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Research Article

Innovation Districts and Complex Sustainability in Urban Economies

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Abstract: This paper addresses the question of the circular economy in the urban realm as manifested through the recent development of innovation districts, which constitute distinct spatial formations aimed simultaneously at economic development and urban regeneration. Based on the analysis of innodistricts, we suggest an approach to analyze sustainability in the context of the knowledge economy. We use a qualitative methodology based on rapid ethnography to describe exemplary cases: Boston and Barcelona. We also describe a failed innovation district, Masdar City, for purposes of comparison. Innovation districts initially obey the logic of the market and the location decisions of specific companies. To meet this demand, many metropolitan governments have decided to plan and create innovation districts as a tool for development, regeneration and the global promotion of their cities. In designing sustainable innovation districts, planners need to be aware of the inherently complex nature of sustainability and its multi-dimensional character. By following the notion of "multiple success factors," we contend that there are a number of requirements that need to be met in order to achieve sustainable innodistricts: (1) environmental sustainability (sustainable infrastructure and sustainable development zones); (2) sustainability in design and planning; (3) sustainability in management; (4) institutional sustainability; and (5) socio-economic sustainability. This multiplicity of factors indicates thatsustainaility is inherently a complex phenomenon. Complexity and transdisciplinarity are key tolos to understand urban sustainability andthe components of sustainability in innovation districts.
Keywords: innovation districts, sustainability components, competitiveness, economic development, urban regeneration, complexity, transdisciplinarity.
JEL Codes: A14, L26, O32

1. Introduction

In order to meet the challenges of the global economy, many countries have resourced to infrastructure development in the form of industrial corridors (for example in India), and reterritorialization via megaregions (in China), and they are paying increasing attention to the innovation district phenomenon. Cities and regions are witnessing the urban relocation to urban areas of advanced manufacturing and high tech corporate activity, around so-called "innovation districts." Innovation districts constitute new urban megaprojects that significantly alter the urban fabric and the socio-economic structure of entire neighborhoods. In turn, many urban megaprojects concentrate innovative corporate functions and activities. In so far as these new centers of corporate activity are located in cities, corporate strategies have a direct impact on urban sustainable development. Innovation districts work as a type of urban megaproject in terms of significance and impacts. In this context, innovation districts present formidable challenges for sustainability: they enable it and constrain it in urban areas to an unprecedented scale.

The ongoing socio-spatial transformations in the global economy represent a formidable challenge for business and society in the 21st century, particularly for developing countries. The rise and continued expansion of megaprojects worldwide stand out as one of the most significant transformations currently impacting the global economy. Megaprojects, and innovation districts,

have multiplied around the world as an urban response to pressures for development, competitiveness and innovation in a context of globalization and neoliberalism. The narrative of international competitiveness and the rhetoric of economic survival embrace most megaprojects. In this context, innovation districts work by fostering urban transformations that would enhance the city´s position in the global economy and within a fluid sociopolitical division of labor. The agenda is to align urban initiatives with the real or perceived requirements of global production, consumption and a deregulated international neoliberal economic system.

Innovation districts share with most megaprojects the fact that they are "privileged particles in the development process." They are planned to be "trait-making," that is, to significantly modify the structure of society and cities (Hirshman, 1967, 36). However, their promoters and some commentators present innovation districts as a major alternative to megaprojects, property-led urban regeneration and neoliberal urbanism strategies, an alternative that purportedly enhances economic development, quality of life and sustainability.

This paper addresses the recent development of innovation districts as a distinct spatial formation aimed simultaneously at economic development and urban regeneration. First, in "The Coming of Innovation Districts," we introduce the reader to innovation districts, including brief descriptions of two prominent examples: Boston and Barcelona @22. In the next section, "Challenges and Drawbacks: Masdar City," we examine some of the challenges and drawbacks in the development of innovation districts with an illustration of Masdar City in Abu Dhabi, United Arab Emirates, as an example not to be followed in planning eco-cities and innovation districts. The following section, "Innodistricts and Ecodistricts," discusses some of the most common requisites, features and constrains of innovation districts and their ecological and sustainable thrust. In the last section, "Components of Sustainability in Innodistricts," we try to unpack the meaning of sustainability and the dimensions of this concept in the context of innodistricts.

2. Theoretical Framework: The Coming of Innovation Districts

For the past 50 years, the innovation landscape has been dominated by regions such as Silicon Valley: spatially isolated corporate suburban corridors, accessible only by car, with little emphasis on quality of life or the integration of work, housing and leisure. However, in recent years a new complementary urban model has emerged: the so-called "innovation districts". According to the Brookings Institution, these districts are "geographic areas where state-of-the-art institutions and companies are grouped and connected with new businesses, business incubators and accelerators" (Katz & Wagner, 2014, 1).

The compact innovation districts, accessible to traffic and with high-tech infrastructure, encourage open collaboration, promote talent pooling and offer attractive places to live. With increasing frequency, startups, incubators and technology accelerators around the world are grouped around these innovation districts. By creating shared value, and promoting "place-making," this emerging geography of innovation in cities has been attracting the attention of scholars and experts (Katz & Wagner, 2014, 7).

Innovation districts can play an important role in an integrated strategy designed to attract, retain and cultivate talent, improve networks and communication flows among innovators and also make the district an attractive destination. Innovation districts begin to occupy today the preeminent place that culture and tourism have occupied for three decades in urban revitalization strategies.

Thus, the geography of innovation is changing. Google, for example, over the previous ten years has taken Silicon Valley's core R&D and innovation activities to a number of cities and urban cores. The company's presence in the Tech City of London, the Chelsea district of New York City and Bakery Square of Pittsburgh displays Google's calculation that being in the cities increases the company's get

admission to the growing ecosystems aimed at technology, superior lookup institutions, giant talent companies and a number of regional economic specializations (Katz & Wagner, 2014).

Barcelona, Berlin, Copenhagen, London, Medellin, Montreal, Seoul, Stockholm and Toronto include emerging or set up innovation districts. In the United States, the most iconic districts can be found in the city facilities of Boston, Atlanta, Cambridge, Detroit, Philadelphia, Pittsburgh and St. Louis. In each of those innovation districts there is a combination of high-quality research universities, scientific and technological agencies, firms and complexes that trigger business expansion as well as commercial and residential growth. Movers to innodistricts include high-value and research-oriented sectors, such as life sciences, creative fields such as architecture, design, theater production, advertising and marketing and advertising and marketing. We even see a return to small-scale and personalized manufacturing activities, made viable by 3D printing and robotics. Much of this activity displays an indispensable rethinking of corporate activities around the concepts of innovation, open innovation, entrepreneurship, sustainability and the requisites for increased competitiveness (Katz & Wagner, 2014).

Barcelona is credited with creating the first innovation district with its Project 22 @ Barcelona, which began in 2000. 22 @ is perceived as a success and has become the pioneer model for other innovation districts, including the Innovation District from Boston.

> "Today, 70% of the industrial land in El Poblenou has been remodeled, led by 141 individual plans for this redevelopment. Since 2000, 4,500 companies that employ 56,000 workers have opened or moved to 22 @. Approximately 72% of the total employees in 22 @ have university studies" (Ajuntament de Barcelona, 2013, 16).

The 22 @ project also requires the continuing education of the community in information-oriented activities, such as coding, product design and training in IT services. Many universities have also established their presence at 22 @, such as the Pompeu Fabra University, the University of Barcelona, the Polytechnic University of Catalonia and the Open University of Catalonia.

> "Several incubators and accelerators have been created, such as the Biomedical Park, the MediaTic building and Barcelona Activa. The MediaTic Barcelona Growth Center is an innovation center that was built through a public-private partnership. The population of the area has grown by 130,000 people since 2000" (Ajuntament de Barcelona, 2012, 19).

The Boston Innovation District is the first innovation district officially labeled as such that is created in the United States. In May 2010, former Boston Mayor Thomas Menino announced plans for the city to develop 400 hectares of land in the South Boston Waterfront.

> "The Boston Innovation District is the fastest growing area in Boston today and has stimulated significant economic development in the city. Since the origin of the District, 5,000 new jobs have been created and more than 200 new businesses have been formed. 40% of companies located in the Innovation District share joint work spaces" (Boston Mayor´s Office, 2014, 33).

More than 1,100 housing units have been built, including 300 innovation micro units. The increase in rental prices in the Innovation District has raised concerns that rapid real estate development in the area

> "is discouraging entrepreneurs and emerging businesses, organizations and people that the District's own design intended to attract. In just a few years, rents increased by 43% at the seaport, and the trend continues today" (Ross, 2014, 31).

3. Challenges and Drawbacks: Masdar City

Masdar City is an example of urban innovation that ought not to be followed. A planned ecological city on the outskirts of Abu Dhabi, Masdar City was fully designed around clean technologies and renewable energy. The construction of Masdar City began in 2006. It was planned and designed as one of the most prominent attempts by the government of the United Arab Emirates "to diversify its economy in anticipation of the future depletion of oil reserves. Mubadala, a government company in Abu Dhabi dedicated to investing in major strategic projects, financed the Masdar City experiment with $ 22 billion" (del Cerro Santamaría, 2019, 221).

Günel has studied the origins and realization of Masdar, the environmental management policies in the new city, as well as the perceptions of the highly qualified professionals who designed it and put it to work (Günel, 2019).

Masdar leaders developed many innovative projects. They even planned a new "energy currency," called "Ergos." "Numerous paradoxes emerged during the development of the energy currency project. The currency would work by issuing "a balance of energy credits as a means to define and regulate an assigned energy budget," which sounds dangerously similar to the "social credit" system implemented in China." "In fact, although Ergos' purpose was to reduce energy consumption in Masdar, some project designers recognized that it could become a tool for a "technocratic dictatorship" (del Cerro Santamaría, 2019, 222).

Another outstanding project within Masdar is the driverless personal rapid transit system (PRTS). "It was intended to cover the entire city, but soon these plans were abandoned. The PRTS started working to take people to the parking lot. Many wondered why not travel such a short distance by bicycle or by foot. Günel shows some of the miseries of techno-futurism, where expectations and realizations are often clearly disconnected" (del Cerro Santamaría, 2019, 222).

Masdar's leaders devoted many efforts to formulating policies on a technology called "carbon capture storage" (CCS), which works by injecting carbon dioxide wastes into the soil, and it constitutes a very controversial climate change mitigation technology. Masdar leaders even made a proposal for the United Nations, and presented their proposal in the context of the Framework Convention on Climate Change (Ferguson, 2018).

As I have argued elsewhere, Masdar functions as an "innovation district" where the district is the entire city,

> "because the innovation component is at the center of its conception, both in design (planned and executed by Foster and Partners) and in content. Masdar can be seen with a multidimensional lens, as a "new city" and as a gated community. It resembles a technopolis similar to Tsukuba Science City in Japan, or King Abdullah University of Science and Technology (KAUST) in Saudi Arabia. It can also be seen as a special economic zone (SEZ) for the development of renewable energy and clean technologies" (del Cerro Santamaría, 2019, 222).

Like the most recent ecological city project in Dubai, The Sustainable City, Masdar can be seen as a prestigious megaproject aimed at promoting a brand, a paradigmatic case that applies the principles of neoliberal urbanism to which we are so accustomed. It could be said that it is a failed project, since it had become a ghost ecological city in 2016, and many of its initially designed components have not yet materialized as of Fall 2019. Masdar represents a deeply wrong approach to innovation districts and urban development.

4. Innodistricts and Ecodistricts

Masdar represents a failed innovation district. However, innodistricts are becoming widespread in Western cities. Innovation districts (*innodistricts*) are usually embedded in regional and national innovation systems, and include a number of stakeholders from civil society. In some cases, such as Barcelona @22, these districts are based on a government-led planning and investment effort, built on the premise that innovation districts can become both effective urban regeneration and economic development tools. Thus, the creation of an innovation district is usually "an attempt for the city to leverage its strengths and resources to emerge as a hub of innovation in the knowledge economy" (Carnes, 2016, 61).

Innovation districts show a wide typology depending on leadership, cluster-type, and firm-support programs.

> "In general, the move towards these innovation hubs reflects the growing importance of the geography of innovation to urban areas, and how developing industry clusters can deliver economic growth, employment and community regeneration. Brookings has called for local decision-makers, global companies and financial institutions, and government "to 'unleash', 'embrace', 'support and accelerate' innovation districts. The result: a step toward building a stronger, more sustainable and more inclusive economy" (Cameron, 2016, 53).

In the case of MIT´s Kendall Square,

> "the revitalization effort was also an attempt to aggregate international and local firms in a more concentrated geographic environment with hopes of fostering increased collaboration. Collaboration amongst the city-government, education institutions, and the private sector has contributed to the success of the district" (Carnes, 2016, 45).

In the case of Barcelona @22, the most important takeaway

> "is the particular validation of innovation districts as a sustainable urban economic regeneration tool. Through strategic programming and a robust planning model that emphasizes the physical, social, and economic aspects, the City of Barcelona has created one of the most successful innovation districts in the world" (Carnes, 2016, 47).

There are a number of requisites and constrains surrounding the development of innovation districts. Perhaps one of the main barriers to innovation district development is the current structure of incentives for investment privileging finance and property-led urban regeneration. A gradual shift-of-focus is required from built-environment investment to socio-economic output, from financial, real estate, property investments into innovation. As Marginson argues:

> "As long as the rewards for investment in financial assets are higher than the rewards for investment in knowledge-intensive industry innovation, the latter will be neglected […] This is a serious problem in the UK economy, where finance generating finance often seems to be the main game" (Marginson, 2016, 21).

Rather than primarily pursuing unrealistic growth targets through major capital-intensive projects (e.g. megaprojects), cities in developing regions should recognize their local context, history and culture and concentrate on their strengths to address priorities such as affordable housing, accessibility of public services and education, thus being able to create a resilient, long-term positive exponential impact (Dall´Orso, 2017).

Among the requisites for successful creation of innovation districts we find the value of collaboration

among stakeholders and investors. Today's most powerful innovation originates from collaboration, sharing of ideas, mashing up of radically different disciplines and technologies to create new solutions to new problems or to upgrade traditional industries. Effective multi-disciplinary, open collaboration requires intellectual density (concentration of skilled actors), diversity, tight proximity, strong networks and partnerships among citizens, businesses, laboratories, academic institutions and investors (Dall´Orso, 2019).

All innovation districts include physical, economic and networking assets. An innovation ecosystems results when these three assets combine in a context and culture that are prone to risk-taking. Such ecosystem often follows a triple-helix model whereby entrepreneurs tie up with universities and research centers to promote innovative thinking and practices supported by government funding. The role of universities is important because they are the actors that have the potential to increase revenues by fostering opportunities for R&D.

Capital, technology and the built environment constitute tangible assets in innovation district development. Intellectual density, impact innovation and social and economic networks are the intangible assets. Physical proximity and density of these key actors can be created in urban environments to foster collaborations. However, creating an entrepreneurial spirit also demands some social, cultural and behavioral aspects of crucial importance, which have to do with "intangible," long-term societal processes such as quality of education, leadership formation, business ethics, etc.

5. Components of Sustainability in Innodistricts

Innodistricts need to be designed as to mitigate environmental impacts. Attaining acceptable levels of environmental sustainability needs to become a priority for planners, developers and other stakeholders in innodistricts. However, the attainment of environmental sustainability does not in itself ensures innodistrict sustainability, a goal that needs to be pursued holistically. One way to do this is to use the notion of "key or multiple success factors" (Grunert & Ellegaard, 1992).

This notion is not new in the field of project management and, in fact, constitutes one of the topics most discussed by specialists. It is increasingly important "to evaluate projects and their impacts at different times and based on multiple criteria in order to fully evaluate their performance. Success is often driven by political and/or power-related factors" (Grunert & Ellegaard, 1992, 34).

Due to the strongly political nature of the stakeholders throughout the supply chain and their different underlying objectives, the success factors usually considered no longer seem sufficient. "Innovative governance solutions are required that align the interests of the different stakeholders in a complex environment with a large number of key actors" (Harris, 2017, 34).

By following the notion of "multiple success factors," we contend that there are a number of requirements that need to be met in order to achieve sustainable innodistricts: (1) environmental sustainability (sustainable infrastructure and sustainable development zones); (2) sustainability in design and planning; (3) sustainability in management; (4) institutional sustainability; and (5) socio-economic sustainability. Thus, an innodistrict can be defined as sustainable

> "if it is planned and executed to account for the capacity, fitness, resilience, diversity and balance of its urban ecosystem. We take the view of sustainability as an organic process including environment, economy and community: form and efficiency (environmental factors in design, architecture, engineering and construction) as well as policy (urban plans and practices that explicitly aim at maintaining and improving the social and economic well-being of citizens)" (del Cerro Santamaría, 2018, 7).

5.1 Environmental Sustainability

5.1.1 Sustainable Infrastructure

Cities now have the opportunity to raise the bar of urban infrastructure delivery to safeguard the natural environment and open the door to the next phase of socioeconomic development.

> "As cities and countries climb the industrial value ladder and expand their service sector to cater to growing domestic demand, environmental quality will become central to achieving sustainable economic growth. Urban residents in the more sophisticated markets are already putting a substantial price premium on high-quality urban environment. To attract the right labor pool, cities will need to raise their game further" (World Bank, 2018, 33).

The backbone of the next phase of infrastructure development

> "should be the "one-system" approach. Infrastructure planners need to consider the development of the entire city-wide infrastructure system, including its energy, transport, land, and water subsystems. Realizing the potential synergies between subsystems will require technology for real-time information, conservation pricing, and demand management" (Ness, 2018, 74).

Foreign infrastructure providers and experts with strong track records in these areas should be poised to make a major contribution to achieving higher infrastructure performance standards in the coming years.

> "Government stimulus and financing will also be critical. Central governments can redouble its commitment to environmental sustainability by continuing to pursue aggressive resource conservation and economic productivity targets, and by backing those efforts up with funding for investment in infrastructure" (United Nations, 2016, 41).

5.1.2 Sustainable Development Zones

Some countries such as China have taken steps to designate "sustainable development zones." Earlier this year, the Chinese government approved three sustainable development zones, which will implement the United Nations 2030 Sustainable Development Goals: Shenzhen, Guilin and Taiyuan.

> "Shenzhen is China's innovation engine. This zone will integrate technologies in sewage treatment, waste utilization, ecological restoration, and artificial intelligence to solve issues from resource management to pollution. Guilin will focus on innovations that tackle desertification, creating solutions that can be replicated by other regions facing the threat of encroaching deserts. In Taiyuan, targeting air and water pollution, this zone will foster innovative solutions that can be replicated by regions relying on resource extraction" (XinhuaNet, 2018, 22).

5.2 Sustainable Planning and Design

The planning of innodistricts should be oriented towards socially progressive goals and to ensure sustainable development rather than focus exclusively on growth and competition. Financial planning ought to avoid strategic misrepresentation of costs and benefits, and clauses should exist ensuring a fair distribution of benefits for the community at large. In the design process, contextual elements such as history and local culture

> "should be important factors to interpret architectural styles and to assign a specific meaning (local, regional, national, global) to the architectural practices used to build innodistricts and make them visible" (Del Cerro Santamaría, 2013, 21).

5.3 Sustainable Management

The management of innodistricts ought to avoid the "exclusivity bias" between planners and managers, who tend to see their projects as unique, which prevents them from learning from other projects. Flyvbjerg has pointed out that "there is often an excessive commitment to a certain project concept at an early stage, resulting in a "block" or "capture", which makes the analysis of alternatives unlikely and leads to ad hoc commitments in later stages" (Flyvbjerg, 2014, 14). We can add that the planning and management of innovation districts – and their sustainability components – does not obey the rules of a deterministic Newtonian world of cause, effect and control. Budgets and strategic priorities need to factor in the complex, uncertain, indeterminate, incomplete and undecidable nature of socio-economic development.

5.4 Institutional Sustainability

When studying innodistricts in connection with urban growth coalitions, we can ask ourselves if the form of development represented by these large projects simply legitimizes *growth machines* and commercial interests or if this phenomenon can be analyzed from the prism of the role that actors and state agencies play in urban restructuring and regeneration. Besides growth coalitions, the governance of innovation districts needs to take into account additional stakeholders in order to ensure institutional sustainability. There is no room in this paper to adequately develop this argument, but I will simply mention the following aspects that would need to be taken into account: (1) the role of civil society; (2) the role of local context, history and culture; (3) the importance of keeping urban variety and diversity; (4) the importance of megaproject local embeddedness; (5) the role of public space; (6) the role of urban design professionals.

5.5 Socio-Economic Sustainability

The embeddedness of the multiple scales of socio-economic action has paradoxically come along with a tendency towards providing innodistricts with their own strategic spatial planning and management tools that funcion independently of state and urban regulations. Thus, aligning the goals of those innodistricts with regional and national policies is expected to become a necessity. New institutional arrangements between administrative levels, vital for implementing strategic policies, need to emerge, due to the negative results of separating the primary objectives of the innodistricts from regional and national policy goals.

Therefore, innodistricts, usually planned as catalysts of urban development and regeneration, should be used at the national level as tools to advance sustainability policy. The result can be an optimization of sustainable policy outcomes due to synergistic, multiplier effects. From this perspective, the key question for future research would be how to plan and build innodistricts that simultaneously foster both sustainability and competitiveness.

6. Governance of Complex Sustainability

Innodistricts give us a good empirical reference to analyze the complexities of sustainability. This is an anthropocentric perspective on sustainability, which links it to entrepreneurship, innovation and competitiveness. In order to proceed towards a transdisciplinary framework guiding the governance of sustainability, however, we need to enrich such an approach to sustainability with contributions from new materialisms and transdisciplinary approaches, which favor a better understanding of sustainability's complexities, its mechanisms and purposes, and therefore its management.

The consensus established around the idea of sustainable urbanism tells us that we must strive to

> "maximize the efficiency of energy and material resources, create a zero waste system, support the production and consumption of renewable energy, promote the neutrality of carbon, or zero carbon footprint" (United Nations, 2016, 33).

We are also expected to reduce pollution, decrease transportation needs and encourage

> "walking and cycling, provide efficient and sustainable transportation, and preserve ecosystems. Scalability of the design and spatial proximity (compact cities) are emphasized, which promote livability and communities's sustainable prospects" (Lin & Gámez, 2018, 65).

The emission limits established by the European Union and other organizations, and the various ecological transition policies, determine what types of specific strategies should be implemented in each case and in each place (De Clara & Mayr, 2018). Indeed, although the *ethos* and *telos* of sustainability can be understood in a univocal way, it is a complex and multidimensional concept with many concrete variants, among other reasons because the zero or starting points of each human settlement differ.

"Complexity" refers to assemblages in which inseparability, inter-retroactivity, interactivity and interdependence prevail between the elements that form it and between the subject of knowledge and its context:

> "Pertinent knowledge must confront complexity. *Complexus* means that which is woven together. In fact there is complexity whenever the various elements (economic, political, sociological, psychological, emotional, mythological …) that compose a whole are inseparable, and there is inter-retroactive, interactive, interdependent tissue between the subject of knowledge and its context, the parts and the whole, the whole and the parts, the parts amongst themselves. Complexity is therefore the bond between unity and multiplicity. Developments proper to our planetary era confront us more frequently, ineluctably with the challenge of complexity" (Morin, 1999, 15).

The Latin word *complexus* means "intertwined", "twisted." We can define it as a joint or union of two or more things that constitute a unit and that is composed of different elements. Here we find the basic duality between parts that are at the same time different and connected, which indicates that something complex requires two or more components that are linked in such a way that it is difficult to separate them.

> "Since the components of a complex cannot be separated without destroying it, the method of analysis or decomposition into independent modules cannot be used to develop or simplify such complexes. This implies that complex entities will be difficult to model, that eventual models will be difficult to use for prediction or control, and that complex problems will be difficult to solve (they are *wicked problems*). Complexity contains simultaneously order (the connection between the components) and disorder (variety and heterogeneity) it is therefore permanently in unstable equilibrium, even to the edge of chaos" (Edmonds, 1996, 45).

Urban complexity can be said to emerge

> "from the decentralized and self-organizing webs, assemblages and networks of transactions and interactions among a wide range of heterogeneous actors, agents and stakeholders that typically occur at multiple scales in dynamic, fuzzy, changing and uncertain urban settings. These transactions and interactions of cooperation and competition, informed by serendipity

> and randomness, highlight agents' perceptions, choices, decisions and preferences" (Batty, 2008, 27).

Agents, actors, actants and stakeholders can be individual, community, city and regional, involving social, economic and political institutions. Their mutual interactions produce feedback loops that allow the adaptation of individual and group actors and the emergence of phenomena, patterns and outcomes (physical, behavioral, social, economic, ecological, environmental) that cannot be predicted by analyzing the particular webs, assemblages, networks and their constituents and components (Miller, 2016; Bunge, 2014; Alexander, 1965; Barabasi, 2003).

To the complex nature of sustainability contribute not only the scope and variable geometry of its own sustainable practices but also the overall socio-economic context where it has been recently developing and the situation of crisis and uncertainty to which is applied as a possible *strategy to contain systemic risks*.

Some elements in this situation are known: (1) the unpredictability introduced by the mechanisms of action at a distance in globalization and the increased inequalities and consequent transnational migration flows that has caused; (2) the complexity in the global territorial organization, which reflects an incessant *planetary urbanization* (Brenner & Schmid, 2011), but also the formidable challenges of the ecologies of towns and regions (Forman, 2019); (3) the relative decline of the West and the tectonic shift in the center of gravity of the global economy to Asia, coupled with geopolitical multipolarity and the rise of geo-economics and geo-technology (Lee, 2018); (4) the profound disruption of production and labor triggered by the informational and technological revolution of the last thirty years (Stiegler, 2019); (5) the emergent understanding of the Earth system as a variable, responsive, adaptive and self-regulating mechanism in the Anthropocene , which calls for re-centering (or, better, de-centering), within the universe of life, the human being and its mechanisms for the production of knowledge and transformation of the environment (Latour, 2016; Margulis, 1999).

7. Sustainability, Mind and Matter

The prevailing idea of sustainability evokes environmentalism without an environment and ecology devoid of living creatures that are not human beings. A standard definition of sustainability that remains in force is that expressed in the 1987 Brundtland report: development that "meets the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations, 1987). Not only are "generations" considered here to be human, but also the animate world is reduced to that which can satisfy human needs. Faced with this anthropocentric attitude, the new materialisms recognize the pre-eminence of objects, things and matter over mind and ideas (Harman, 2002). Its relevance comes from accepting that the open gaze to a radically transformed world and the observant attitude must prevail over the existing conceptions, visions, plans, analyses or solutions based on the schemes that created the problems that we need to solve.

Within urbanism,

> "the new materialisms propose to interpret the built environment as an inescapable material reality that can be understood from the outside, through 'the observation of concrete materials, not from the functioning of the isolated mind'. Jane Jacobs already noted that buildings, streets and neighborhoods function as dynamic organisms, changing in response to how people interact with them" (Sennett, 1992, 192; Jacobs, 2000, 35).

This perspective facilitates the understanding that city and nature (culture and nature) are very closely interrelated ideas. Both are organized complexity and both are distant from any self-regulating harmony.

> "Darwin does not celebrate nature as an autonomous and self -regulating internal harmonious relationships always returning to equilibrium, but the small differences that can suddenly become significant differences as a result of geographical drift and climate change. He is also interested in the kinds of transversal and cross-species relationships that generate new vectors of becoming leading in totally surprising directions, something very similar to what happens in the city as organized complexity" (Morton, 2009).

"Nature," then, is not "the other" in an increasingly urban world, but a new way of thinking

> "about the sustainable integration of all sentient beings and the environment. What we call "environment" is always a combination of nature and culture, and both express the creativity, emergence and self-organizing power of complex adaptive systems. In turn, the natural thing is the preservation of the world, that is, its sustainability, and this attitude is necessary above all in urban environments, but also in non-urbanized or hardly urbanized environments" (Morton, 2019, 37).

For this reason, the idea of *urban ecology* expresses the way of thinking about "the natural" in our time.

> "The anthropocentrism that underlies the dominant ecological vision is perhaps the main ideological obstacle that prevents the achievement of sustainability, since it does not treat nature as a community to which we belong but as an external ideal that must be pursued to save ourselves" (del Cerro Santamaría, 2020c).

Faced with anthropocentrism, the new materialisms invite us to know and re-know life, matter and the planet. We must not know by defining the objects of knowledge, but by responding to the immanence of vibrating matter, its influences, results and consequences. In this sense, the French sinologist François Jullien has stated that "a wise man does not have ideas" that are independent of matter (Jullien, 2001). Thus, if continue "sleepwalking" regarding the ecological crisis (Sklair, 2017) it is possibly because we have not acquired the capacity for mutual involvement with matter that allows us to be truly human (Bonshoms, 2007).

New materialisms can enable the adoption of more robust sustainability strategies by highlighting the connections between norms, technologies, and worlds of life through networks of human associations, natural ecologies, mechanisms, devices, places, and environments. The focus on matter allows us to move away from the secular attitude of placing humans at the center of reality and experience and instead look around to see the power of the "forgotten masses," that is, the artifacts that populate the world (Latour, 1992). A material conception of sustainability affects how we conceptualize space, place, scale and context, as "places" are places and environments that interact with the practice of the planning of development in significant ways. *Place* is not to be seen as a topological but as a relational space, a notion originating in Leibniz (Lefebvre, 1992). Such a relational notion is structured around configurations of humans, non-human life, and material artifacts.

The complexity of material sustainability is thus far from the formal harmony of a system; it is more like a whirlwind in motion or a heterogeneous, non-linear and non-hierarchical assemblage. He responds to the idea of "baroque complexity," where the parties are neither components of a cohesive whole nor insignificant and powerless, since they are not isolated (Beauregard, 2015).

The sustainability of the economic development process in conjunction with processes of capital mobility, the formation of network states or planetary urbanization, among other elements, can be approached from one material perspective where the global is intrinsic to the local and where mind and matter are part of the same assemblage.

8. Transdisciplinary Sustainability

Complex sustainability requires new analytical tools (or transforming the ones we have) to capture and understand the heterogeneous, dynamic and changing assemblages that cause the unpredictability and uncertainty of the Earth system in the Anthropocene. With this understanding, perhaps viable strategies to contain systemic risks can be forged in the "somber clarity of chaos," which does not invite us to expect a new order in the near future (Castells, 2018). The new materialisms point in this direction, as do transdisciplinary approaches (Gibbons, 1994).

In both cases (materialism and transdisciplinarity), the overcoming of binary logics and the distancing of anthropocentric approaches are postulated. The focus is on complexity, hybridization, non-linearity, reflexivity, and heterogeneity. As discussed above, in both cases it is assumed that sustainable development planning does not occur in a context of determinism where control, causes and effects can be used for establishing predictions. Instead, what we have is the high probability of finding events yielding extremely negative results.

Both sustainability and sustainable development are concepts that refer to the ability of systems to absorb disturbances, evolve and co-evolve with other systems with which they interact. It seems therefore reasonable that policies related to sustainability (pursuing a transformation of social organization and economic activity) be designed on the basis of a transdisciplinary perspective. By using such an approach, questions that are relevant to address systemic problems in changing environments can be formulated collaboratively with the analytical tools contributing to fully understand its complex nature.

Indeed, a transdisciplinary approach is advantageous in order to understand the complexity inherent in sustainability science, since pursuing sustainability requires understanding and managing unprecedented and interconnected challenges. Increasingly, science and knowledge production are geared towards overcoming of classic disciplinary questions and approaches, integrating perspectives of different *stakeholders* (experts and citizens, academics and professionals) and showing to be particularly receptive to contextual differences and local knowledge (Elmqvist et al, 2018; del Cerro Santamaría, 2019b, 2020a).

In addition to including the general principles of integration of *stakeholders*,

> "cooperation and containment of risks, transdisciplinary approaches to sustainability are usually oriented to scientific research on new technical and institutional alternatives. Indeed, knowledge innovation strategies are crucial to better align practices related to the use of resources with heterogeneous ecological and socioeconomic conditions, and to be able to adapt to unforeseen changes" (Brandt, 2013).

Although sustainability can be approached as a practice that unifies the base of material ecosystems and resilience (maintaining levels of activity and equity versus internal and external perturbations), from an interdisciplinary perspective the strategies and policy responses policies would need to consider the unpredictability, variability and heterogeneity inherent in the functioning of such eco-systems (Waltner-Toews, 2008).

The practice of transdisciplinary research still needs to develop significantly. There is no common glossary, not a shared communication platform or a single research framework. A transdisciplinary attitude and practice seeking integration, complexity and holism may not be capable of producing a shared instrumental canon, but it nevertheless fulfills its function by raising awareness about the need to co-create knowledge in the interstices between disciplines. From these gaps one can clearly observe the assemblages of material sustainability, which is not a problem to be solved, but a complex normative strategy whose mechanisms and purposes we need to understand better in order

to manage them effectively and handle them appropriately in a context socio-ecological concern (and even alarm), structural uncertainty and global risks.

9. Conclusions

Innovation districts share with most megaprojects their privileged position as fundamental particles in the development process aiming at significantly modify the structure of society and cities. However, innovation districts are presented by their promoters and some commentators as a major alternative to megaprojects, property-led urban regeneration and neoliberal urbanism strategies, an alternative that enhances, simultaneously, economic development, quality of life and sustainability.

There may be advantages in promoting innovation districts as opposed to property-led urban regeneration strategies via megaprojects. The drawbacks of megaprojects are well known: risk of gentrification, expectation shortfalls, cost overruns, spatial polarization, socio-spatial segregation, among others. Innovation districts are usually planned to focus on livability, regeneration, development, ecology and sustainability, and these are positive goals.

Innovation districts initially obey the logic of the market and the location decisions of specific companies. To meet this demand, many metropolitan governments have decided to plan and create innovation districts as a tool for development, regeneration and the global promotion of their cities. They are districts that generate economic value for cities, but one of the drawbacks is the large increases in the prices of housing and other goods and, sometimes, the population displacements they cause.

As with culture and tourism, which became catalysts for urban economic prosperity but at the same time triggered gentrification, innovation districts promote the increase of urban wealth, a process where we find both winners and losers. Without adequate public policies that limit their negative impact, innovation districts can cause processes of dualization and socio-economic polarization that are usually detrimental to the well-being of cities and countries.

In designing sustainable innovation districts, planners need to be aware of the inherently complex nature of sustainability and its multi-dimensional character. Ecological design by itself, or the goal of environmental sustainability, would fail at promoting a balanced and equitable pathway towards economic development unless other components, such as institutional and socio-economic sustainability, are factored in. These components ought to be the cornerstones of planning and management of innovation districts, cities and regions in developing countries.

Further research on innovation districts needs to take into account the synergic interactions within innovation ecosystems and between these ecosystems and their outside environments. In addition, we need a better understanding of the ways in which urban politics and policies can foster sustainable innovation districts, thus avoiding the unbalances of property development that is associated to the growth science & technology, and the knowledge economy.

Conflicts of interest

The author declares no conflicts of interest.

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