1.1 THE DYNAMIC URBAN SYSTEM IN NEED OF ALTERNATIVE THINKING AND PLANNING

1.1.1 MAIN CONCERNS OF THIS THESIS

This thesis is concerned with the dynamic urban transformations occurring around us, exploring the mechanism behind these transformations and seeking better interventions from a planning and institutional perspective. This topic is not new but has progressed in parallel with the evolution of cities and our knowledge of urban systems. This research considers cities to be complex adaptive systems and argues that self-organization is a fundamental mechanism underlying various urban transformations, in particular those which include spontaneous and unexpected change. In addition, it is argued that the role of institutions and planning also needs to be reconsidered in the face of a dynamic and uncertain urban environment. The three main reasons for the necessity and importance of this research topic are addressed in turn below.

1.1.2 THE EVOLVING URBAN SYSTEM REQUIRES AN ALTERNATIVE PLANNING PERSPECTIVE

An ever evolving urban system continuously acquires (or loses), transforms and upgrades (or degrades) its functions and structures, which provides rich empirical data for the creation of new knowledge and perspectives. This knowledge and new perspectives contribute to a better understanding of cities and support the role of urban planning in relation to complex planning issues. In predominantly agricultural eras, the urban system was a simple combination of market facilities for trade and a defensive system of city walls. Direct physical intervention could be effective in creating and managing this function. Industrialization has greatly expanded the size of cities and the variety of urban functions, entailing cities with an efficient production system, and a considerable number of workers and consumers. The changing structures and the increasing uncertainties in urban society today demand more systemic thinking and sophisticated intervention packages.

Since the early 1980s, information technology has greatly improved the speed and efficiency of information exchange, empowering individuals to receive and also deliver information at the neighbourhood, city, regional, national and international levels. This fundamental change has enhanced interactions between individuals and organizations within and beyond urban systems,
leading to a network mode of urban society (Castells, 2010; Hajer & Wagenaar, 2003). Such a society manifests emerging characteristics, highlights interactions between individuals and increases social-spatial networks and dynamics within the urban system (Newman, Barabasi and Watts, 2006; Healey, 2006; Buckley, 2008). These new characteristics of the urban system are challenging the conventional wisdom of planners and demanding additional ideas to improve positively oriented planning and governance. More recently, the planning debate has discussed how to embrace more post-structural planning approaches as a necessary supplement to current theory and practice (Byrne, 2003; Boelens & De Roo, 2014).

The theoretical shift in relation to urban systems, moving from a Cartesian-Newtonian mechanism to the complex sciences – from system equilibrium to a complex adaptive system – also requires alternative thinking from the planning perspective (Allen, 1997; Batty, 2008a). The Cartesian-Newtonian worldview is characterized by mechanistic determinism, dualism and reductionism, and as the most profound paradigm in modern science it has been influential in planning and policymaking (Wallerstein, 1991). Newton’s view of absolute space-time provided the framework for a fixed, predictable and rigidly law-abiding reality (Rynasiewicz, 2004). In Newton’s universe, matter can ultimately be reduced to individual particles and various forces through which these particles interact. The movement of these basic particles is governed by the deterministic laws of nature (Heylighen et al., 2006).

The Newtonian paradigm provided support for urban planning and the development of the built environment. For example, various types and a large number of new urban facilities have been built based on a demand-supply model and aided calculations. The infrastructure of cities, such as streets, buildings and metro, is well organized on a blueprint, which benefits from analytical simplicity and positive modelling techniques. However, in recent decades the Newtonian worldview has been increasingly questioned. In theory, small changes in operating conditions can also lead to large disruptions in performance, or even disorder and chaos; similar causes can have different effects and different causes can have similar effects (Prigogine & Stengers, 1984; Waldrop, 1992). Gradually, there is a loss of normalities and generalities, while there is increasing confrontation with non-linearity, regressions, variability, circular causality and the emergence of new forms. Increasing evidence from planning practices that does not align with the Newtonian paradigm has further stimulated interest in alternatives. For example, a municipality-wide traffic jam may result from a small accident at the conjunction of a ring road; or housing prices keep increasing despite the implementation of a series of institutional regulations aiming to stabilize prices.

In summary, both the theoretical debate and planning practices have highlighted that urban transformation may be creative, based on a circular causality, non-linear and spontaneous. These new properties of urban transformation – which are not well explained by conventional knowledge – have prompted planners to seek alternative models. Among the many research streams, theories of complex adaptive systems have manifested an ability to deal with complex issues but are still underdeveloped with regard to urban issues (Portugali, 2012). As Weaver pointed out that organized complexity was becoming the cutting edge of science because most problems belong to organized complexity when controlled conditions or assumptions were destructed (Weaver, 1948). New thinking and approaches that recognize the urban system as an interconnected whole, within which the components and their interrelationships are in a constant state of discontinuous change, are needed.

1.1.3 SELF-ORGANIZATION AS A POPULAR BUT CONFUSING CONCEPT REQUIRES IN-DEPTH RESEARCH

Among the theories of complex adaptive systems, the notion of self-organization is fundamental and popular. ‘Self-organization’ refers to a process out of which new structures and functions can be created as emergent consequences of interactions between systemic constituents within the physical or social environment (Heylighen, 2008). Self-organization has gained attention in a wide range of disciplines in the past decades and quite recently has led planners to explore this non-linear concept in relation to the dynamics and uncertainties of planning (De Roo & Silva, 2010; Rauws & De Roo, 2011; Boonstra & Boelens, 2011; De Roo et al., 2012; Meerkerk et al., 2013; Zhang et al., 2015). The increasing popularity of self-organization has stimulated rich debate and discussion in the domain of planning. However, the increasing diversity and variety in the understanding and interpretation of the concept of self-organization is also causing problems. Implicit, over exaggerated or loose ways of using the concept might cause misunderstanding in the planning debate and consequently hinder the adoption and integration of the concept into planning theories. For example, not every bottom-up transformative process can be considered to be self-organization; not all efforts by the ‘self’ will lead...
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This occurred when McDonalds opened a new shop next to a traditional Chinese courtyard (Siheyuan); and when Adidas set up its factory in a small Chinese town it employed half of the local residents. These changes indicate a network-style of interaction in urban economic activities, which has replaced the hierarchical structure, and this fundamentally influences the mechanisms behind urban transformation.

Secondly, there has been a shift in the State’s development strategy, from centralization to a more decentralized pattern, which provides more freedom for bottom-up initiatives (Breslin, 2000; Lin et al., 2014). The centralized or polarized strategy was very effective in boosting the Chinese economy in the initial period of reform in the 1980s. This was due to its efficiency in gathering resources, the organization of production and the scale of the economy (Lin et al., 2003). However, the drawbacks of this policy soon started to become apparent. For example, the polarized policy aggravated regional disparity (Li & Haynes, 2011). In 2003, the highest GDP per person in Chinese cities was about 15 times that of the lowest. Regional disparity has threatened sustainable development, causing problems such as massive migration to megacities, safety issues, congestion and environmental issues. Another negative consequence of the polarized policy is that bottom-up innovation is restrained by top-down regulation. Small private companies are at a disadvantage in the competition with state-owned enterprises. As a response to negative consequences resulting from the polarized policy, the State’s development strategy was reoriented to encourage the decentralized distribution of public investment aiming to trigger bottom-up innovation. This new development strategy aimed to shift the economy from one driven by state investment to a consumption-driven economy, and to stimulate regional cooperation and integration. All of these new changes loosened regulations and provided more freedom for bottom-up initiatives.

Thirdly, as mentioned in the previous section, information technology has fundamentally changed the way individuals communicate, in China, as elsewhere. Information and knowledge are widely and efficiently distributed throughout urban society. Thus, the process of planning and policymaking becomes more transparent to individuals. People are informed, the processes are explained and they are involved in these processes. With abundant online information, individuals can analyse the potential effects of situational changes and take action or respond quickly, which can significantly influence urban development. For example, the implementation of a new policy constraining car use (e.g. prohibition on use during a specific period or at a certain place) will lead individuals to look for alternative modes of transport, which collectively may lead to a spontaneous new pattern of transportation. Such a change requires...
1.2 THEORETICAL CORE: COMPLEX ADAPTIVE SYSTEMS, SELF-ORGANIZATION, URBAN LAND USE AND SPATIAL PLANNING

This section will elaborate the theoretical foundation of this thesis, which primarily concerns self-organization and spatial planning. We regard the urban system as a complex adaptive system, which we will consider before introducing the concept of self-organization, understood as a mechanism that allows such an urban system to acquire a new pattern. The concept of self-organization will also be related to transformations in urban land use. Therefore, theories of complex adaptive systems, self-organization, urban land use and spatial planning will be discussed respectively.

1.2.1 COMPLEX ADAPTIVE SYSTEMS

An urban system is a typical complex adaptive system, composed of a very large number of components which, as elements of the system, interact in an iterative and recursive manner. In a complex adaptive system, the whole is more than the sum of its parts and much can emerge from little (Holland, 1992). It is impossible to separate the behaviour of individual elements from their context in order to simplify a problem. The complex adaptive system is complex in the sense that the sub-systems and individuals are such that their influence on the system cannot be evaluated in concrete terms. The complex adaptive system is adaptive because it is able to respond, adjust and absorb changes in the environment. Due to these characteristics, complex adaptive systems are able to adapt to major contextual changes and create new patterns spontaneously out of an apparently chaotic environment. The ability to adapt to environmental change and to create new patterns is the result of the interactive networks of agents and the various flows they create (money, resources, information) (Innes & Booher, 2010). These flows support individuals to adjust through actions that respond to environmental change.

We live in a world full of such complex adaptive systems, from a cell composed of a large number of interacting molecules to the brain operating as the entire complex of neurons, to the market composed of merchants and customers, to the city composed of individuals (Innes & Booher, 2002). Complex adaptive systems and the mechanism of pattern formation have been recognized and studied in a wide range of academic domains (Fleming & Sorenson, 2001; Ellis & Larsen-Freeman, 2009; Romero & Ruiz, 2013). Aggregations of molecules can form laser lights, flow patterns in fluids, crystals and cloud formations, without a prescription or instructions given beforehand. The Bénard phenomenon is one example: when a liquid in a round vessel is heated from below, at a certain moment, molecules of the liquid which at first moved randomly will exhibit a coherent macro-movement made up of hexagonal cells or parallel rolls (Benard, 1901). Using the analogy of a sand pile, Bak and Chen (1991) demonstrated what they called ‘self-organizing criticality’, where adding another grain of sand to the pile at some indeterminate point causes an avalanche and the formation of a new pattern without external intervention (Bak & Chen, 1991; Portugali, 2000).

Examples outside physics are also widespread. For example, the human brain is composed of billions of cells which, by virtue of their coordination, give rise to how we think, act, decide, remember, perceive, learn and develop. This is a genetic process of non-linear self-organization (Kelso, 1995). In cities, we might understand the unplanned, spontaneous growth of informal settlements to be the result of the collective effort of individuals and individual organizations. The mechanism behind the pattern formation in complex adaptive systems through bottom-up interaction is called ‘self-organization’ (Vesterby, 2008; Portugali, 2011).

1.2.2 THE EVOLUTION OF SELF-ORGANIZATION

According to the Longman Dictionary, ‘organization’ is defined as the arrangement or planning of parts so as to form an effective whole. Correspondingly, the literal meaning of ‘self-organization’ is an arrangement made by the components of the system themselves. However, when used specifically as the mechanism by which a complex adaptive system creates order out of chaos, the meaning of self-organization goes beyond such a literal interpretation. In this case, ‘self-organization’ refers to a non-linear process within which new structures, patterns or organizations emerge spontaneously as a result of
interactions between elements, parts, agents or actors that are not externally controlled, coordinated or regulated (Nicolis & Prigogine, 1977; Bonabeau et al., 1997; Bak, 1999; Heylighen, 2008). A review of the concept of self-organization below will indicate its key properties and clarify where this thesis stands theoretically.

(1) **Self-organization within the natural sciences**

Self-organization is a well-known, important term and a general methodology which originated from the ‘hard’ sciences. Self-organization has been applied in a wide range of academic domains and theories, such as cybernetics (Ashby, 1947; Forster, 1984), dissipative structures (Prigogine, 1978), synergetics (Haken, 1980), fractals (Mandelbrot, 1983), biology (Maturana, 1980; Kauffman, 1993, 1995), chemistry (Lehn, 1990), computer modelling (Langton, 1997) and self-organized criticality (Bak, 1996).

The concept of self-organization was first introduced by W. Ross Ashby (1947) in his works on cybernetics. According to Ashby, the principle of self-organization assumes that a deterministic dynamic system will automatically evolve towards a state of equilibrium. This idea was further developed by Forster in the 1960s, who formulated the principle of ‘order from noise’ and developed what is called second-order cybernetics. This approach asserted that the investigator is part of the cybernetic system, emphasizing the importance of self-referentiality, self-organizing and the subject-object problem, among other things. Investigators of a system can never see how it works by standing outside it because the investigators are always engaged cybernetically with the system that is being observed. While cybernetics has since had a strong effect on systems thinking that is closely related to planning theory, at the time, the increasingly popular concept of self-organization did not receive much attention in planning theory, if any at all.

‘Self-organization’, as a word and a concept, was used mostly within the realm of general systems theory in the 1960s, and did not gain broad attention until the late 1970s through the work of Prigogine and Nicolis (1977) in the fields of physics and chemistry, who introduced the idea of dissipative structures and systems. They argued that the concept of self-organization entailed the notion of an irreversible ‘Becoming’, replacing Newton’s static framework of ‘Being’ (Prigogine et al., 1977). In comparison to traditional theories of thermodynamics, Prigogine’s dissipative structures theory explained how, within an open system, energy, matter and information can be exchanged with the outside of the system, triggering the system itself to change. Through dissipative mechanisms a system receives energy, matter and information as input. This allows systemic parts to take action from within, changing and adapting to the outside world. This theory was also applied in urban studies, for example in the reinterpretation of central place theory through dynamic models (Allen & Sanglier, 1979; Chen & Zhou, 2006), where the formation and disappearance of urban centres is taken to be the spontaneous result of the collective actions of migrants and employers.

Prigogine’s work initiated a new era of scientific research focusing on non-linearity, of which Hermann Haken’s (1983) theory of synergetics is the most profound representative. While Prigogine emphasized external interactions, Haken’s synergetics explained interactions within the system. At the system level, energy, matter and information is absorbed, used, transformed and passed on, resulting in both stable phases and dynamic transition phases. Haken’s theory contributes to the grasping of complexity through the notions of systemic symmetry and symmetry breaking (Helbing & Vicsek, 1999; Hartman, 2000). In biology, the discussion of ‘autopoiesis’ by the Chilean biologists Humberto Maturana and Fransisco Varela (1974) also contributed to research on self-organization. Maturana and Varela’s model of autopoiesis explains how subsystems are capable of reproducing and maintaining themselves. While these subsystems are considered to function more or less autonomously, they are ‘structurally coupled’ with their contextual environment. Through this bottom-up process, the system holds the subsystems together. A living system can self-reproduce and maintain its essential form. In addition to the above, self-organization has also been applied in the study of fractal geometry (Mandelbrot, 1983); urban research, such as work on infrastructure systems and urban networks by Batty and Longley (1994); fractal theories and self-organized criticality (Bak, 1996); rich modelling research in chemistry (Lehn, 1990); physics (Wolfram, 1984, 2002; Manneville, 1990); computer and system science (Bonabeau et al., 1999); and of course in urban planning (White & Engelen, 1993; Batty, 2007, De Roo, 2010).

(2) **Self-organization within the social sciences**

While it is apparent that the notion of self-organization has flourished within physics, chemistry, biology and the hard sciences generally, it is not the only root of this concept. Economics, sociology and even urban studies have also contributed to the study of self-organization.

Adam Smith’s idea of the ‘invisible hand’ already informed an autonomous self-organizing mechanism within economic systems in 1776, although in an implicit manner. It came with the idea of an interaction process entailing coordination
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as an unintended side effect in the pursuit of self-interest (Witt, 1997). Krugman (1998) illustrated the economic consequences of self-organization, arguing that: ‘Self-organisation is something we observe and try to understand, not necessarily something we want’ (Krugman 1996: p. 5–6). Economics is about what individuals do, and individuals are self-interested; moreover, the societal impact of these individuals (the parts) might be disappointing and might even contribute to a crisis, such as the global credit crisis of 2008. Thus, in response to an increasing interest in self-organization, Krugman reminds us that self-organization does not necessarily entail a positive outcome. This is crucial when considering the transfer of self-organization from the hard sciences to the social sciences.

Self-organization has also received broad attention in sociology (Luhmann, 1982; Byrne, 1998; Fuchs, 2003). Luhmann (1982) applied the concept of autopoiesis in the social domain, regarding society as a self-referential system, the basic element of which is human communication (Fuchs, 2003). Luhmann emphasized that communication among individuals is most important for the formation of social structures, arguing that it is through the permanent production or reproduction of communication that social systems are well maintained and reproduced (Luhmann, 1988). Such a view of self-organization denies that spontaneous results arise from independent individual behaviours, which is an important type of self-organization (Fuchs, 2003).

Luhmann’s ideas on social self-organization were later developed and improved by Giddens in his work on structuration and agency theory, although the term ‘self-organization’ was not used explicitly in his work. According to Giddens (1981), the human being is neither a determined object nor an unambiguously free subject: ‘All human action is carried on by knowledgeable agents who both construct the social world through their action, but yet whose action is also conditioned and constrained by the very world of their creation’ (Giddens, 1981, p. 54). Giddens argued for a dialectical relationship between self-organization and institutional rules based on social structures and actions, with this relationship being a heuristic for the study of the relationship between individual actions and institutions, planning and policies.

(3) Response to complexity in the urban and regional domains

Planning has its own history of response to the notions of systemic complexity and self-organization. In the 1960s, Jacobs implicitly expressed a non-linear notion of autonomous urban evolution and cities as organic wholes. She asserted that something had gone wrong in the way we understand cities, which led us to make inappropriate interventions justified by planning. She proposed that a city should be viewed as a problem in organized complexity. Such complexity can lead to aggregate patterns, created by heterogeneous and coherent local interactions (Jacobs, 2010). Therefore, a relational and non-linear perspective is proposed. Similar to Jacob’s ideas, Christopher Alexander also pointed out that bottom-up evolution is a key part of urban change. One of the earliest planners to discuss uncertainty in planning issues and the way we should deal with it is Karen Christensen (1985), although the method that is used is very much linear. Christensen classified planning problems into two dimensions: whether the planning goal is agreed upon or not, and whether the technology (means) is known or unknown.

More recently, self-organization has been increasingly accepted by planners and geographers, who are enriching the theoretical debate (e.g. Boonstra & Boelens, 2011; Portugali, 2000, 2011; Rauws & De Roo, 2011; Zhang et al., 2012). This research can also be linked to some extent to the research from various hard science disciplines mentioned in previous sections. For example, influential research on self-organization and cities by Portugali, with his concept of ‘dual complexity’ and ‘cognitive cities’, directly engages with synergetic theories, as well as brain and nerve research in biology.

(4) Summary: reflection on the concept of self-organization

Based on the above, it is apparent that self-organization is a concept and a general metaphor which has been broadly used in various scientific domains. In general, self-organization designates a mechanism that allows complex adaptive systems to achieve order out of chaos through the interactions of system components. Self-organization is a spontaneously evolving process, giving rise to new structures, patterns or functions as a result of interactions between system components which are not externally controlled, coordinated or regulated (Portugali, 2012). However, this meaning of self-organization is too abstract and does not become concrete and instructive for practice until it is related to the analytical subject. For example, self-organization appears as the dissipation of heat in dissipative theory; the theory of synergetics interprets self-organization as a mechanism of laser light formation resulting from the coherent movement of molecules; in biology, the details of coordinated human movement are seen to arise from the synergetic assembly of muscle collectives (Kelso & Tuller, 1984); autopoiesis interprets the self-organizing process as the self-production of a subsystem in order to maintain the functioning of the
system. In summary, the abstract concept of self-organization has to be related to an analytical subject to acquire a specific meaning. This thesis relates self-organization to transformations in urban land use, exploring how macro land use transformations (physical and functional) relate to micro or individual activities within the urban system.

We should also keep in mind that since the meaning of self-organization as a concept originated from the natural sciences it might change slightly when it is employed in the social context. The elements of social systems—human beings—in comparison to particles (atoms, molecules, electrons, etc.) in natural systems, are more complex, in the sense that human beings are capable of transforming, reducing, elaborating, storing, recovering and utilizing information from outside the system. In social systems, individuals can be reflective and make adjustments with greater freedom and thus generate more possibilities. The thesis will also consider these differences in complexity when transferring self-organization into the social domain, examining what Portugali (2000) calls ‘dual complexity’.

1.2.3 CONNECTING THE CONCEPT OF SELF-ORGANIZATION TO URBAN LAND USE

Urban land use constitutes one of the most widespread forms of human engagement with the environment (Harvey & Josey, 2004). The current state of urban land use, as well as changes to this, offers a comprehensive reflection of social and economic activities and institutional interventions into the urban system. Urban land use is not only a local environmental issue, but also has an effect on global climate change, ecosystem cycles, biodiversity and environmental pollution (Kalnay & Cai, 2003; Foley et al., 2005), all of which are closely connected with the sustainability and livability of human societies. Therefore, urban land use change has been an important issue in both academic research and policymaking: on the one hand, there is much scientific debate on urban sprawl, the notion of the compact city and optimal urban size; on the other hand, in practice, we find urban land development projects with public investment, and policies such as urban growth boundaries.

While urban land makes up only a small share of all land use types, it is the most active, dynamic and influential. Globally, urban land accounts for around 3 percent of the terrestrial surface, but produces 78 percent of carbon emissions and accounts for 60 percent of all residential water use, while 76 percent of all wood used for industrial purposes has been attributed to cities (Brown, 2001).

Urban land expansion leads to increasing motorized transport, air, water and noise pollution, energy consumption, a loss of agricultural land and a reduction in biological diversity (Randolph, 2008; He et al., 2011). Therefore, intervention is needed to control the speed and space of urban land use change and its negative consequences.

However, the demand for urban land continues to grow rapidly, due, for example, to the increasing numbers of urban residents, a demand for new and larger houses, industry, services and public facilities. The world has been in a rapid process of urbanization and this will continue in the near future. In 2007, the world’s urban population surpassed the rural population and the United Nations expects that the world’s urban population will have increased by 72 percent by 2050, from 3.6 billion in 2011 to 6.3 billion in 2050 (The United Nations, 2011). In China, the most populated country in the world, the percentage of the urban population exceeded 50 percent in 2011 (Chinese Statistical Bureau, 2012) and it is expected to reach 70 percent by 2030.

Based on the above, we can assume that urban land use change is inevitable and that it will be rather difficult to control this process due to the strong bottom-up demand. At the same time, there is an urgent need to reduce the negative consequences that accompany rapid urban land growth and, thus, planning and regulations are still required. The question thus becomes: What is the mechanism behind urban land transformation? How can self-organization be linked to such transformation, and correspondingly what is the best solution for planning and governance in a dynamic period of rapid change?

1.2.4 SELF-ORGANIZATION PROVIDES AN OPTION FOR THE EVOLUTION OF PLANNING THEORY

The evolutionary path of planning theory reflects a continual process of looking for answers to the key question: ‘What is the best way to intervene in urban change?’. The answer has been enriched, revised and reconsidered from time to time as the idea of what a city is and how it operates changes. Some of these ideas brought about paradigm shifts in planning theories.

Cities used to be taken as a combination of buildings designed by architects and engineers. Before the 1960s, planners intervened through the direct design of urban elements such as buildings, roads, parks, etc. Cities were regarded as a blank canvas on which the most wonderful landscapes could be painted. Later on, planners started to realize that cities are not static entities but rational,
systematic wholes. In what came to be called ‘rational theory’, planning was
then undertaken on the basis of a series of scientific analyses which aimed
to find the best solution. As a systematic whole, the general functions and
structures of a city were considered to be more than the sum of its parts.
Cities were to be treated in terms of finding equilibrium and optimization.
Corresponding to this view, planning theories moved from a design approach
to a technical rationale and, in turn, to a communicative rationale. How did
this come about? Critics of rational theory increased sharply following a period
decentralization and changes in the structure of governance, with the view
of cities changing slightly from the notion of a rational system to the city as a
constructive whole made up of stakeholders. Decisions on urban development
were thus to be communicatively determined by the stakeholders.

The communicative planning approach has dominated planning theory since
the 1990s, but cannot solve all the planning issues, in particular the increasing
uncertainties appearing in planning over the past decade. These uncertainties
have triggered debate on how cities operate and thus how cities can be
managed. Innovative theories and alternative perspectives are needed to cope
with this new challenge to planning. In this context, complexity theory, in
particular self-organization theory, has found its way into urban and regional
studies and has demonstrated its ability to offer new interpretations and
approaches to complex planning issues. Self-organization, with its concern for
the temporal dimension, the non-linearity of change and the dynamic conditions
within which change occurs, provides an option for the further evolution of
planning theory.

Research featuring the dynamic modelling of cities, such as the cellular
automata model, the agent-based model and the neuronal network model,
have prospered in complexity research on cities. While this has attracted broad
interest in the potential of non-linear mechanisms to govern cities, it has also
raised criticisms. For example, it has been argued that micro-level dynamics
and qualitative information are poorly represented, that parameters can often
be too aggregated and that emergent global outcomes may not always be easily
anticipated (Gilbert & Troitzsch, 2005). As these multidisciplinary theories are
grounded in the hard sciences, the application of self-organization to urban
development and planning still needs a considerable amount of research, in
particular regarding the social aspects.

1.3 RESEARCH OBJECTIVE AND MAIN QUESTIONS

The research objective of this thesis is to explore and reveal the mechanism
behind urban transformation in which emergent urban change occurs
in a spontaneous way. Moreover, we will reflect on and clarify the role
of planning in the process of self-organizing urban transformation. In order
to achieve the aim of the research, the following sub-questions will be answered:
1) What is the alternative solution for planning in the face of complexity, which
is challenging both the technical and communicative rationales? 2) How should
we understand and identify self-organization in real urban transformation? 3)
How can spatial planning, as a manifestation of collective intent, relate to an
unintentional self-organizing process?

In answering these questions, this thesis provides an innovative contribution
to the field of planning. Firstly, this research goes beyond the debate between
technical and communicative planning, both of which are mainly based on the
assumption that at any given moment it is possible to identify a fixed urban
reality, whether a factual reality (technical rationale) or an agreed reality
(communicative rationale). Of course, both methods work well under certain
circumstances, but both seem to be inadequate in the face of increasing
uncertainties. This research takes into account the temporal dimension in which
planning occurs – a context in continual flux which influences actors within the
urban system.

Secondly, this research builds a conceptual understanding of the self-organizing
process in the context of the theoretical debate in planning. A self-organizing
process is a non-linear transformative process which follows three main steps:
first, there is a break in symmetry, with increasing tensions, approaching
criticality; second, adjustments in behaviour respond to situational change;
and, third, new, spontaneous patterns emerge. Such an analytical framework
will be tested using empirical evidence from urban transformation in practice.
Moreover, this thesis will examine the applicability of self-organization theories
in a wider context by providing illustrations from China.

Thirdly, this research transfers the concept of self-organization from the hard
sciences into the social context and relates it to urban systems and planning,
which is an unusual approach which deserves more exploration (Collier, 2003;
Portugali, 2012).
Last but not least, this research is distinguished from the work of those who conceive of self-organization in a radical and revolutionary way. We do not wish to overemphasize or deny the role of either self-organization or institutional intervention in urban transformation. Instead, this research argues that urban transformation is the autonomous outcome, as well as a natural manifestation of, interactions between self-organization and institutional intervention. At the same time, traditional institutional intervention can still have a role in the transformation of urban areas, albeit through a different mechanism. Thus, this thesis reveals the bridge between the unintended process of self-organization and spatial planning, which intentionally intervenes in space and place with the intention of supporting societal wellbeing.

1.4 RESEARCH STRATEGY

1.4.1 RESEARCH FRAMEWORK

(1) Ground of self-organization in urban transformation

In this thesis, self-organization in urban land use transformation is understood as a process of spontaneous adaptation of a complex urban system to form a macro-level land use pattern (or function) due to the unintended, independent actions of individuals on the micro-level. In the light of theories of self-organization and complex adaptive systems, we build a theoretical framework to analyse and test self-organization in urban land use transformation.

Haken’s theories of synergetics reveal the fundamental role of self-organization within the dynamic process of systemic mismatch and systemic order formation. According to Haken, a system is self-organizing if it acquires a spatial, temporal or functional structure without specific interference from the outside (Haken, 2006, p. 11). The system as a whole is composed of many subsystems. The subsystems may be atoms, molecules, cells, animals, or human individuals in the case of an urban system. Under certain conditions, these subsystems perform a well-organized collective motion or function (Haken, 2004, p. 24). When the situation changes, the system is able to transform itself into another state, with new functions or structures acquired through the mechanism of self-organization.

Based on this knowledge from synergetic theories, a new framework of urban transformation can be built from the perspective of self-organization (as shown in Figure 1.1). An urban region can be seen as a typical synergetic system (Haken, 1983), which means that the urban system operates on the edge of instability and achieves order through self-organization, which will lead to the emergence of new structures or functions. The appropriate state (structure or function) is achieved by maintaining flux of energy and matter through the system. State A can be well maintained in dynamic equilibrium until the moment when the conditions (energy, resources, institutions, etc.) which supported this equilibrium change through a trigger event. Such an urban transformation event can take various forms, on different spatial levels: a shrinkage or boost in the economy, a natural disaster such as a flood or earthquake, a change in state policy, and even the implementation of spatial planning on the macro level, or hygiene deterioration, or the aging of a community on the micro level. The trigger event will create instability in the urban system, causing a symmetry break. Such a conditional change becomes the initial phase of the urban transition. Increasing tension resulting from the symmetry break, if not fixed by planning or the market, will push the system to criticality and trigger adjustments by the individual parts of the system.

![A self-organization framework of urban land transformation](image)
These individual adjustments, as responses to the situational change that aim to improve individual welfare, are characteristically independent of each other and are not intentional. In the beginning, the individual adjustment might exhibit a distinct pattern, with various possibilities arising that might even contradict each other. On the system level, a chaotic period will be visible, or a period of non-identity. Nevertheless, at a certain moment these seemingly heterogeneous individual adjustments will spontaneously perform as a collective activity. Once the collective activity begins, the transformation process is irreversible, which will ultimately lead to a spontaneous pattern: an emergent State B. The unexpected spontaneous outcome, in turn, might bring environmental changes to the initial conditions and cause a new symmetry break. In such continuous interactions, the urban system is able to evolve and upgrade itself.

It must be emphasized once again that the individual adjustments are independent of each other. Individual actions are not intentional in any form. In a self-organizing process, it is of key importance to distinguish self-organization from other, similar bottom-up processes, such as self-governance and shared governance. In a process of self-governance, there is a collective intent which instructs individual actions. This collective intent is achieved by interaction, discussion and negotiation among individuals within the system. In a process of shared governance, there is also a collective intent instructing individual actions. However, the collective intent is not only created by individuals within the system, but also by external authorities.

(2) Relation of institutions and planning to self-organization

Policymakers and planners have developed various forms of institutions (regulations, spatial policies, planning, etc.) to intervene in urban development, with the aim of creating the desired urban environment. As a collective manifestation of ‘intent’ in relation to urban land use change, planning will inevitably be confronted with self-organization, or the ‘spontaneous’ transformation of urban land use. What is the relationship between planning and self-organization? Here, we use two analytical figures to elaborate.

The first figure represents how institutions work when we take cities to be linear systems made up of causal relationships, a model which has been predominant in the planning field. In this case, the task of planners is to identify the underlying causal relationships and the input-output principles, on the basis of which the institutional intervention can be conducted in a scientific way. The changes achieved after the institutional input are considered to be the institutional effects, while the changes that are not achieved, in addition to the unexpected changes, are ascribed to residuals which can be partially ignored and/or partially resolved by the improvement of institutions (see Figure 1.2).

Figure 1.2
Linear thinking on the mechanism of institutions in relation to the urban system

In contrast, Figure 1.3 represents the role of institutional intervention in the urban system when we also take into account the self-organizing mechanism. According to this framework, institutional input into the system actually triggers a conditional change, which will cause a symmetry break, manifest as a mismatch between function and structure, or between reality and expectation. Due to the conditional change, individuals within the system who are influenced by system conditions will adjust their strategies and activities in order to adapt to the new situation, to find the best fit to the mismatch, or the best response to the symmetry break. In the beginning, the individual activities might appear chaotic. However, gradually, through communication and interaction, individual activities become collective. The collective activities are irreversible and ultimately result in a spontaneous outcome that has two main aspects. On the one hand, changes are achieved by the institutions as expected, but as the result of a different mechanism that is not in line with the institutions. On the other hand, there are spontaneous changes that were not expected by the institutions at all. Both the spontaneous mechanism and the spontaneous changes
1.4.2 RESEARCH METHODS

The argument of this thesis is supported by three case studies from Beijing. The first case study focuses on new urban development at the periphery of the built-up area of the Beijing urban region; the second case study concerns urban renewal of a *hutong* area in Beijing’s inner city; and the third case study looks at the functional transformations of a peri-urban village.

This thesis adopted a qualitative research approach to the collection of data. This includes: desk research performing literature reviews and document analysis to acquire historical data about developments and information related to policy, institutions and planning; field visits and informal discussions to verify information from desk research and gain an understanding of the case study area; and questionnaires and semi-structured in-depth interviews to collect objective facts and subjective opinions of the relevant actors. Detailed information on research methods and research techniques will be explained in the respective chapters on each case study.

1.5 RESEARCH ORGANIZATION

This thesis is organized into six chapters, as shown in Figure 1.4. Chapters Two to Five explore answers to the three main research questions.

Chapter Two will begin with a critical review of planning through a comparison of the evolution of planning within two different contexts: China and Europe. Spatial planning is one of the most prominent institutional interventions in urban development, which reflects the current understanding of cities and urban regions. A comparison of the two trajectories in planning reveals that inadequate attention is being paid to the dynamics and uncertainties of any urban system. Here, it is argued that spatial planning entails a learning process – about the current situation and the context of a society, and the continuous adjustment to it. Instead of pursuing an atemporal perfect planning approach, the key is to understand the mechanism that lies behind the complex urban transformations, which, in turn, will determine what kind of planning is appropriate. Therefore, from Chapter Three to Chapter Five, we explore the mechanism behind various urban transformations through empirical studies.
Chapter Three argues that the mechanisms behind urban land use patterns are the consequence of an interdependence between self-organization and institutional actions. The chapter is based on an empirical study of two land development cases in the Beijing urban region. The study found that in both cases of urban land transformation self-organizing processes occurred, triggering symmetry breaks, unintended collective behaviour and spontaneous patterns, while still being institutionally framed. The interdependence of self-organization and institutional rules builds on a framework of circular causality at different spatial levels. This study tested whether self-organization is a driver for autonomous urban change and non-linear transformation.

In Chapter Four, we further confirm the role of self-organization in urban transformation, providing evidence from Nanluoguxiang, an urban redevelopment case, at the neighbourhood level. In addition, this chapter argues that self-organizing transformation, as a property of complex adaptive systems used to acquire order, can also lead to ‘chaos’ when judging by social standards. Therefore, planning is still required to complement the self-organization of urban development if we are to ensure that societal needs are taken into account.

Chapter Five deals with the question of the relevance of self-organizing processes in relation to top-down institutional regulations. This chapter explores the relationship between formal institutions and self-organizing urban transformations by discussing two primary questions. Firstly, in what way do institutions constrain urban self-organization? Secondly, to what extent can institutions also stimulate, facilitate and make use of the processes of urban self-organization? This chapter also focuses on the world in between top-down planning and self-organization, by looking at the positions of shared governance and self-governance. Empirically supported by a case study of Gaobeidian in the Beijing peri-urban region, it is concluded that the interrelationship between self-organization and institutions is, in general, symbiotic, and self-organizing urban transformation is the autonomous outcome of the interaction between self-organization and institutions.

Chapter Six presents the conclusions with respect to the research as a whole, beginning with a brief summary of the findings in the previous chapters. In addition, this chapter also provides recommendations for planning and policymaking, as well as indicating future directions for research in relation to the role of self-organization and institutions in the transformation of urban systems.