Middlesbrough City Council and the Homes and Community Agency. According to
Middlehaven Development Framework (2012), the genuine design approach in Middlehaven “provides a flexible platform for development to come forward, ranging from larger inward investment schemes, down to small and incremental development driven by local people and businesses” (p.5). In general terms, Middlehaven’s development framework is quite opposite to the conventional masterplanning and design process. It is based on creating a fine-grain plot configuration on which small-scale stepwise development would be generated and potential change and transformations in the space would be facilitated by relying on a very illustrative masterplan and a one-page long, brief and open-ended design guideline.

Figure 5.18: Aerial view of the project site: Middlehaven Urban Development Project (Google Earth, 2018)

5.2.1 Planning and Design Process

Middlehaven is the actual birthplace of the city of Middlesbrough and served as a main dockland for the rapidly growing industry until the end of 19th century. Especially after the mid-1900s, Middlehaven was subjected to a series of unsuccessful urban regeneration activities including slum clearance and infrastructure renewal; and,
eventually remained vacant with the closure of large scale industrial buildings. Just after the failure of Will Alsop’s Middlehaven Masterplan (2003) (Figure 5.19) – which offered a number of iconic buildings scattered through a large landscape and could not be realized because of the impossibility of such large-scale land acquisition – in 2010, Middlesbrough City Council and The Homes and Community Agency (HCA) decided to initiate a more novel and innovative approach and appointed Urban Initiatives Studio for the current planning and design process.

![Figure 5.19: Will Alsop’s masterplan (left) and aerial view of envisaged composition of iconic buildings in a large landscape (right) (Urban Design Poliba Website, 2018)](image)

In 2011, contrary to the over-ambitious, prescriptive and over-deterministic masterplan, Middlehaven Partners (City Council, HCA and Urban Initiatives Studio) prepared an open-ended ‘development framework’ which is supported by an ‘illustrative’ masterplan and a very brief design code to guide the transformation process into a vibrant and mixed-use living environment incrementally. According to this abstract and flexible framework, Middlehaven was envisaged to be a diverse and attractive extension of the existing town center hosting various social classes, offering wide range of building typologies and including different development propositions to invite both local people and design professionals from every scale. According to Middlehaven Development Framework (2012),

“based on a fine-grain parcelisation pattern, which lends itself to incremental land release and organic growth, Middlehaven can offer sites for a range of development schemes, including those delivered by local contractors or
smaller developers, by self- builders or community build groups, and also by larger development companies” (p.31).

In that sense, Middlehaven Urban Development Project aimed to generate an urban space welcoming various ideas, “establish the right condition to build on this potential, harness already existing developer interest and stimulate further change and development” (Middlehaven Development Framework, 2012: p.88). It is not a conventional urban planning and design project aiming to achieve pre-determined goals of the plan with a single shot; but an experimental approach promoting small-scale and flexible design interventions through an incremental process of design, construction, change and transformation.

Middlehaven is an ongoing urban development project which is just started a few years ago with a kick start project called ‘Urban Pioneers’ constituting the 1st phase of the planning and design process. “The Urban Pioneers Project is one of a number of delivery routes being pursued by the Middlehaven Partners to help further stimulate development” (Urban Pioneers Prospectus, 2013: p.3). It aims to initiate the whole planning and design process with the direct involvement of different parties (individual self-builders, housing collectives, small developers) into the development project by using the first-released plots at the center of the Middlehaven. From this aspect, in terms of distributing design formation over various parties on a fine-grain spatial configuration, Middlehaven seems as having quite similar approach to the former case of IJburg in Amsterdam. In fact, by relying on some of the planning and design documents (e.g. Urban Pioneers Prospectus, 2013) including lots of examples from IJburg’s building compositions to illustrate envisaged urban form in the area, it would not be wrong to state that Middlehaven is inspired by some of the achievements of IJburg. According to the project and design director of Middlehaven Urban Development Project – Kelvin Campbell – who was interviewed as part of this research, “IJburg is a very instructive and special case study to understand many things like diversity, coherence, design control and so on. However, we cannot learn
everything from there. At that point Middlehaven offers additional understandings for the contemporary urban design practice; such as responsiveness, change and adaptation\(^\text{62}\) (Kelvin Campbell, 2018).

Within this context, Middlehaven offers important lessons and critical understandings about the notion of ‘adaptive capacity’ – some of which can be observed in IJburg as well and some cannot. Therefore, it complements the case of IJburg on several counts and enables to discover new methods and approaches to improve adaptive capacity of urban form by design.

### 5.2.2 Evaluation of the Adaptability in Form

By relying on the aforementioned vision of generating a mixed use vibrant neighborhood incrementally and stimulating further change in this area, Middlehaven Partners decided to use a different planning and design approach which is very opposite to conventional masterplanning approaches trying to prescribe and control urban form and formation with blueprints. In that sense, an ‘illustrative masterplan’ was developed to indicate the layout of the site, grain or plot-subdivision character, mix of urban uses for characteristic sub-areas, open space and movement network and capacity of further development in an extremely abstract manner (Figure 5.20).

According to Middlehaven Development Framework (2012), “the built form (illustrated in the plan) is only indicative, showing how development could come forward in response to the development framework. it is not a blueprint for development” (p.45). Therefore, because of the fact that this masterplanning approach is quite open-ended and flexible in terms of allowing different design interpretations and emerging circumstances in the space, all of the three-dimensional massing models and illustrated architectural typologies in the plan should not be understood as the proposed final images of the Middlehaven. Instead, they are just illustrative images to represent how related design principles would be applied and how Middlehaven is

\(^{62}\) Excerpted from the interview conducted with Kelvin Campbell – who is the project coordinator of Middlehaven – within the context of this research.
envisaged in different periods of time as a result of the incremental development actions.

Figure 5.20: Illustrative masterplan of Middlehaven (Middlehaven Development Framework, 2012: p.44).

**Modularity and Diversity: Creating Fine-Grain Spatial Configuration**

In Middlehaven, the general urban layout is based on a grid structure coming from the historical traces of regular street grid in St. Hilda’s part of the area. The remains of the former grid network provided the inspiration for Middlehaven partners to structure the project area with an extensive network of streets defining the modular composition of rectangular urban blocks and development parcels in a coherent manner. This continuity in the structural character of the area has also minimized the cost of the new infrastructure and accelerated the development process in a positive way (Middlehaven Development Framework, 2012). The proposed grid layout subdivides the area into almost same-size urban blocks which are relatively larger than enough to enhance the capacity of further development within these blocks. Blocks are formed in a courtyard typology and the initial development is promoted through the edges of
each block by both creating well-defined streets and leaving the inside of urban blocks for open spaces. These open spaces are used for parking areas, playgrounds and open spaces initially; and, in the meantime, they provide a basis to generate secondary inner blocks system composed of mews and additional buildings when further intensification and urban change is needed. Middlehaven Development Framework (2012) defines this system as “a two-tier system of street blocks” which both creates a larger and coherent superblock system and allows internal flexibility in terms of intensification, modification and transformation for each urban block (p.47).

Within this general layout, Middlehaven was envisaged as a mixed-use and diverse composition of five different character areas each demonstrating various typologies, forms and functions. While defining these character areas, Middlehaven partners decided to avoid from conventional zoning regulations and considered these character areas to be overlapped into each other in order to achieve more complex and diverse living environment. Therefore, “the edges of those zones are deliberately fuzzy and overlap. This provides flexibility for development in response to available demand, to determine the final shape of Middlehaven” (Middlehaven Development Framework, 2012: p.37) (Figure 5.21).

Boho is the closest part of Middlehaven to the Middlesbrough town center and have a mixed-use spatial programme including mainly commercial activities, offices, creative industries. It is also complemented with diverse residential typologies including apartment buildings, live-work units and fine-grain townhouses to integrate the urban patterns of Middlehaven and city center. The Middlesbrough Dock character area demonstrates a contrast image to the remaining fine-grain configuration of the Middlehaven and composed of relatively coarse-grain urban fabric in which mixed urban uses and single-standing diverse building typologies are located – such as office buildings, residential towers, hotels and leisure activities and retail developments. The education character area includes an already-built college and surrounding open spaces including public parks, playgrounds and sport facilities. The largest and most diverse character area in Middlehaven is Tees Neighborhood and Riverfront and it includes overlapping sub-areas with all of other character areas, as well. Although the area is
envisaged as a mixed-use quarter, the development focuses primarily on residential units including an extremely wide range of architectural typologies, sizes and styles – detached and semi-detached family housing with gardens, loft-like live-work units, terraced housing and apartments. The neighborhood also encourages self-build housing typologies to increase the involvement of individuals and small-scale developers into development process and to generate a collection of different design approaches.

Figure 5.21: Overlapping character areas in Middlehaven (Middlehaven Development Framework, 2012: p.36)

For each individual character area, the development framework defines indicative percentage ranges and appropriate uses and functions rather than prescribing each urban block with distinctive land-uses. As it is expressed in Middlehaven Development Framework (2012), “the actual mix of uses will largely be determined by the market, including developer and occupier interest, and over time may change as the area develops or adapts to new circumstances or requirements” (p.53). Therefore, the illustrative masterplan provides necessary structure having enough flexibility to allow the emergence of different formal and functional compositions according to the arising needs of wide range of developers and individuals. In addition
to the programmatic and typological diversity, the illustrative masterplan defines the building-height parameter to control the volumetric variation within urban blocks in a coherent manner. In that sense, the plan does not prescribe directly the building heights for each individual block; instead, it proposes a concept called *benchmark height* and allows the variation between a defined range to achieve vertical diversity (Figure 5.22). “The concept of benchmark height focuses on the general or average height of buildings [...]. It also allows for a variation by one storey up or up to two storeys down” (Middlehaven Development Framework, 2012: p.63). Therefore, in terms of the volumetric diversity, the plan provides enough room to increase or decrease building heights in a flexible manner within the boundaries of defined intervals – in other words, the concept of benchmark heights allows freedom of choice by both limiting and allowing infinite possibilities to designers and individuals.

![Figure 5.22: Benchmark heights for block perimeters and maximum heights for block interiors](Middlehaven Development Framework, 2012: p. 62)

In order to generate a diverse spatial programme on a simply modular structure of close-knit grid, Middlehaven Partners considered *parcelisation* and *fine-grain plot subdivision* as the most fundamental development strategy for Middlehaven.
According to Middlehaven Development Framework (2012), “plot parcelisation provides a necessary precondition [...] for smaller scale development to happen and it will result in a fine grain development pattern and generate a rich environment” (p.51). For that reason, illustrative masterplan also proposes a fine-grain plot subdivision which is again extremely indicative and flexible enough to be changed and modified through development process (Figure 5.23). However, the most innovative part of this approach in Middlehaven is problematizing the plot as “it can become too limiting if its dimensions are fixed at the outset and cannot be easily changed. We therefore use the ‘lot’” (Campbell, 2012: p.35). According to Campbell (2018), the lot is the aggregate of certain amounts of plots and it is an intermediate physical component of the urban space between the urban block and the plot. The most important reason of using the notion of ‘lot’ against ‘plot’ is that the lot is a scalable unit contrary to the plot; it can be scaled up to block or scaled down to plot in a flexible manner. Contrarily, the plot is the smallest unit of subdivision, it cannot be further subdivided and constrain the possibilities of development.

Figure 5.23: Plot-subdivision plan in Middlehaven (Middlehaven Development Framework, 2012: p. 50)
The recent studies on optimum lot sizes conducted mainly in the UK by Smart Urbanism, Massive Small Collective and Urban Initiatives Studio prove that 15 meters-wide lot is the most efficient one because it allows a wide range of sizes with subdivision and amalgamation operations and enables to achieve most diverse typological compositions in the urban space^{63}. In that sense, parcelisation based on a lot structure provides great freedom of choice by allowing subdivision into smaller plots and by stimulating further and various subdivision after the amalgamation of two or more lots (Figure 5.24).

Figure 5.24: Diverse configurational solutions within standard lots achieved by subdivision and amalgamation operations (Campbell, 2018: p. 163).

^{63} As illustrated by Kelvin Campbell in London Popular Home Initiative (2012), practical researches on the Newcastle Scotwood Housing Expo and the Aylesbury Estate Regeneration Masterplan in London were conducted with leading architects of the UK and it proved that the most appropriate dimension for a lot is 15 meters to provide room for various enough typological solutions. (For more, see: London Popular Home Initiative (2012) and Neighbourhood Co-efficient (2011)).
The availability of diverse configurational solutions naturally paves the way for various architectural design solutions and building typologies including row houses with narrow frontages, terraced housing solutions, detached and semi-detached family housing, free-standing residential units, loft-like live-work units, apartment blocks, mixed use urban blocks and many others (Figure 5.25).

*Figure 5.25:* Diverse architectural typologies by relying on diverse plot/lot configurations (Adopted from: Campbell, 2018: p.162).

Middlehaven Partners used this innovative approach in Middlehaven, as well and created a fine-grain plot and lot configuration to generate an incremental diversity in the area by allowing enough spatial choices for a wide range of forms and functions. Moreover, this extremely flexible approach invites different parties – such as individuals interested in self-build housing, a housing cooperative, small builders, a large housing association and a larger housebuilder company etc. – to the design and development process by providing enough room for all kind of needs (Figure 5.26).

*Redundancy: Back-up Capacity*

In addition to the diverse and fine-grain spatial configuration, Middlehaven offers also a redundant urban space in which various urban components are available in different...
sizes, forms and typologies. Especially the subdivision system based on the concept of lot prepares a ground for the emergence of various sizes within the urban blocks in a coherent manner. This close-grain and mixed use spatial programme helps Middlehaven to have more than enough choices – which is key to develop back-up capacity – and improves the redundancy of the area. Redundancy is also associated with generous dimensions to provide a chance for further intensification and change for the urban space. In addition to its physical qualities, Middlehaven Development Framework emphasized also some important notions like ‘incremental change’ and ‘reserved space for emerging circumstances’. At the initial stages of the project, it is proposed that building composition would be developed along the perimeters of urban blocks by leaving the interior of the blocks as ‘reserved spaces’ for the following development phases and intensification processes. In that sense, vacant courtyards having generous dimensions increases the back-up capacity of the existing urban space and allows the physical transformation of the area through time. Moreover, these reserved spaces, at the initial phases of development, can be used for temporary urban uses like playgrounds, public gardens or car parks. “In the longer run, when priorities change with a growing residential population, they may become more focused on community uses” (Middlehaven Development Framework, 2012: p. 48).
Permeability: Enhanced Plot-Street Relationship and Choice of Movement

The grid-based urban layout and modular composition of urban blocks increases the permeability of Middlehaven at structural level and allows diverse set of choices for pedestrian flow. In addition to the connectivity of street network, Middlehaven Partners care the relationship between building composition and street relationship by emphasizing the notion of ‘frontage condition’. According to Middlehaven Development Framework (2012), “the frontage condition, that is the way a building sits in relation to the street and to its neighboring buildings, will vary in accordance to the role of the street and its place in the street hierarchy” (p.47). Therefore, the masterplan also offers an illustrative frontage plan in which different ways of plot-street relationship is identified in order to create different levels of permeability in Middlehaven (Figure 5.27). In that sense, while the outer edges of urban blocks are controlled with a continuous frontage line (or built line), secondary frontages within the interior of urban blocks are more loose and flexible to generate additional mews increasing the level of permeability for each block as similar to the case of IJburg.

Figure 5.27: Frontage plan demonstrating the level of fixity and flexibility of plot-frontages and allowing different levels of permeability (Middlehaven Development Framework, 2012: p.46).
As it is expressed in Middlehaven Development Framework (2012), varied frontage conditions and diverse relationships between plot and street “provides a variety of opportunities for different forms of developments including terraced, semi-detached and detached houses” (p. 48). Because of the fact that different frontage and relationship types provide an opportunity to integrate relatively dense urban uses with looser and informal environments within the same urban block, it also contributes to the amount of spatial choice and richness in a flexible manner.

5.2.3 Evaluation of the Adaptability in Formation

While the formal pre-conditions of Middlehaven prepare the ground for incremental adaptations to emerge and continue through time; they are not enough to improve adaptive capacity of the urban space and they should be complemented with the mechanisms that steers urban change and transformation. In that sense, Middlehaven, as an innovative urban development project perpetually emphasizing the possibility of change and adaptation of the urban space in an incremental manner, offers key understandings about the adaptability of formation process – with respect to formal and functional change; and, disjointed design formation.

**Formal and Functional Change**

As it is expressed before, illustrative masterplan of Middlehaven promotes the initial phases of development through the outer edges of each urban block and provides ‘reserved areas’ in the interior parts of these blocks. The main objective of this development strategy is leaving room for further intensification or functional transformation of the area for the following periods of development in Middlehaven (Figure 5.28). In the meantime, these initially vacant parts of urban blocks provide opportunities for unprecedented and emergent urban land uses like playgrounds, community gardens, temporary usages or serve as car-parks until the area reaches its maturity. Moreover, a comprehensive capacity assessment is conducted within the context of masterplan to complement the reserved areas strategy and to respond unexpected scenarios in the future. Under three different scenarios (commercial focus,
residential focus, mixed-use), “the capacity has been estimated separately for the perimeter development of superblocks and the potential future intensification in superblock centers” (Middlehaven Development Framework, 2012: p.60). By doing so, these reserved spaces are used not only for additions to the existing physical form, but also to enrich the functional programme of each urban block and increase spatial diversity and available choices.

Campbell (2018), the project and design coordinator of Middlehaven Development Framework, defines these blocks having reserved spaces as “soft-centred ward blocks” and considers them as the most fundamental mechanism to allow incremental

![Image: Change of spatial composition in Middlehaven with the help of reserved areas for intensification and change](image-url)
adaptations in the Middlehaven – in his words “allows for inner growth and change to occur over time”. With its procedural approach to spatial planning and design, illustrative masterplan of Middlehaven offers a step-wise phasing development in response to the emerging market conditions and interests. These phased approach is relatively different from conventional masterplan phasing – it is not a blueprint but a dynamic and open-ended process which could be achieved through the flexible design interventions for each plot or lot. Through this flexible formation process within soft-centred blocks, amalgamation and subdivision operations between plots; construction of new buildings; extending some masses towards the center; and, generating different urban uses and enriching the block programme become possible (Figure 5.29).

![Figure 5.29: Formal and functional change of soft-centred blocks through incremental adaptations (Adopted from: Van Noten, 2012: p.70-71).](image)

**Disjointed Design Formation**

According to Matthias Wunderlich (2014), one of the directors of Urban Initiatives Studio responsible for Middlehaven Urban Development Framework, at the beginning of planning process, UK was suffering from an economic recession in the housing market and it was a challenging task to accomplish such a large-scale project in spite
of the uncertain and unpredictable conditions: “If this plan was to succeed, it needed to be based on a realistic strategy for land delivery.” Therefore, Middlehaven Partners’ developed a novel delivery and land release strategy which was focusing on smaller scale projects and emphasizing the distribution of design formation over many parties – which they called “diffusion of innovation”.

Within this context, the development framework emphasized the importance of a bottom-up regeneration of Middlehaven and aimed to attract a group of volunteer people – named as ‘Urban Pioneers’ interested in building their own spaces individually or collectively. The Urban Pioneers Project is a pilot project to offer local community of Middlehaven and various design professionals to be involved in the design and development process and to trigger the formation process of the neighborhood with a small-scale action. The project site is located just in the center of Middlehaven as two pieces aligning the Middlehaven Park (Figure 5.30). Both of these project areas have been subdivided into fine-grain lots having 15-meters standard width by relying on the aforementioned lot-based approach.

![The place to own YOUR plot.](image)

**Figure 5.30:** The Urban Pioneers project site and subdivision of blocks into 15-meters width lots to be delivered incrementally (Urban Pioneers Prospectus, 2013: p.8).

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These subdivided lots can be delivered in various ways to different design parties according to their design propositions. According to Urban Pioneers Prospectus (2013), “land released to a prospective owner is normally a minimum of one lot and maximum of two adjoining lots. Owners are free to combine two adjoining lots into one larger lot to accommodate a larger development, or to subdivide their lot(s) into a number of sub-plots” (p.11). For instance, a housing cooperative may purchase two adjoining lots, amalgamate them and subdivide this 30-meters lot into 5 plots of 6-meters frontage. Similarly, group of two or three people, or just a single individual may be involved into the development process by purchasing a single lot or plot, as well. Therefore, it would not be wrong to state that the flexible lot system provides a basis to distribute design formation over many parties ranging from individuals to small housing cooperatives or large scale corporations.

In order to control such a disjointed and incremental design process, a brief and open-ended design code (A Design Code for Middlehaven) was prepared. This design code aims to ensure both a coherent spatial structure and flexible set of choices for the different lots/or plots designed by different parties. For that purpose, while the design code controls some physical parameters like subdivision boundaries, permitted uses and building frontage-lines; it also provides certain level of flexibility for the others like, building heights, plot coverages and amalgamation and subdivision operations of the plots (Figure 5.31).

As it is demonstrated in the design guideline, the most controlled and fixed physical parameter is the front building line which follows a consistent linearity to create a coherent facade composition and enclosed streetscape. Contrary to the front facade, building coverages are various and buildings may extend into the block in different ways like it is observed in the case of IJburg, as well. In addition, because of the fact that lot structure system allows diverse set of subdivisions in the block, there is a crucial need to balance this flexibility with a slight control mechanism. Therefore, a party wall rule has been developed by the designers: “As a general rule, party walls should not be used between adjacent lots. Two independent end walls will need to be erected each on its respective plot where two buildings meet at the lot boundary. This
enables each project to be independent” (Urban Pioneers Prospectus, 2013: p.15). That makes each lot to be developed and transformed without being dependent to each other; and, paves the way for incremental and genuine adaptations through disjointed design process. Today, development of the Middlehaven is in progress; and, the first three lots in the Urban Pioneers Project site has been purchased by North Star Housing Group to build nine ‘live-work’ units for its members by relying on the simple rules of the design guideline (Figure 5.32).

Aforementioned simple rules of the design guideline would be enough both to create a coherent spatial composition and also to provide a basis for diverse set of choices in a flexible manner. According to Campbell (2018), the most essential reason behind this merit is the scalable system of lots which creates the necessary preconditions of design:
“In this system, lot or plot sizes both constrains the available millions of choices and steers enough flexibility within boundaries; because each plot size and their collective configuration necessitates distinctive architectural typologies and there is no need to prescribe all details of the design like we have always done with a conventional approach – such as floor heights, location of the doors or windows and many others. Therefore, each plot or lot is ‘self-coded’ because of its size and its relationship with the others.”

Figure 5.32: The first completed design project of nine ‘live-work’ units in the Urban Pioneers Project site by Halsall Lloyd Partnership Architects and Designers (North Star Housing Group, 2018)

In that sense, Middlehaven demonstrates a responsive approach in which necessary pre-conditions of design are defined with an innovative lot-based spatial system and slightly controlled with a few simple design rules. Within these loose boundaries, the proposed framework offers enough flexibility for each design party to achieve a diverse living environment in a coherent manner. Therefore, the case of Middlehaven provides key lessons about improving adaptive capacity of the urban form without

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65 Excerpted from the interview conducted with Kelvin Campbell – who is the project coordinator of Middlehaven – within the context of this research.
excluding the notion of ‘design’ from the development process.

5.3 Concluding Remarks

The examined contemporary urban design and development practices – IJburg and Middlehaven – offers both similar and different lessons to draw a general framework for a novel urban design model. Therefore, these two important case studies complement each other from several aspects and enables to discover new methods and approaches to improve adaptive capacity of urban form by design.

The delicate balance between diversity in micro scale and coherence at macro scale is the most fundamental aspect that defines the IJburg. In that sense, when the characteristic features of modularity and diversity in IJburg are taken into consideration, it is possible to observe a diversified and mixed fine-grain spatial configuration which is a natural result of the diverse spatial composition built upon a simply modular structure. This high level of spatial resolution (granularity) creates the most vital pre-condition of adaptive capacity by offering diverse set of spatial choices and paves the way for incremental adaptations in time. Moreover, the modular spatial structure of IJburg has made it possible for various group of designers and developers to be involved into design process. Thus, it helps to distribute design formation over various parties which steers incremental formal and functional changes in each plot or lot; and, improves capacity of spatial change. Contrary to the availability of various spatial choices, IJburg shows a relatively limited adaptive capacity for formal changes of the space. The reason behind this problem is that most of these urban blocks were designed and covered at maximum rates (lack of incompleteness/open-endedness); and, it makes hard to extend buildings or make some additions for most of these urban blocks in the IJburg.

In addition to its structural and configurational similarities with IJburg (fine-grain plot/lot configuration, diverse spatial programme, enhanced plot-street relationship and so on), Middlehaven also provides some complementary lessons to improve adaptive capacity of urban space in terms of allowing spatial change and
transformation in an incremental manner. ‘Reserved areas’ in the interior parts of urban blocks demonstrate an incomplete and open-ended spatial framework leaving room for further intensification or functional transformation of the area for the following development periods in Middlehaven.

These key lessons derived from examined case studies complement the conceptual framework of adaptive capacity and provide a better understanding about what kind of design approach enables to achieve morphological and programmatic pre-conditions of adaptability. In that sense, the following chapter – conclusion – would evaluate these derived lessons and propose a new model approach by synthesizing the distinctive design approaches in IJburg and Middlehaven; and, associating them with the formal principles and formational mechanisms of adaptability.
CHAPTER 6

CONCLUSION

This research adopts a critical approach to the stationary and conventional perspectives dominating the discipline of urban planning and design by tracing the fundamental paradigm shifts in the history of science and correspondingly in the theory of urbanism with regard to the emerging paradigm of complexity sciences. Within the context of complexity theories of cities, this study asserts that dominant planning and design approaches conceptualizing the city as a finite and static product of a single mastermind, trying to predict its future state with deterministic projection mechanisms and designing it with a clear image of optimal form and structure would inescapably fall short to understand their true nature based on the notion of complexity. According to this point of view, the research conceptualizes cities as ‘complex ecosystems’ which are ever-evolving and adaptive, far-from-equilibrium and optimality, having no definite form and size, and whose long-term behavior and formation could not be totally predicted because of the inherent uncertainties and non-linear processes. However, it does not mean that all kind of planning and design interventions are in vain; instead, it means urban planning and design theory should discover and develop a new form of intervention which is more responsive to the uncertainties, unpredictabilities and non-linear urban formation processes.

By relying on the abovementioned research motivation, this study problematizes the explicit theoretical gap and lack of research and studies addressing to the issue of ‘responsiveness of the urban form to the emerging uncertainties and unpredictabilities’. The tangible reflections and spatial implications of this theoretical gap can be traced within the urban spaces, as well. Designing urban spaces in an obsessively certain manner as if they would not change and transform at all makes the urban form and spatial programme fragile against the emerging uncertainties and changing needs – that creates an infinite and unsustainable loop of
construction, demolition and re-construction of urban spaces as static, non-progressive and unchangeable physical outcomes. Concerning about the problem of formal and functional adaptation and responsiveness of urban spaces, the main objective of this research is to develop a model approach improving adaptive capacity of urban form to respond emerging uncertainties and changing needs by operating design within the revealed context of urban complexity.

In order to fulfill this main objective, the research puts forward two significant research questions: (1) what are the morphological and programmatic characteristics of an adaptable urban form; and, (2) what kind of design approach enables to create these defined morphological and programmatic characteristics by avoiding rigidity and over-determination. In that sense, for the first research question, in Chapter 4, the study revisits the theoretical definitions and conceptualizations of ‘adaptation’ and ‘adaptability’ to translate them into the urban planning and design; and, examines three historical plot-based urbanism examples demonstrating an enhanced capacity of adaptation to learn from their form and formation processes. Thus, an overarching framework of adaptive capacity is developed and key morphological and programmatic features are identified. For the second research question, in Chapter 5, two different contemporary urban design and development projects – IJburg, Amsterdam and Middlehaven, Middlesbrough – are examined in detail to develop a better understanding about what kind of design approach enables to achieve pre-defined characteristic features of adaptability. The derived key lessons from these case studies substantially overlaps with the conceptual framework of adaptive capacity and offers significant insights to develop a new model approach to improve adaptive capacity of urban form by design.

Within the context of these main discoveries, drawing an operational design framework to improve adaptive capacity of urban form would fulfill the main objective of this research. In that sense, the following part of this chapter critically evaluates the main findings of the research and offers a new model approach which responds to the emerging uncertainties and changing spatial needs. This responsive framework also creates a remarkable interface between relatively contrasting notions – such as design
and emergence, control and freedom, deterministic place-making and uncontrollable self-organization – and steers further questions and theoretical expansions.

6.1 From Deterministic Place-Making to ‘Responsive Condition-Making’

As it is illustrated in Chapter 4, the notion of urban adaptability is a synthesis of two contrasting ends: ‘the capacity for change and transition’ and ‘remain fit and robust against changes’. That makes adaptive capacity an inclusive term established upon the relationship between resilience and flexibility, permanence and change, order and chaos, coherence and variation, top-down and bottom-up, design and emergence. By relying on the key lessons derived from the historical plot-based urbanism examples which demonstrates a high level of adaptive capacity, it could be argued that adaptive capacity is the output of both design act and unpredictable and incremental transformations. It is explicitly evident that characteristic design features of these cases have prepared a ground for adaptation to occur and continue through time – that makes these spaces both the product of successful place-making and the emergent outcome of partially self-organized and incremental actions of individuals.

It means that the adaptive capacity of an urban space cannot be improved by just relying on deterministic place-making solutions; or just using highly uncontrollable and bottom-up self-organization mechanisms. Especially, with the advent of complexity theories in the last decades, urban planning and design scholars started to conceptualize self-organization practices as an alternative to the deterministic place-making solutions. As argued by Savini (2017), “the concept (self-organization) is increasingly used to legitimize sociocratic approaches to urban change, like do-it-yourself (Iveson, 2013), everyday (Fraker, 2007), tactical, open source, emergent and smart urbanism (Oosterlynck and González, 2013)” (p.1153). As parallel to these theoretical discussions, wide range of urban planning and design practices – emphasizing the notions of ‘smart-parcelization’ (Adams et al. 2013), ‘incremental and organic development’, ‘self- build’, ‘design by coding’ and so on – started to be developed especially in European countries like the Netherlands and the United Kingdom. While some of these frameworks are not different from conventional and
deterministic place-making approaches by not leaving room for further change and adaptation, some of them are equally undermine the rationale of urban planning and design by offering a totally self-organized world without any control and regulation mechanism. In that sense, contemporary urban planning and design need to invent a new model approach to improve the adaptive capacity of urban form by asking the very question of ‘**how can we produce the necessary structure for urban space which ensures adaptability and responsiveness for unexpected changes by simultaneously avoiding from rigidity and over-determination**’. In that sense, the answer to this urgent question lies in the interface between over-deterministic place-making approaches and uncontrollable self-organization mechanisms (Figure 6.1). This grey zone between two different ends is the place in which necessary pre-conditions of design are defined to allow the emergence of further adaptations in urban space. Campbell (2018) defines this approach as ‘**responsive condition-making**’.

![Figure 6.1: Responsive condition-making as an interface between deterministic place-making and uncontrollable self-organization](image)

The notion of ‘condition-making’ does not mean to move away from planning and design; instead, it indicates a different way of planning and design. Asserted by Campbell (2018), “we must move from deterministic place-making (where there is a
focus on fixed end states) to responsive condition-making, which gives rise to emergent solutions” (p.75). The notion of ‘responsive condition-making’ frames a new model approach in which necessary pre-conditions of design are defined and enough level of spatial choices are supplied to stimulate further growth and change; instead of physically determining all parts of the urban space with strict design rules which will eventually result in fix and stable end-states. This model definition is quite parallel with the bipartite mechanism of adaptive capacity illustrated in Chapter 4: ‘offering enough choice to leave room for change’. Thus, it would not be wrong to state that creating the right and necessary conditions (condition-making) entailing wide range of spatial choices is key to generate the possibility of change and to improve adaptive capacity of urban form. In that sense, identifying these necessary pre-conditions of design and developing related strategies and tools to achieve this would be the most challenging and recent task of urbanism. Within the context of this broad framework, derived lessons from contemporary urban design practices of IJburg and Middlehaven would provide valuable insights and key strategies about what kind of pre-conditions of design (spatial choices) should be offered to leave room for change and how these pre-conditions would improve adaptive capacity of urban form.

6.1.1 Creating Fine-grain Plot Configuration

The first and most important lesson is creating fine-grain plot/lot configuration which will provide a basis for creating diverse set of spatial choices (i.e. pre-conditions); because, the grain and the level of granularity is the most important determinant of the spatial morphology. As being the most fundamental component of urban space, size and form of the plots and their configurational relationship between each other directly affect the building sizes, typologies, compositions, uses and ownership patterns, as well. Therefore, smaller plot subdivisions constitute the first and most necessary structure on which many individuals could find a chance to express their needs and choices via design – i.e. fine-grain plot configuration increases the total amount of intervention surface available for different individuals. The increased level of complexity within the ownership composition allows design formation to be distributed over various developers and users and enables diversity to occur in
terms of user profiles, desired functions and formal expressions. Moreover, fine-grain plot configuration contributes to the incremental development of urban space via independent actions of individuals to adapt and respond to the changing circumstances.

At the first glance, although IJburg seems like an urban space which was developed as a relatively coarse-grain urban fabric by a block based approach, coherent composition of extremely diverse building typologies demonstrates the opposite. In IJburg, the initial configuration of large urban blocks was subdivided further into various lots (within each block) to be designed by different parties and it has increased the level of granularity; and, variety of sizes, forms and typologies by distributing the design formation. As similar to the IJburg, fine-grain plot subdivision is the most fundamental development strategy of Middlehaven. However, as being different from the former, a scalable system of ‘lots’ (collection of plots) is used in Middlehaven to increase the level of diversity in plot sizes, building typologies and urban uses. That makes Middlehaven to achieve more fine-grain spatial resolution and improves adaptive capacity of the urban space in a positive direction. Both of these case studies demonstrates that fine-grain plot configuration and modular structure of the urban space is highly essential to offer diverse set of spatial choices and it constitutes the most important pre-condition of adaptability in urban space.

6.1.2 Improving Plot-Street Relationship

In addition to the fine-grain plot configuration, the relationship of this modular structure with the street is important, as well. Because of the fact that, fine-grain spatial resolution and variety of design parties pave the way for an extremely diverse spatial composition, streets and their relationship with the plots are crucial to integrate diverse form and functions in a coherent manner. In that sense plot-frontages play an important role to balance ‘diversity in individual units’ (micro scale) and ‘coherence in spatial structure’ (macro scale). Moreover, improving plot-street relationship also contributes to the permeability and connectivity of the urban space by increasing the level of enclosure while offering various choices of flow.
In that sense, in IJburg, built-line of the buildings is a strict control parameter for each individual block which both allows coherence in structural terms and also ensures diversity in compositional terms. According to this parameter, the outer edges of the building blocks should be aligned to achieve coherence between each individual block. On the other hand, the amount of extensions into interior part is highly flexible to allow the emergence of diverse building composition. Thus, the parameter of fixed frontage line allowed to achieve a balance between ‘formal exterior’ and ‘informal interior’ for each urban block; and, paved the way for the integration of extremely diverse building blocks. As being quite similar to the case of IJburg, in Middlehaven, while the outer perimeters of urban blocks are controlled with a continuous frontage line, secondary frontages within the interior of urban blocks are more loose and flexible to allow various spatial choices for each individual unit. Enhanced plot-street relationship both constrains available choices to integrate diverse spatial outcomes and also still allows various possibilities within that boundaries – i.e. it is key to integrate coherence and diversity; certainty and flexibility; order and chaos. Therefore, street and its relationship with the spatial configuration is important to create both a resilient urban space enduring changes and a flexible one which allows adaptation to occur without disturbing the coherence.

6.1.3 Promoting Incompleteness and Reserved Spaces

Leaving room for change and further development is important as much as offering enough choices within urban space. In that sense, incompleteness of the urban form and available reserved spaces improve the adaptive capacity of urban space. These reserved spaces could be used for temporary usages for a while and increases the chance of emergent land-uses unexpectedly; and at the same time, they provide a basis for future growth of the urban form and enrichment of the spatial programme – i.e. improve back-up capacity of the urban space.

In IJburg, although the dimensions of blocks and lots are generous enough, most of these spaces were built and covered at maximum rates in order to meet the defined prerequisites of the spatial program effectively. Because of this drawback, it is hard to
extend buildings or make some modifications for most of the urban blocks; and, that problem leads to a decrease in the adaptive capacity in terms of further intensification and compositional change in IJburg. Contrary to this drawback, it is possible to observe some merits in IJburg in terms of the incomplete form of urban space. Even if it was not planned in that way, through the development process of the area, some of the urban blocks and lots remained vacant because of the problems related with financial issues and project development; because each individual lot was assigned to different design parties and the area had to be developed in an incremental manner – that creates a certain degree of open-ended and incomplete urban form in a positive manner. IJburg has turned this crisis into an opportunity and these vacant lots were started to be used by local inhabitants for some temporary and emergent land uses like playgrounds, community gardens, urban farming and so on. This experience created an awareness for the planning authorities of Amsterdam to develop following phases of the IJburg by using ‘grey zones’ which are named as reserved spaces for emergent uses and changing circumstances. Contrary to the IJburg’s accidental discovery, Middlehaven promotes consciously reserved spaces in the interior parts of each urban block to leave room for further intensification of the urban form or functional transformation of the area in the following periods. These incomplete parts of the urban form both provide opportunities for unplanned and temporary urban land uses and also allow incremental adaptations in the Middlehaven. The notion of ‘change’ has always been the core idea of the project; therefore, Middlehaven offers valuable insights and lessons not only for allowing diverse set of choices in the urban space but also for leaving room for a possible urban change.

6.1.4 Distributing Design Formation Over Various Parties

Open design and development process with the contributions of various design parties and individuals is important to improve adaptive capacity of the urban space; because, this distributed delivery strategy is key to generate necessary pre-conditions like fine-grain plot configuration, emerged diversity in form and functions, incompleteness and open-endedness in form. Moreover, this principle allows to distribute possible risks of the development process and defines a gradual process of adaptation
without the central coordination of any controller; but according to the collective agreement on simple rules. Therefore, it makes possible to generate an urban space in an incremental manner by responding to emerging circumstances and changes in time; and, increases the adaptive capacity of urban space. IJburg is a perfect contemporary urban development example in terms of creating an urban space by distributing design formation over various parties – it has been generated with the collective actions of many individuals. This strategy paved the way for an increased level of diversity in a fine-grain composition, and allowed to offer wide range of spatial choices in IJburg. Moreover, it is possible to observe some distinct parts of IJburg developed with self-build and plot-based urbanism approaches. It increases the level of diversity in the profile of collaborating parties involved in design and development process – such as individual landowners, small housing co-operations, large-scale architecture offices and so on. Similarly, in Middlehaven, a disjointed delivery and land release strategy – which is promoting smaller scale projects and emphasizing the distribution of design formation over many parties – is developed and used, as well. Especially, highly scalable and flexible system of lots enables to create various plots which are extremely diverse in size and form – that makes it possible to observe different design parties from different scales within an individual urban block. Moreover, The Urban Pioneers Project in Middlehaven offers local community of Middlehaven and various design professionals to be involved in the design and development process and to trigger the formation process of the neighborhood with small-scale actions. It would not be wrong to argue that, both of these case studies owe their achievements in terms of formal pre-conditions of design – defined as necessary for adaptation – to the appropriate formation and development mechanisms. Therefore, distributed design formation is a complementary principle to operate design on a fine-grain and diverse spatial configuration, and contributes to improving adaptive capacity of urban space.

All in all, these key lessons derived from international case studies of IJburg and Middlehaven demonstrate that creating the necessary pre-conditions which are open to re-interpretation, modification and change is crucial to improve the adaptive capacity of urban form. While these emphasized pre-conditions of design narrow down
Figure 6.2: General framework of the synthesized model approach: ‘responsive condition-making’
infinite number of choices, it also still leaves room for many others within that boundaries. Thus, this approach enables to achieve an adaptable urban space which is both controlled with some distinctive parameters and open to re-interpretation to some extent. In other words, it helps to create an urban space which is both resilient enough to sustain its macro-structure and flexible enough to accommodate change within its sub-parts. This alternative model approach, responsive condition-making, establishes a conditional relationship between theoretically contrasting notions like permanence and change, order and chaos, control and freedom, design and emergence, top-down and bottom-up (Figure 6.2). From this perspective, an adaptable urban space can be designed neither with top-down and deterministic place-making solutions; nor with highly uncontrollable and bottom-up self-organization mechanisms – each of these two different means fall short to improve adaptive capacity of an urban space. Therefore, the solution of improving adaptive capacity lies behind the grey zone between these two contrasting approaches: creating necessary pre-conditions to offer enough spatial choice ‘by design’ and leaving room for these pre-conditions to be changed over time.

By relying on this model approach, rather than dreaming about a ‘good city form’ or an ‘optimal’ urban space intending to last centuries and resisting to respond uncertainties and spatial changes; this research entails the idea of ensuring a responsive design structure and framework which both satisfies the rationale behind ‘designing’ and also enables urban space to adapt changing circumstances both formally and programmatically. In that sense, from the perspective of this research, a ‘good city form’ is not a frozen image of a master-mind but the one which enables change and provides potentials and choices even beyond the imagination of its designer.
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246


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APPENDIX A

INTERVIEW QUESTIONS FOR THE DESIGN OFFICES RESPONSIBLE FOR THE DEVELOPMENT OF IJBURG, AMSTERDAM

Question 1: Masterplanning Process of IJburg

As we know, in 1965 Van den Broek and Bakema presented their visionary Pampus plan for a new city of 350,000 people on an artificial island. Following this vision, in 1995, Palmboom Urban Landscapes prepared a plan in which they offer a general orientation for the site and some basic decisions. By relying on this conceptual scheme, Frits van Dongen of the Architekten Cie., Felix Claus of Claus & Kaan Architecten Amsterdam and Ton Schaap of Schaap & Stigter prepared an urban design scheme.

a. Could you please share some information about the masterplanning process? For instance, did the master plan provide any basic rules and limitations that guide your architectural design?

b. Was the document of “Design for IJburg” (Ontwerp voor IJburg) the sole design guideline for the whole architectural design process. Are there any other urban design guideline provided for you?

c. How would you interpret this design guideline? Was it too restrictive or is it relatively flexible allowing each designer/architect to make their own individual and creative interpretations by design?

Question 2: Responsible Parties for Planning and Design

As we know, development of each block was entrusted to one consortium and some coordinating architects. Their various responses are then reflected in the variety among the blocks.

a. Within this chain of responsibility sharing, what was the specific role of municipality, consortium, coordinating architect and the architect of the
project? Was the coordinating architect the one taking all design decisions for each block according to the abstract design principles coming from guideline or was it possible for you to make your own original decision?

b. By relying on the concept of ‘flexibility’ of design process, how would you explain your experiences? Was the design process open enough in consideration of your design process?

**Question 3: Adaptive Capacity of Design**

a. Do you think that your design project is **adaptive/responsive to emerging issues of change and transformation**?

b. Does it allow extensions, additions and so on in terms of allowing further intensification in the following period, or does it **allow change** of function, for example can it be used as a retail/commercial unit instead of a residential one? If your answer is positive, which design features and characteristics make it adaptive/responsive to change of form and function?

**Question 4: Design Diversity in IJburg**

*In IJburg, each urban block contains a varied building typology and mixed choice of housing and work spaces. Although a single masterplan controlled the design and development process of the site, architectural design responses varied for each block.*

a. What was the main reason for that? By considering that the masterplan and its guiding rules are valid for all of the blocks, how was it possible for the block/lot/plot that you have designed to be different from the one which is adjacent to yours and designed by a different architect?

b. Could you please share us the rules, principles and parameters offered by design guideline to you in the scale of plot, lot and block? Which rules were restrictive and not open to re-interpretation, and which rules were flexible and easy to challenge by various design responses?