

Livable Districts and Cities CPC_004_Livable_Districts_and_Cities A CP Contribution to Test and Drive City Transformation Developed by the CPTSC and Chairs of Task Teams 3 December 2015

Executive Summary

Statement of Need

Successful cities in the twenty-first century will be those that embrace and leverage technology to develop, sustain and improve the quality of life for their inhabitants. In this context, quality of life relates specifically to livability. A livable district or city is a self-sufficient community that enjoys high levels of social equity, benefits from a healthy environment, and sustains a strong economy with returns through public and private sector investment and the creation of businesses and jobs.

This document addresses the transformation or creation of Livable Districts, in a context that can easily be extended to Livable Cities. Thus, for purposes of this document, the term Livable Districts should be understood to encompass the broader term Livable Cities.

Relationship to City Protocol Development.

Following the City Protocol Development Theme of **City Transformation**, specifically improving livability/quality of life, this document is inspired in part by the observation made by EcoDisctricts, a Portland based nonprofit: "the district is the optimal scale to accelerate sustainability —small enough to innovate quickly, and big enough to have a meaningful impact." This document seeks to advance this observation by assessing the concept of urban livability according to the three systems of the City Anatomy. In this anatomy terminology, a livable district or city is an urban community living in a **structure** that fulfills **societal** needs with highly performing **interactions**. Thus, it must be people oriented, for social equity and empowerment, and ICT enabled for enhanced performance and interactions. In Urban Ecology terminology, it is a **densely populated** and geographically cohesive urbanized area located within a city that has:

- (i) economic, environmental and social health (*i.e.*, is sustainable);
- (ii) **a good balance between structural elements** (environment, infrastructure and built domain) **and city functions** to deliver quality services and improve social interactions;
- (iii) **efficient metabolic cycles** and **mobility** (*i.e.*, employs technologies and design elements to reduce resource use and pollution, and improve productivity);
- (iv) **a participatory governance** with well-connected social networks and informed citizens who feel ownership of their district future; and
- (v) a human scale and safe living with attractive public spaces for socializing and improving quality of life and well-being.

These urban ecology elements map into the 10 action domains that are summarized in the

attached diagram. The first two domains, Context and Complex & Adaptive, should guide and frame all decision making processes related to city transformation since they respectively define any city reality, with its strengths and justification for being, and account for the intrinsic characteristics of a system of systems and interactions that cities are.



Action domains for livable districts or cities

Transformational actions can take place in the remaining eight domains, that have been clustered into four categories (colors) according to their close interrelationship. A forthcoming extension of this Contribution will document several city examples to show how the vision and transformational initiatives of several cities map into these action domains for urban livability. For example, the Olympic City of Rio de Janeiro has launched Vision Rio 500 to engage its citizens in the process of reaching a consensus, based upon a shared vision, on the best city projects for the future. The Mayor has established, in the early stages of his mandate, that Rio must: (i) be environmentally friendly (domains 6 & 7); (ii) deal with mobility integration (domains 3, 4 & 5); (iii) be socially integrated (domains 9 & 10); and (iv) use technology to be present (domain 7). The initiatives/projects already started and/or completed in Rio have, as a reference base, the context and the key elements that help sustain the complexity and adaptability of city life (domains 1 & 2).

This document ties into at least two Protocol Elements: The Problem Statement

(developing livable districts and cities despite the challenges presented in many places) and **Definition** (developing a definition of livable district or city that encourages collaboration across disciplines).

Approach and Target Users

This document examines human needs that livable districts and cities must respond to (Section 2). In Section 3 we review challenges to the development of livable districts and propose guidelines to transform such areas. The guidelines are organized (in Section 4) around ten domains where action is required to attain and sustain livable districts or cities: context, complex & adaptive (eco)system, urbanization & land use, public & common spaces, mobility, green spaces & biodiversity, metabolism, ICT – enabled, social cohesion, and governance. These domains stem from the elements proposed by urban ecology experts to measure sustainability in cities. A proposed Definition is presented in Section 5. Supporting documents about Green Districts and Indicators for Sustainability are reported as Annexes which can be respectively downloaded as separate files at: http://cityprotocol.cat/publications/green_districts; http://cityprotocol.cat/publications/indicators sustainability

The target users of this Contribution are the following: city officials; urban planners; community organizers and advocates; transit planners and managers; systems engineers; real estate developers.

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1. Introduction

A city is a system of systems, an arrangement and set of relationships and interactions among people who self-organize in a relatively large and permanent human settlement. This settlement is physically formed by the local environment, infrastructures and the built domain (including public spaces) that define its morphology.

The genesis of cities can be traced back to the Neolithic revolution when humans began to cultivate land and domesticate animals. These behaviors led to a gradual abandonment of nomadic lifestyles in favor of more permanent settlements. Over time critical services such as security, potable water and mobility systems, and critical attributes such as a thriving economy (commerce and jobs creation) and shared values (culture, information) became common elements that today characterize city dynamics worldwide. This is described in the <u>City Anatomy document</u> shown graphically in Figure 1. Successful 21st Century cities must respond to human motivation and needs,¹ attract talent, and be managed with visionary leadership to provide and balance social, environmental and economic development.

City Anatomy organizes the evaluation of cities as organic and dynamic collections of interconnected systems, establishing a common language and conceptual approach that can respond to the diversity of scale, environment and morphologies. As city officials, planners and citizens strive to meet the ever-evolving needs and paradigms of changing times, the City Anatomy construct enables assessment and evaluation of strategies to improve quality of life by focusing at the district level. These districts offer a manageable scale for analysis, planning and transformation, as they tend to be more homogeneous and therefore reflective of a place citizens feel connected to and invested in.

This document follows the City Protocol Development Theme of **City Transformation**, specifically improving livability/quality of life. It identifies first in Section 2 the human needs that citizens expect to be satisfied in livable cities and districts. The challenges and guidelines to transform existing districts into more livable ones (or to build such districts in new cities) are presented and discussed in Section 3. These guidelines are organized around the elements of sustainable cities (land use, public space and habitability, mobility and services, urban complexity, green spaces and biodiversity, urban metabolism, social cohesion, and management and governance) for which indicators have been developed and field tested². These sustainability elements, including context, have been extended into City Anatomy livability domains in Section 4. A Definition to inform Livable District/City creation

¹ Maslow AH (1943). A theory of Human Motivation. *Psychological Review*. 50: 370-396. See also: Koltko-Rivera ME (2006). Rediscovering the Later Version of Maslow's Hierarchy of Needs: Self-Transcendence and Opportunities for Theory, Research, and Unification. *Review of General Psychology*. 10(4): 302–317 ² http://bcnecologia.net/en/conceptual-model/ecological-urbanism.html

or transformation is proposed in Section 5^3 .



Figure 1: City Anatomy as the common foundation for the City Protocol

2. Urban Performance, Human Needs and Livability

2.1 Urban Performance

Recent studies⁴ have shown that:

 Metropolitan areas with lower polycentricity and higher urban primacy tend to associate with higher GDP per capita⁵. In addition, regions that contain large urban agglomerations grow their GDP per capita faster than those that do not⁶, with regional population density

³ This document addresses the transformation or creation of Livable Districts, in a context that can easily be extended to Livable Cities. Thus, for purposes of this document, the term Livable Districts should be understood to encompass the broader term Livable Cities.

⁴ Several International and Global Organizations, such as the OECD, collect and analyze city-related data. <u>http://stats.oecd.org/;</u>

⁵ Brezzi M., Veneri P (2014). Assessing Polycentric Urban Systems in the OECD: Country, Regional and Metropolitan Perspectives. *OECD Regional Development Working Papers*. 2014/01, OECD Publishing. http://dx.doi.org/10.1787/5jz5mpdkmvnr-en

⁶ Ahrend R, Schumann A (2014). Does Regional Economic Growth Depend on Proximity to Urban Centres? *OECD Regional Development Working Papers*. 2014/07, OECD Publishing. http://dx.doi.org/10.1787/5jz0t7fxh7wc-en

being highly correlated with economic growth.

- Regional growth is related to the physical distance and more significantly to time of travel to a large agglomeration of people/jobs outside of the region⁷.
- Urban productivity is influenced by city size and population size of nearby cities in the metropolitan region. Administrative fragmentation without coordination of local governance bodies impacts negatively on productivity.

Thus, urban environments with a compact city center and districts (*i.e.*, proximity of living and working places and diversity of transport solutions), local mix-of-uses, and good pedestrian access to public spaces, are the most efficient economically, socially and environmentally, tend to be safer, and are therefore models that perform at high levels. District regeneration or new developments should fulfill these efficiency recommendations.

2.2 Human Needs

Figure 2 lists the objective and subjective human needs in hierarchical order, with the basic ones at the bottom of the Maslow's pyramid and the higher level growth needs at the top. The 5 categories of needs proposed by Maslow in his motivational theory (physiological, safety, social, esteem and being [self-actualization]) have been expanded to add self-transcendence as a motivational status and two high level needs (cognitive and aesthetic)⁸.

Cities and districts are social constructs. Residents do not know the vast majority of the other inhabitants but all share basic quality of life needs, a perception of belonging, and a sense of community identity, all shown hierarchically in Figure 2. The formation of urban communities has also a biological component as a response to the socializing nature of humans, and to the need to create, innovate and share knowledge, and help and support each other at the highest level of transcendence. In many cities community identity encompasses a cultural appreciation of beauty for the urban landscape and the design of public spaces (open and closed) where people meet and interact.

The evolution of cities and urbanization within the spatial-temporal diversity of natural environments, cultural backgrounds, and social and economic realities is regularly challenged by a number of factors including population changes and the need to ensure the ever-evolving quality of life needs of city inhabitants.

⁷ Research reports and publications available at <u>https://lsecities.net/</u>. The set of studies carried out by the London School of Economics in collaboration with the Alfred Herrhausen Society on social equity, cities and energy: urban morphology and residential heat demand, and integrated city making, document exhaustively these and other findings in relation to urbanization and spatial city development world wide.

⁸ See McLeod SA (2007). Maslow's Hierarchy of Needs. http://www.simplypsychology.org/maslow.html



Figure 2: Human needs

2.3 Livability

Livability is the set of key elements in urban ecology that recognize and measure how quality of life in a district or city develops and can be improved by:

(i) developing, changing and/or transforming the city **structure** (natural and built environments, landscape, public spaces and the 6 infrastructures – communication, energy, water, matter, mobility and nature) to optimize performance (resilience, reliable and equitable delivery of city services, self-sufficiency, resource efficiency, etc.);

(ii) maximizing **interactions** by assuring universal accessibility (affordable, convenient and equitable) to all city functions (housing, jobs, education, health, security, leisure, culture, etc.) and utility infrastructures, and by fostering economic prosperity and opportunities, with an ICT–enabled environment; and

(iii) promoting participative governance, *i.e.*, empowering citizens and engaging them in all decision-making concerning **societal** issues, including urban planning and management.

Thus, livability can best be understood by mapping the community's quality of life onto the three systems of the City Anatomy depicted in Figure 1. In this anatomy terminology, a livable district is a urban community living in a **structure** that fulfills all **societal** needs with highly performing **interactions**, as discussed in subsections 2.1 and 2.2. Figure 3 highlights

this mapping by identifying some key livability elements in the city structure (blue), interactions (red) and society (green). This figure highlights that a livable district is also a sustainable community that enjoys social equity and environment benefits, and that generates a healthy circular economy with returns via investments and the creation of businesses and jobs. It should be noted that resilience, equity, self-sufficiency, cohesion and habitability are considered city performance indicators in the City Anatomy and, thus, belong to the system of Interactions.



Figure 3: Mapping of some key livability elements into the City Anatomy

Following this City Anatomy construct, a livable district is understood as a compact and dense green district⁹ distinguished by its responsible use of resources and minimal environmental impact through the adoption of appropriate technologies and design elements. Embedded in the foundations of such a district is the concept of space for socialization and community development, with citizen engagement in the process of governance and decision making in ways that will meaningfully influence the future of their district. The livable district is, in short, a densely populated and geographically cohesive urbanized area located within a city that has:

(i) economic, environmental and social health (*i.e.*, is sustainable);

⁹ Bouton SN, Newsome D, Woetzel J 2015. Building the cities of the future with green districts: Better design can make sense aesthetically, environmentally—and economically. McKinsey on Sustainability & Resource Productivity 3 (Summer 2015): 49-55.

(ii) a good balance between structural elements (environment, infrastructure and built domain) and city functions to deliver quality services and improve social interactions;

(iii) efficient metabolic cycles and mobility (*i.e.*, employs technologies and design elements to reduce resource use and pollution, and improve productivity);

(iv) participatory governance with well-connected social networks and informed citizens who feel ownership of their district future; and

(v) a human scale and safe living with attractive public spaces for socializing and improving quality of life and well-being.

A McKinsey & Company paper on Green Districts, which can be downloaded separately as Annex A at http://cityprotocol.org/publications/green_districts with permission of the authors, points out that better design can make sense not only environmentally and economically, but also aesthetically, linking "green" with the highest level needs in Figure 2. The top level human needs of creativity and innovation (*i.e.*, self-actualization and transcendence in the same figure) can also be more productively expressed at the district level. As noted by EcoDisctricts¹⁰, a Portland based nonprofit, "the district is the optimal scale to accelerate sustainability —small enough to innovate quickly, and big enough to have a meaningful impact." This statement summarizes very well the need to focus on districts on the journey towards livable cities. This City Protocol Contribution document is an effort to frame this proposition for sustainable development at the district level into the City Anatomy, together with useful and complementary proposals made by other organizations and cited herein.

Two inspiring approaches to livable districts are the conceptual model for ecological urbanism, proposed by BCNecologia, and the Global EcoDistrict[™] protocol, which will offer the possibility to register projects. The former approach of BCNecologia identifies compactness & functionality, complexity, efficiency and social cohesion as the backbone of ecological urbanism and, as previously mentioned, proposes to evaluate cities in eight fields that, along with the City Anatomy Indicators set out in CPA-PR_002_Anatomy_Indicators, are the basis of the ten domains defined here in terms of both livability and the City Anatomy taxonomy: context; urbanization & land use; public & common spaces; mobility; complex & adaptive (eco)system; green space & biodiversity; metabolism; social cohesion; and governance.

The McKinsey & Company paper offers an interesting insight analysis on how to build cities of the future with green districts. This short but useful document moves beyond the typical description of the environmental benefits offered by green districts and examines their

¹⁰ The Global EcoDistricts Protocol. http://ecodistricts.org/protocol/

economic viability in three different world regions (North America, China and the Persian Gulf). The analysis shows that green districts are viable if planners match the right technologies to the location by considering climate, resource costs, regulation, and technology costs (including subsidies) and a careful consideration of investment and operating costs. In addition, the analysis exemplifies how districts can improve quality of life and suggests ways of shifting from the traditional business model of developers selling properties as quickly as possible to a model where developers themselves, or perhaps cities or land owners, own and operate the assets until they recoup additional costs.

The website of the EC Regional Policy¹¹ offers a set of resources that include a toolkit to facilitate development of a city project for sustainable cities¹². It offers the selection of a preset of actions that best suit city priorities and strategy, choosing the level of commitment on each and evaluating the relevance of the choices made.

The Indicators for Sustainability study carried out by Sustainable Cities, with the financial support of the Canadian International Development Agency¹³, examines and documents the work that several cities worldwide have made towards establishing indicators to monitor the success of their sustainability plans. The work helps identify the commonalities among the cities analyzed and, as a result, proposes a toolkit to guide other cities that may establish or develop sustainability projects with relevant indicators¹⁴. This document can be downloaded separately as Annex B at http://cityprotocol.cat/publications/indicators_sustainability. Finally, the most popular assessments and certifications of building sustainability (*e.g.*, BREEAM, LEED, POLE BDM and PASSIVHAUS) have been considered since buildings are the basic element of neighborhoods and districts.

3. Morphology Challenges to City-to-City Collaboration for Livable Districts

The global diversity of urban topologies and morphologies presents a challenge for the quick adoption, adaptation and implementation of successful district developments. Even the approximate number of Urban Fabrics that exist in the world of cities is still an unknown. Urban communities can be examined at the scale of a block or a development area (100 x 100m), at the scale of a neighborhood (1,000 x 1,000m) and at the scales of a district, city or region (10,000 x 10,000m in different locations), as indicated in the City Anatomy document

¹¹ <u>http://ec.europa.eu/regional_policy/index.cfm/en/</u>

¹² http://www.rfsc.eu/

¹³ Indicators for Sustainability. http://sustainablecities.net/our-resources/document-library/doc_download/232indicators-for-sustainability

¹⁴ The City Anatomy Indicators proposed in CPA-PR_002_Anatomy_indicators are of equally important use in this regard

and depicted in Figure 1. Density Atlas¹⁵, an organization dedicated to planning, design and development of resources for comparing urban density around the world, defines scale as the extent of land being measured.

The Density Atlas identifies in a typical metropolitan region the three levels of scale shown in Figure 4 for three different locations: Hong Kong, Paris and Boston. This figure is an adaptation of the original illustration on scales reported at the website of Density Atlas to merge it with the City Anatomy format for the Built Domain. Users of the current document on livable districts are encouraged to access all the resources and case studies provided by the Density Atlas organization as well as those of the Lincoln Institute of Land Policy¹⁶. The recently published Demographia World Urban Areas document¹⁷ reports a complete and upto-date inventory of population, corresponding land area and population density for urban areas with more than 500,000 population, with a consistent definition to built-up urban areas.



BLOCK OR DEVELOPMENT AREA Pixel analysis 100m x 100m

Scale A

This level typically includes one block or a few small blocks, with few or no supporting services within its boundary. Note that FAR is typically higher at Scale A than at Scale B, since less non-residential space is required for smaller sites



Scale B NEIGHBORHOOD Pixel analysis 1,000m x 1,000m

This level is defined as a cluster of walkable blocs with some local services. Many new developments, especially in the developing world, are of this size. These clusters include some neighborhood services and open space, but are still mostly self-contained



Scale C DISTRICT / CITY / REGION Pixel analysis 10,000m x 10,000m

At the district, city and regional scales, the elements affecting overall density increase dramatically, rendering macro-level density measurements that are less meaningful. FAR does not apply to these levels, since the variability across areas at these scales is too large



Tseung Kwan O Statio

Hong Kong





Paris

Tent Citv Boston

Faubourg Saint Anto Paris





Figure 4. Examples of scales in cities. This figure has been adapted from the original in Density Atlas (http://densityatlas.org/measuring/scale.shtml) to make it compatible with the City Anatomy formats. FAR is the floor area ratio.

15 http://densityatlas.org/

¹⁶ http://www.lincolninst.edu/

¹⁷ http://www.demographia.com/db-worldua.pdf

The diversity of physical forms depicted in Figure 4 can be further visualized with the comparison of some examples of urban fabrics. Figure 5 presents the urban fabric of the district of Al-Dhafrah in Abu Dhabi. It includes the nomenclature and metrics for Edification (E) + Parceling (P) + Urbanization (U) that was proposed and used to characterize fabrics.



Figure 5. Urban fabric of Al-Dhafrah district (Abu Dhabi) with information on Edification (E), Urbanization (U) and Parceling (P)



Figure 6. Examples of urban fabrics with Edifications (E) ranging from disperse low-rise residential and industrial to compact med-rise with mix-of-uses

Figure 6 provides some examples of fabrics with different edification and uses. Examples in Figures 5 and 6 have been facilitated by the Institute of Advanced Architecture of Catalonia (IAAC)¹⁸. The variety of physical structures in this figure suggests that the study of urban fabrics coupled with climate, social and economic information of each district would facilitate the systematic analysis and classification of transformational projects worldwide and contribute to city-to-city collaboration and learning.

4. Livable Districts

4.1 Methodology

The principles and values that inspire the planning and development of livable district projects should also be an integral part of the methodology applied to achieve the targeted actions. For example, without transparency and trust, community participation and stakeholder engagement will be a fallacy and the sustained success of any livability initiative will be put at risk.

A district regeneration initiative focused on improving its livability, or the creation of a new livable district, can be developed, implemented and improved following the four-step Deming cycle (*e.g.,* plan–do–check–act). The methodology adopted here and depicted in Figure 7 has been extended to five phases to emphasize the participatory nature of the process.



Figure 7. Methodology to progressively develop livable districts

¹⁸ http://iaac.net/

The five stages to plan and develop livable district projects are:

- 1. Observe and set the vision. A baseline evaluation of the district status quo is needed to identify hotspots. Grasping the realities of the district status quo with qualitative and quantitative information is necessary to share objective transformational challenges and perceptions about needed actions with the community. This is the starting point to establish a shared community vision that is self-motivational and triggers continuous community engagement and participation. Equity issues relevant to sustainability and wellbeing that could conflict with patterns of economic development and environmental protection should be clearly identified at this time.
- Establish priorities and decide on the most appropriate projects and a realistic timeline according to economic capacity and resources available. This must be accomplished with the participation of stakeholders to ensure commitment and engagement to the action plan and its deployment.
- 3. Develop an Action Plan towards the agreed priorities within the ten domains described in Subsection 4.2 below. This Action Plan should:
 - establish goals, strategies, actions, policies, execution measures, and a procedure to continuously monitor, report, review and revise the Action Plan;
 - implement a process to manage and resolve conflicts among stakeholders, private developers, public agencies and service providers;
 - develop a business model identifying credible financial resources and mechanisms, and the correct sequencing of investments. Include life-cycle analysis as much as possible in the financing decision making process. Make a clear assignment of responsibilities within the city and district departments, offices and staff (and stakeholders if necessary);
 - select a set of indicators by adopting those that have been published as standards (*e.g.*, ISO 37120¹⁹) and extended by the CPS (CPA-PR_002_Anatomy_Indicators), by public administrations, and by other organizations (*e.g.*, EcoDistricts and Sustainable Cities; the latter can be downloaded separately as Annex B). This topic of indicators exemplifies the benefit of collaborating with and learning from experiences in other cities²⁰. Well documented case studies for the cites of Bogotá, Buenos Aires, Ilhéus,

¹⁹

http://publicaa.ansi.org/sites/apdl/ANSI%20Network%20on%20Smart%20and%20Sustainable%20Cities/ISO+371 20-2014 preview final v2.pdf

²⁰ It should be noted that cities choose indicators on the basis of data availability, which is very city-specific. As a consequence, the current document focuses only on framing the domains for action within the City Anatomy (see subsection 4.2), with actions and specific targets, without identifying or suggesting indicators.

Portland, Durban, Kitakyushu, Singapore, Sydney, Yangzhou, Barcelona, Dublin, and Tel Aviv – Yafo are described in Annex B.

- 4. Execute the Action Plan using implementation strategies, execution measures, and transparent communication and reporting channels. Share progress with citizens and stakeholders. Adhere to an agreed timeline. The implementation strategies should be continuously reviewed and revised during this execution stage.
- 5. Monitor results over time to evaluate and understand the impact of the livable project. Document the experience.

The five-step cyclic methodology summarized in Figure 7, and the key actions described in the 10 domains for livable districts presented below in subsection 4.2, align with the Aalborg Commitments established and adopted by 620 local governments in Europe in 1994 and 2004²¹. Annex B lists these commitments.

4.2 Action Domains

DOMAIN	ACTIONS	SPECIFIC TARGETS
Context (Global, Regional & Local)	SWOT of city's status quo Adopt education and awareness strategies to facilitate citizen engagement. Identify global organizations that provide guidance, success stories and choices.	Involve citizens in the identification of city's status quo and opportunities for livability. Document, catalog and protect cultural, architectural and natural heritage. Nominate a Cooperation Officer to manage collaboration with different level regional, national and international authorities. Participate in international organizations that promote City-led transformational projects.
Complex Adaptive (eco)System	Ensure social interactions for community building, interdependence and social resilience. Promote diversity of urban functions by balancing living with other activities. Update mobility infrastructures to increase spatial and functional street continuity. Support knowledge intensive activities. Create public facilities	Ensure that multi purpose built or reclaimed public spaces promote social interaction and act as structural attractors. Favor functional street continuity of services and of diverse business and professionals so that they act as functional attractors. Plan for an evenly distributed and diverse urban functions within the district. Promote the creation of units for professional training, higher education and research. Plan and document short, periodic, individual and collaborative district activities. Promote social entrepreneurship and co- working, and good corporate practice.

²¹ <u>http://ec.europa.eu/environment/urban/aalborg.htm</u>

	aiming at innovation, creativity and co-working.	Develop and sustain cultural systems. Create or restore iconic buildings to increase visibility and vitalize district activity.
Urbanization & land use	Optimize use of land focusing on optimal high density of urban housing/dwellings, absolute compactness and proximity of services. City planning to ensure mix-of-uses and connectivity.	Develop a shared long-term vision, with livability principles and a participatory, open, accountable and transparent decision-making processes at the core. Regulate densities with mix-of-uses and proximity of jobs, housing and services. Support conservation and design practice in accordance with local conditions.
Public & common spaces	City planning to ensure a reasonable number and total surface area of livable public spaces. Facilitate connectivity between all built and natural public spaces.	Develop guidelines for multi purpose public spaces with physiological performance, <i>i.e.</i> , air and soil quality, acoustic and thermal comfort, ergonomics, connectivity, spatial proportions, and social and green perceptions. Ensure equitable access. Restore, reclaim, and redesign mobility infrastructures into public spaces (<i>e.g.</i> , street sidewalks, pedestrian networks, and transformed infrastructures).
Mobility	Develop an integrated, multi-modal urban mobility plan. Adapt public transportation to the urban morphology to increase its use and reduce time of travel. Reduce negative impacts of transport on public, environmental, and economic health.	Availability and proximity to clean, affordable, convenient and reliable public transportation. Feasibility of safe human powered modes of transportation (walk, run, bike). Prioritization of low-emission vehicles. Reorganization of mobility networks with superblocks and regulated private and goods distribution traffic. Assessment and regulation of micro-transit alternatives.
Green spaces & biodiversity	Promote environmental health. Increase biodiversity, promote productive agricultural land and forestry, and maintain physical factors in district habitat. Design green infrastructure with aesthetic quality.	Commit to the protection and preservation of the nature infrastructure and ensure equitable access for all citizens. Availability and proximity to the nature infrastructure in all public spaces and to agricultural land. Ensure biodiversity of flora and fauna and connectivity in the nature infrastructure. Improve the quality of soil and its permeability (porosity).
Metabolism	Promote responsible consumption and lifestyle. Manage energy, water and matter with self-sufficiency and resource efficiency objectives.	Circular City. Ensure resilience of district structure (infrastructures and built domain). Integrate management and operations of all infrastructures.

	Reduce water and carbon footprints to improve environmental quality. Waste prevention and product-life extension	Reduce consumption of primary energy from non-renewable or renewable sources. Promote renewable energy sources (solar, wind, tidal, biomass and geothermal). Reduce water consumption, treat and reuse waste water and minimize loses in the distribution network. Increase energy and water efficiency in buildings and public spaces. Promote a local sustainable production and a responsible consumption of food. Favor the use of environmentally friendly and recyclable materials in the public space. Implement waste management process with 3Rs policies and waste-to-energy solutions that favor local neighborhood and businesses. Improve indoor and outdoor air quality.
ICT - Enabled	Implement and manage a diversified communication infrastructure to assure multiplatform, multimodal and multi-object connectivity. Ensure a transparent and efficient flow of information.	Provide ICT services to efficiently manage and enhance all actions listed in the action domains for livability, especially those supporting the performance of economy, services and urban metabolism. Ensure people's interactions and governance. Support end-user access to ICT and apps, especially for vulnerable populations.
Social Cohesion	Ensure wealth production and distribution, <i>i.e.</i> , social and economic resilience. Leverage technology and social equity. Facilitate investments in the public sector with project agglomeration strategies. Ensure safe living environments.	Ensure affordable housing with universal access to services and public facilities. Transform neighborhoods into inclusive and supportive communities with social programs to mitigate inequalities, the creation of new businesses, access to secure and healthy food, care system for the elderly, activities to incorporate non-residents into community life, with out-school activities to generate opportunities for all, social housing and public facilities in deprived district areas, and voluntary work. Decrease the technology gap in vulnerable populations. Leverage technology in ways that increase opportunities across social and economic demographics. Approve regulations to incorporate social equity and quality of life in urban planning. Adapt current urban and tax regulations to facilitate and promote district equity.
Governance	Integrate policymaking with service delivery.	Engage in community conversation with open access to all information, regular meetings and a participatory decision making process.

	Integrate governance. Deliver Accountability	Protect citizens' rights with an ombudsman office to mediate and manage conflicts.
	Enhance social empowerment and engagement.	Facilitate project agglomeration to attract investments either directly or by means of Public, Private, People Partnerships (PPPP).
	Adopt strategies to facilitate capacity development	Develop information material of district activities, ongoing projects and initiatives, and
	Manage all finances in an integrated manner to increase economic health and competitive resource- efficient economy (circular economy).	results. Disseminate information via social media, apps and also in printed format.
		Develop educational hands-on materials to increase knowledge and awareness about district operation, and also about the risks and opportunities of managing open, complex and adaptive systems.

Table 1. Guidelines for the regeneration or the construction of livable districts

A city, a district, a neighborhood, a building or a house are each ecosystems of different sizes. A system is a set of interacting, interrelated, or interdependent physicochemical elements than can be identified to form a complex whole. The system is called ecosystem when there are biological organisms or living entities among the elements. The 10 domains listed in Table 1, which are described in the subsections below, guide the regeneration of districts or the construction of new ones with livability principles by proposing actions with specific targets. The 10 subsections that follow explain and frame these action domains and targets.

They have been selected with the following criteria:

- (i) identify the most significant actions and specific targets that might be considered when planning for livable development;
- (ii) frame all initiatives within the City Anatomy taxonomy and its system-approach (structure, interactions and society) to facilitate city-to-city collaboration and learning. The description of each of the 10 domains includes a list of related terms/elements labeled according to the City Anatomy to understand implications and to also facilitate the extension of the foundational city anatomy ontology (CPA-PR_003_Anatomy_Ontology);
- (iii) be compatible with the methodologies, objectives and the guidelines for the selection of indicators for sustainable cities proposed elsewhere (see Annexes). The current action plan does not consider the selection of any measures or descriptors for sustainability since they can be easily derived from the specific targets in each domain;
- (iv) be consistent with the ecosystem principles that inspired the City Anatomy and the urban

ecology approach that has been successfully applied to auditing, certification and accreditation of the quality and sustainability of cities.²²

4.2.1 Global, Regional and Local Context

The first step toward city or district transformation is recognizing the value of the status quo: how does it perform overall? how does it respond to quality of life needs and service delivery? is it scalable and resilient? how does it reflect current cultural values? This includes assessing how culture has influenced the structure of the city environment (biodiversity, resources, and quality of environmental compartments), infrastructures and built domain, the social environment (diversity, tangible and intangible social expressions, heritage, city knowledge, etc.) and vice versa. Context should be understood beyond cultural sustainability and consider environmental impact (*i.e.*, maximum self-sufficiency in energy, water and matter), the local, regional and global economy, and the body of laws and regulations that supports city governance.

The candid recognition of the status quo context should inform the development of livability projects by focusing upon the specific potentialities that all urban communities have (*i.e.,* focus on the solutions rather than on the issues), and a better understanding of current cultural values that will inform proposed citizen engagement and the sense of belonging (social need in Fig. 2). Learning from successes and failures in projects undertaken in the past by the city, or by other cities with a similar district context and fabric, should increase viability of any transformational or regeneration project. A SWOT analysis might prove especially useful at this stage.

<u>Actions</u>

- 1. Analyze strengths and weaknesses of district status quo to properly plan for livable district development.
- 2. Adopt education and awareness strategies to embed into the local culture the principles of livability development; adopt training programs to enable citizens to keep pace with livable district innovations, jobs and economies.
- 3. Identify city-led organizations, like the City Protocol Society, whose projects and activities could provide: (i) guidance to circumvent institutional barriers to city/district transformation for livability; (ii) success stories to set-up vision, objectives and priorities; (iii) participation in global city-to-city collaboration and learning; (iv) rapid policy transfer between similar but separated locations; (v) a collaboration platform to share know-how; (vi) up-to-date information regarding alternatives that could lower costs and risks

²² Rueda S, Cormenzana B, Vidal M (2012). Guía metodológica para los sistemas de auditoría, certificación o acreditación de la calidad y sostenibilidad en el medio urbano. ISBN 978-84-498-0914-9

(including public/private/people partnerships); and (vii) access to creative city/district solutions with interoperable information.

Specific targets

- 1. Involve citizens in the identification of city or district status quo and opportunities for livability.
- 2. Document and catalog cultural, architectural and natural heritage.
- 3. Nominate a Cooperation Officer to manage collaboration with different level regional, national and international authorities.
- 4. Participate in international organizations that promote city-led transformational projects.

Keywords with anatomy labels

• Structure

Infrastructure: re-appropriation

<u>Built domain</u>: reclamation, reuse, rehabilitation, revalorization, re-appreciation, reconversion, revitalization

o Interactions

<u>Functions</u>: education, training, environmental jobs <u>Economy</u>: finances, investment, tax, subsidies <u>Culture</u>: cultural heritage, architectural heritage, natural heritage, tradition, values, symbols, cultural sustainability, food culture <u>Information</u>: interoperable information

o Society

<u>Citizens</u>: knowledge, lifestyle, identity, sense of belonging, awareness, status quo, participation, engagement, empowerment, open politics <u>Government</u>: vision, shared leadership, long-term goals, decision-making, participatory governance, ombudsman, mediation, collaboration, cooperation, transparency, accountability, open decisions

4.2.2 Complex Adaptive (eco)System

A city is a system of systems and interactions, an ecosystem where living entities (humans) interact (flow of information and data) with the physical structure that supports the system (see Figs. 1 and 3). Given the non-linear dynamics of the networked interactions that occur in cities and their proven historical capacity to respond to changing situations, they can be considered, understood and described as Complex Adaptive (eco)Systems (CAS). Complex

and adaptive systems, like cities, have self-organization behaviors around attractors^{23,24} that are observable at the larger scales (*i.e.*, at district and city scales) together with the emergence of new structures resulting from local interactions between adapting and interacting individuals (*i.e.*, smaller scales).

Cities are the result of self-organization first around the environment (and climate) of the physical location, and later around the infrastructures and built domain made by their inhabitants. Every layer of early urbanization together with human-made attractors, either functional (services) or structural (infrastructures to access services and provide public spaces to socialize), became more diverse, added more interactions in city life and, thus, more complex city patterns. This complexity increases with the passage of time and the increase of city population.

Cities that evolved in Europe following this process of increased systems complexity tend to be compact. The result is cities with versatile and hybridized uses, that optimize resources by occupying the public space with activities and interactions (including information) that accommodate diversity with a minimum built footprint. This urban model that emerged and evolved over time differs from that of a city with districts specialized according to uses (through modern "zoning") and connected with giant transport networks. The former compact urban development pattern, with a more intensive and mixed land use, is characterized by an enhanced number of interactions per unit time, which triggers a more connected and inclusive social development and unleashes the full economic and innovation potential of cities (as discussed in Section 2).

As a consequence, emergent behaviors in district and cities cannot be inferred directly from the linear or additive behavior, knowledge and understanding of the individual smaller parts and scales of the system. Nevertheless, emergence can help us understand the genesis of communities, understood as dynamic networks of complex interactions at all scales, to better guide the evolution towards livable districts and cities. Measures can be progressively applied in districts to encourage these interactions and revert community disaggregation. Simply promoting mix-of uses, with more homogeneous residential occupation, and creating public spaces like small-scale ecosystems where human, non-human, nature, and resources coexist in the same space, can guide district development or regeneration. The adaptive characteristics bring in itself stability (*i.e.*, district resilience).

It should be noted that social interactions, in addition to promoting inclusion, solidarity,

²³ Sanders, TI (2008). Complex Systems Thinking and New Urbanism. New Urbanism and Beyond: Designing Cities for the Future. Tigran Haas (editor). Rizzoli, New York

²⁴ http://www.complexsys.org/ http://www.complexsys.org/

recognition of difference, acceptance of the other, helping the other, etc., also encourage the exchange of information, social learning, individual and collective knowledge building which fosters the development of collective intelligence, interdisciplinary initiatives, hybridization, innovation, networking, etc.

Actions:

- 1. Ensure social interactions for community building, interdependence and social resilience.
- 2. Promote diversity of urban functions by balancing living with other activities available or accessible nearby.
- 3. Plan to update mobility infrastructures to increase spatial and functional street continuity.
- 4. Support knowledge intensive activities within the community.
- 5. Create public facilities where innovation, creativity and collaborative activities could be carried out.

Specific targets:

- 1. Ensure that the multi-purpose built or reclaimed public spaces described in the action plan act as structural attractors and favor the development of activities that promote at a small scale the type of interactions that we aim for at the neighborhood/district scale.
- 2. Favor business and professional diversity in the occupation of office or commercial spaces to assure functional continuity and that they act as functional attractors.
- 3. Plan for an evenly distributed and diverse urban functions within the district.
- 4. Collaborate with professional training, higher education, and/or research institutions to promote the creation of units or affiliated colleges in small district or nearby campuses.
- 5. Plan and document short, periodic, individual and collaborative district activities, open or directed, aimed at making the district more livable.
- 6. Promote social entrepreneurship and co-working, and good corporate practice in local businesses and nonprofits.
- 7. Create an iconic building for a city function (museum, concert hall, etc.) that could increase visibility and enliven district activity and interactions, while promoting local tourism.

Keywords with anatomy labels:

o Structure

Infrastructures: infrastructures reclaimed for public use

<u>Built domain</u>: @ district, innovation district, complete street, structural attractors, zoning, mixed land use, multi-purpose public space, reclaimed public space, seclusion space

o Interactions

<u>Functions</u>: functional attractors, hybridization, versatility <u>Economy</u>: open innovation <u>Culture</u>: open culture <u>Information</u>: non-linear dynamics, knowledge sharing, networking, interdisciplinary, multidisciplinary, social resilience

o Society

<u>Citizens</u>: self-organization, co-working organizations, emergent behavior, social learning, collaborative innovation, creative synergy, collective intelligence, community building, interdependence, knowledge activities, capacity development <u>Government</u>: adaptive planning, adaptive strategies

4.2.3 Urbanization and Land Use

The attainment of a City's vision and long-term objectives strongly depends on how urbanization takes place (*i.e.*, how land consumption and optimization of use is managed) by efficient use of local resources and the densification and diversification of the population fabric. Cities are responsible for their local geophysical and environmental resources.

Urbanization of the land is the process by which value is added by means of occupation, development and use. Infrastructures channel the flows of information, energy, water, matter, people, and nature within the city and across city boundaries. This pattern of occupation, development and use results in community and society development and a set of interactions that are identified as city functions (or services to citizens), culture, economy and information. Society establishes a local governance to regulate city planning through appropriate policies that balance all interests involved in urban development (*i.e.*, citizens, stakeholders, private developers, public agencies and service providers).

The built domain emerges from the process described above to create different urbanization patterns and parceling, as shown in Figures 5 and 6. The evidence on urban performance presented and discussed in Section 2 indicates that the density of people and city functions, driven by compactness²⁵, is a dominant precondition for sustainability and livability. Compact and less scattered occupations have a lower built footprint and lesser impact on the natural environment. In addition, these occupations imply a greater proximity to services or city functions, more social interaction and connectivity.

Mix-of-uses should also be part of the dense occupation strategy to assure intense usage (24/24 and 7/7) of the built domain. Thus, buildings should be very adaptive since they

²⁵ Hofstad H (2012). Compact city development: High ideals and emerging practices. *European Journal of Spatial Development*. Art. No. 49, October

should respond to changing types of occupation over time. Excessive neighborhood density and compactness can cause the built domain to go beyond human scale and alter environmental conditions like wind movement and thermal conditions in the public spaces.

Cities are complex and adaptive ecosystems. As such, urban planning should guide their evolution rather than attempt to determine it²⁶. A largely unplanned urbanization process is quite consistent with the complex system approach in highly evolutionary ecosystems, such as cities, where the number of interactions among people, and between those people and the city structure, are huge. As mentioned in this reference, "cities should be encouraged to evolve spontaneously in the direction of achieving the best open-ended expression of our collective nature."

Of course the absence of a structured planning process carries with it risks that a few powerful interests (developers, construction industries) will fill the vacuum and proceed with projects that are neither sustainable nor likely to lead to a livable district. Balance and vigilance are critical to ensure that planning processes are in place to prevent such outcomes.

Actions:

- 1. Optimize the use of land with urban planning initiatives and regulations that prioritize:
- o Optimal high density of urban housing/dwellings
- o Absolute compactness
- o Proximity of services
- City planning to ensure mix-of-uses in all blocks and a good balance of conflicting interests between citizens, stakeholders, private developers, public agencies and service providers.

Specific targets:

- 1. Develop a shared and evolving long-term vision:
- o Participatory, open, accountable and transparent decision-making processes
- o Livability at the core of urban decision-making processes
- 2. Regulate appropriate urban densities:
- o Re-use and regenerate disadvantaged or neglected areas
- Avoid or revert urban sprawl
- Mixed use of buildings with proximity of jobs, housing and other services
- o Occupation of built domain with a good balance of jobs, housing and services across the

²⁶ Bettencourt LMA (2013). The kind of problem the city is. Santa Fe Institute working paper 2013-03-008 (and references therein)

district

- 3. Support conservation and sustainable design practice:
- o Cultural and architectural heritage
- o Design and construction that match local climatic conditions and resources
- o Design a morphology with high connectivity
- Building technologies that are up-to-date

Keywords with anatomy labels:

• Structure

Environment: wind channeling, resources

Infrastructure: connectivity

<u>Built Domain</u>: land use, land optimization, subdivision, parceling, densification, compactness, built footprint, re-appropriation, reuse, rehabilitation, revalorization, regeneration, re-appreciation, flexibility, adaptability, design, pattern of occupation, morphology, urban sprawl, zoning

 \circ Interactions

<u>Functions</u>: use intensification. balance of services, mix-of-uses <u>Culture</u>: heritage <u>Information</u>: property registry

o Society

<u>Citizens</u>: collaboration, cooperation, community development, capacity development, population fabric

<u>Government</u>: long-term vision, planning, long-term goals, decision-making, regulations, planning, priorities, policies, transparency, accountability, open decisions, reporting

4.2.4 Public and Common Spaces

Squares, public urban recreational areas, parks, playgrounds, and plazas are the most common public spaces, (*i.e.*, open and universally accessible urban spaces). Some common areas of buildings can also be included into this category of the built domain. European cities often make their streetscapes more accessible and pedestrian-friendly, in part by leveraging green infrastructure. Even though in most cases the streetscape is significantly occupied by private cars, they are part of the public open space. More recently some cities in the US (Portland, Charlotte, San Francisco) have considered streets as part of the public space and transformed them into "Complete Streets" (*i.e.*, streets that include sidewalks, bike and car lanes, some green infrastructure component, and are accessible to all ages and abilities).

Public spaces are locations where people meet and socialize, relax, and/or carry individual or

community activities of any kind, including leisure, sports, performing arts, open exhibition spaces, open markets, etc. Therefore, the design of these relational spaces, their physical and social quality, and their attractiveness have an impact on the livability of districts. Their physical quality is determined by: (i) good visual and physical connectivity with the surrounding areas; (ii) easy accessibility; (iii) their human dimension and green perception; (iv) their acoustic, lighting and thermal comfort; and (v) their air and soil quality, among others. Social quality depends on the ability to attract people and encourage interaction, contact and coexistence.

Facilitating the physical interactions between and among people in public spaces is beneficial not only from the resources point of view but also socially since they promote cohesion (inclusion, justice, solidarity, etc.). It is not only a matter of increasing the number of these spaces but also their level of livability (social and physical quality).

Actions:

- 1. City planning to ensure a reasonable number and total surface area of livable public spaces with a good balance between built and open space.
- 2. Facilitate connectivity between well distributed built public spaces and also with natural spaces.

Specific targets:

- 1. Develop guidelines for the design of livable and multi purpose built public spaces with acceptable physiological performance:
- Air and soil quality
- Acoustic and thermal comfort
- Public space ergonomics
- o Visual and physical connectivity with all mobility infrastructure
- Spatial proportions
- Visual spatial perception of urban green (green infrastructure) and social perceptions
- 2. Ensure equitable access to all public and common spaces.
- Restore, reclaim, remake and redesign mobility infrastructures into built public spaces²⁷ to provide access to:
- o street sidewalks accessible to all ages and abilities
- o pedestrian network of pathways
- any other transformed infrastructure (*e.g.*, bridges and elevated rail lines)

²⁷ http://asla.org/uploadedFiles/CMS/Meetings and Events/2014 Annual Meeting Handouts/FRI-A07_Infrastructure%20is%20Public%20Space.pdf

4. People flow experience

Keywords with anatomy labels:

o Structure

<u>Environment</u>: air quality, soil quality, green infrastructure, thermal comfort, sunlight, acoustic comfort

<u>Infrastructure</u>: nature, accessibility to communications, pedestrian network, walkable city, lighting comfort

<u>Built domain</u>: public space, multi-functional, accessibility, square, plaza, community space, playground, park, recreational area, recreation facilities, streetscapes, complete streets, spatial connectivity, human dimension, green perception, insulation, restore, reclaim, remake, multi purpose, ergonomics

o Interactions

<u>Functions</u>: open space functions, leisure <u>Culture</u>: contact, coexistence, street life <u>Information</u>: performance

o Society

<u>Citizens</u>: perception, people flow experience <u>Government</u>: regulations, planning, policies, guidelines

4.2.5 Mobility

The mobility domain encompasses both the mobility network and the function of transport in the City Anatomy. It has large social, economic and environmental impacts. District livability is highly interdependent with mobility which in turn is closely related to densification - compact urban morphology (proximity of services or city functions, mix-of-uses, accessibility to a network of complete streets) and access to a variety of transportation options. These options include a clean (low-emission), reliable, convenient and affordable public transport system as well as safe human-powered transportation modes (walking, running, and biking). The former reduces private vehicle traffic while the latter empowers and encourages a healthier multi-modal lifestyle. In both cases, social interaction (exchange) and community development are enhanced, carbon impacts and noise pollution are reduced, and overall public and environmental health are improved.

Since private vehicles currently occupy most of the public space available in cities all over the world, changes in the mobility infrastructure are urgently needed to reduce time of travel which has a large negative impact on GDP, as mentioned in Section 2. The Curitiba example (surface BRT with dedicated bus lanes, the use of trams and electric buses, underground and cable-car systems) offers some palliative and useful solutions to traffic issues. In addition, cities are adapting specific mobility infrastructures (*e.g.* complete streets) to incorporate bike lanes, park-bikes, bike and electrical bike renting, park and ride areas, etc.

<u>Actions</u>:

- 1. Develop an integrated urban mobility plan that reduces the need for private motorized transport and converts most of open spaces into public spaces.
- 2. Adapt public transportation to the urban morphology to increase its use and reduce time of travel between all district functions (living, working, health services, shopping, leisure, sports, performing arts, etc.).
- 3. Reduce the impact of transport on environmental, public and economic health.

Specific targets:

- 1. Accessibility to clean, affordable and time-efficient public transportation:
- Availability of suitable modes of transportation, including surface, air (cable-car), water (ferries) and underground
- o Proximity of citizens to public transportation networks
- Accessibility for all ages and conditions
- 2. Availability of human powered modes of transportation (walk, run, bike):
- Proximity of parking and renting spots for bikes
- o Segregated bike lanes to avoid accidents and conflicts with pedestrians
- o Parking for private vehicles outside of street network
- 3. Prioritization of low-emission vehicles with taxation and/or recharging benefits.
- 4. Reorganization of mobility networks by segregating traffic intense streets from complete streets:
- Superblocks with regulated private and public traffic
- \circ $\;$ Mobility for goods distribution (parking for loading and downloading)
- Assessment and regulation of other types of mobility systems (*e.g.*, micro-transit alternatives)

Keywords with anatomy labels:

• Structure

<u>Infrastructures</u>: reclaim infrastructures, remake infrastructures, redesign infrastructures, access platforms, physical connectivity, bus rapid transit (BRT) lanes, complete streets, bike paths, walk paths, parking, park and ride areas, sensors, cameras, actuators, charging stations

Built Domain: superblocks, morphology, accessibility, transit oriented development (TOD).

o Interactions

<u>Functions</u>: public transportation, light transport, micro-transit, human-powered, integrated modes of public networks, low emission vehicles, electric vehicles, pedestrianization, electronic transport payment, multimodal fares,

<u>Information</u>: communication, traffic data in/out, logistics, analytics, situation room, dashboards, mobility apps, City OS.

- o Society
 - Citizens: open politics

<u>Government</u>: integrated mobility plan, objectives, regulations, priorities, policies, accountability, responsibility

4.2.6 Green spaces and biodiversity

Cities are part of the natural system with humans, animals and plants sharing the same territory. Urbanization and industrialization pressures have disrupted the natural infrastructure in many cities worldwide and there is a real need to reverse this tendency by consolidating and increasing green spaces, ensuring biodiversity in urban areas and improving soil quality. City life should be made compatible with existing water resources and natural corridors.

A livable district should incorporate native flora, encourage local food production in urban gardens, diminish the carbon and water footprints, and understand the aesthetic and recreational function that the urban green enables in cities. Within the green we encompass all natural (flora and fauna) and landscape elements that formed the ecosystem prior to city creation: beaches, riverbeds or trees in streets, squares with vegetation, parks, vegetation at building rooftops, plants in balconies, urban gardens, as well as birds and other creatures.

Actions:

- 1. Promote environmental health to protect and regenerate all species in the city habitat.
- 2. Increase biodiversity and quality in the nature infrastructure and promote productive agricultural land and forestry.
- 3. Develop a plan to maintain all physical factors in the city habitat (soil, moisture, etc.).
- 4. Consider aesthetic quality in designing green infrastructure.

Specific targets:

- 1. Commit to the protection and preservation of the nature infrastructure and ensure an equitable access to all:
- Accessibility and proximity to green infrastructure in all public spaces, including streets, and to agricultural land (urban orchards)

- o Biodiversity of flora and fauna
- o Connectivity of green spaces to the nature infrastructure
- 2. Improve the quality of soil and its permeability (porosity).

Keywords with anatomy labels:

o Structure

<u>Environment</u>: natural system, native flora, environmental health <u>Infrastructure</u>: urban agriculture, urban gardening, urban orchards, green space, permaculture, compost, automatic irrigation, sensor, actuator, green network, park, garden, urban forest, soil permeability, moisture, watering, biological connectivity, biodiversity, green rooftops, green wall, wetland <u>Built domain</u>: landscape,

o Interactions

<u>Functions</u>: aesthetic and recreational, leisure, environmental education <u>Information</u>: repository of species, georeferenced inventories

o Society

<u>Citizens</u>: awareness, voluntary work <u>Government</u>: environmental protection, conservation policies

4.2.7 Metabolism

Cities, like living organisms, need resources to stay alive and to support their functions. The consumption of these resources depends on the number of inhabitants and on the flows of people in and out of the district. These flows, together with the cycles of energy, water and matter depicted in Figure 1 determine the urban metabolism²⁸. In terms of a city as a complex adaptive (eco)system, the urban metabolism should be viewed as a circular process and understood as the infrastructure uptake of resources and their continuous supply into the built domain to support the self-organizing and adaptive set of city functions that take the form of services when resources are consumed by district/ city inhabitants. As a result of this consumption residual heat and water, air emissions and waste are generated and poured back into the city ecosystem and beyond.

The integrated management of the cycles of energy, water and matter, together with that of the other three infrastructures, determines city performance in terms of self-sufficiency. The broader cycle of matter, which includes materials, food and waste, has been chosen because revitalizing districts (*i.e.*, proximity of all city functions) can be enhanced and consolidated by

²⁸ Suzuki H, Dastur A, Moffatt S, Yabuki N, Maruyama H (2010). Eco2 Cities. The World Bank. ISBN 978-0-8213-8046-8

bringing back into their urban fabric some manufacturing activities at the individual (3D printing) or industrial scale, now that many manufacturing technologies are cleaner, less noisy, and more energy and water efficient. A useful way of characterizing and visualizing urban metabolism is with the quantitative analysis of the flow of resources through an urban area of any size with flow and Sankey diagrams.

A livable district should have policies to guide urban design to make the built domain less resource demanding and promote lifestyle choices that lead to responsible consumption by citizens with the objectives of: (i) reducing energy demand and consumption; (ii) generating renewable energy within the district; (iii) mitigating the emission of polluting gases into the atmosphere; (iv) reducing water consumption and promoting its reuse; and (v) reducing waste generation, increasing reuse and recycle and improving waste management with selective collections and waste-to-energy initiatives.

The use of technology can improve the overall metabolic cycles in the district and city, and provide immediate returns to citizens in terms of self-sufficiency (*e.g.*, feeding electricity back into the district local grid).

Actions:

- 1. Move towards a more competitive resource-efficient economy (*i.e.*, circular economy).
- 2. Promote responsible consumption and lifestyles that are more aligned with a culture of conservation that ensure an equitable access to resources for all residents over time.
- 3. Supervise and control the cycles of energy, water, matter (materials, food and waste) with self-sufficiency and resource efficiency objectives, and in accordance with the flow of people.
- 4. Implement restoration and reconditioning activities to improve city's infrastructures and built domain.
- 5. Prevent waste generation, promote long-life products and reduce water and carbon footprints to improve environmental quality.

Specific targets:

- 1. Ensure resilience of district structure (infrastructures and built domain).
- 2. Adopt restoration and reconditioning policies.
- 3. Integrate management and operations of all infrastructures.
- 4. Reduce consumption of primary energy from non-renewable or renewable sources.
- 5. Promote renewable energy sources (solar, wind, tidal, biomass and geothermal).
- 6. Reduce water consumption in private and public activities and domains, and repair the distribution network to minimize losses.

- 7. Increase energy and water efficiency in buildings and public spaces:
- Responsible energy and water consumption by individuals, families, businesses, etc.
- \circ $\,$ Energy and water management in buildings and public spaces $\,$
- o Design guidelines towards water and energy self-sufficiency in the built domain
- \circ $\;$ Rainwater and greywater harvesting, reclaimed and potable water cycles $\;$
- 8. Favor the use of environmentally friendly and recyclable materials in the public space.
- 9. Promote sustainable production and responsible consumption of food:
- Food self-production in urban orchards and proximity criteria in consumption (life-cycle assessment)
- o Organic, eco-labeled and fair-trading
- 10. Implement an efficient waste management process for solids and liquids with 3R driven policies:
- o Environmental policies to reduce waste generation in any city function
- o Selective collection of solid and liquid wastes
- Waste collection system, with containers or collection points located on the average at reasonable distances from the waste generation locations
- \circ $\;$ Waste containers, with capacity and disruption sensors
- o Waste collection trucks equipped with mobile capacity sensors for instant route planning
- Waste-to-energy conversion with organic waste cycle (composting and biogas-toelectricity), and the production of electricity and district energy by incineration of final non-recyclable and non-reusable residues. These waste-to-energy processes should aim at benefiting local neighborhoods and businesses
- 11. Improve indoor and outdoor air quality by reducing emissions into the air from all indoor and outdoor sources. Emissions into the air from different fixed or mobile sources are the most important attributes of the urban metabolism that contribute to the global environmental health and quality of the atmosphere and troposphere.

Keywords with anatomy labels:

o Structure

<u>Environment</u>: water, infrastructure, fossil fuels, coals, uranium, gas, solar, wind, tides, geothermal water and vapor, atmosphere, troposphere, ozone, particulate matter, noise pollution, air pollution

<u>Infrastructures</u>: restoration, recondition, energy, materials, food, waste, rainwater and grey water harvesting, biomass, sensor, containers, paintings, coatings, construction materials <u>Built domain</u>: photovoltaic cell, paintings, coatings, construction materials

o Interactions

Functions: greenhouse gas emissions

<u>Economy</u>: circular economy, competitive, resource-efficient <u>Information</u>: self-sufficiency, efficiency, mitigation, uptake of resources, ecological footprint, monitoring, sustainable procurement, flow of people, Sankey diagrams.

o Society

<u>Citizens</u>: responsible consumption, waste prevention, lifestyle <u>Government</u>: regulations aligned with circular economy, restoration policies, reconditioning policies, design guidelines, waste management

4.2.8 ICT - Enabled

The communication infrastructure and the information layer pertaining respectively to the system of structure and interactions in the City Anatomy (Fig. 1) are the two elements that ensure the connectivity and flow of information (*i.e.*, access, store, transmit, and manipulate information) that are needed to keep the city ecosystem in operation. In smart city terminology, ICTs should be viewed as enablers that enhance city performance in all aspects of livability considered in this document, and in ways that are consistent with the city's shared vision. In terms of interactions, with its maximum expression of the Internet of Things (IoT), Figure 8 depicts how ICT – enabled interactions should ultimately lead to collaboration as a result of connecting and communicating, and also to thinking and the conscience of species via information and knowledge. Information and knowledge should lead to thinking individually and as a species, that fosters collaboration individually and city-to-city, satisfying the highest human need of helping others in Figure 2.



Figure 8. ICT – enabled interactions leading to collaboration and thinking with a conscience of species, in accordance with the highest level needs in Figure 2

There are some common mistakes that government should avoid when deploying technology infrastructure and/or smart city strategies. Government should (i) share and explain the urban challenges to citizens first and justify the use of technology afterwards; (ii) provide sufficient evidence that technology helps either by saving resources that could be used where more needed or by enabling or enhancing the city function/service affected; (iii) be aware how other cities address the same or similar challenges; and (iv) focus the attention to citizen engagement and to reduced the technology gap of vulnerable population (bridging the digital divide).

Actions:

- 1. Implement and manage a diversified communications infrastructure to assure multiplatform, multimodal and multi-object connectivity.
- 2. Ensure the transparent and efficient flow of information emanating from any content and format obtained from sensors, data analytics, apps, static or moving objects, people, government, external sources, etc.

Specific targets:

- 1. Provide ICT services to efficiently manage and enhance all actions listed in the action domains for livability, especially those supporting the performance of economy, services and urban metabolism.
- 2. Ensure people's interactions and governance.
- 3. Support end-user access to ICT and apps, especially those aiming at vulnerable populations.

Keywords with anatomy labels:

o Structure

Air: electromagnetic pollution

<u>Infrastructure</u>: communication network, routers, hardware, satellite, fiber optics, sensor, actuator, camera, device, 3G/4G/LTE, Wi-Fi.

 \circ Interactions

Information: platform, city OS, application, software, radio, television, cellular phone, computer, telecommunication, internet, middleware, dashboard, situation room, library, storage, repository, audio-visual, ontology, semantics, data, open data, analytics, performance, safety, security, transmit, server, cloud, front end, freeware, encryption, fuzzy, email, controller, digital, ADSL/DSL, API, interface, code, PCI, GUI, hub, gateway, ISND, IAS, peer-to-peer, redundancy, TCP, publish, logical operators, asynchronous, processor, SDK integration, apps, AI.

o Society

<u>Citizens</u>: end user, connect, knowledge, skills, technology gap, participation, open politics, capacity development

<u>Government</u>: regulations, policies, apps portal, e-government, accountability, transparency, reporting

4.2.9 Social Cohesion

Social cohesion is the state of well-being, safety and satisfaction that is reached in a district when citizens cooperate to achieve community goals and agree to share the prosperity outcomes. Thus, it contributes to build social bonding based on trust, social and professional relationships, a sense of belonging and a perception of unity, that facilitates economic prosperity and urban health. In a cohesive community there is a good degree of coexistence among people across different income levels, genders, cultures, ages and professions.

Social cohesion in districts can be facilitated by the urban planning and design of attractive public spaces and the creation and consolidation of district facilities. Cohesion also depends on trust in the fiscal and justice systems, the equitable and transparent redistribution of urban benefits and resources, effective employment and social protection systems, education and gender equality programs, and other actions and policies that encourage integration and promotion of values such as cooperation, solidarity, equality, inclusion, resilience, and acceptance of difference as a positive value, among others. It is important to emphasize that the promotion of these values must occur at all scales, from the individual and domestic spaces, district organizations and businesses, to the district and city scales. The attributes and values mentioned above are the bricks needed to build and secure a stronger, informed, aware, happy, and involved district community that is capable of developing itself in a more sustainable (and ecological) way and of acting in a more powerful and effective way within the action domain areas presented and discussed in this document.

Communities evolve over time and require the transformation of districts and cities. An important element in these transformations is the development of activities, and the adoption of strategies and methodologies, that are needed to strengthen the knowledge and abilities of individuals, organizations, and government and attain transformational objectives in a sustainable and collaborative manner. This capacity development will in turn strengthen the adaptive capabilities of citizens in an era of accelerated change.

Actions:

1. Ensure wealth production and distribution within the district that could spontaneously alleviate or prevent poverty and increase district well-being and economic resilience:

- manage the flow of people
- o reinforce economic attractiveness
- \circ ensure knowledge and skill provision for businesses and nonprofits.
- 2. Facilitate investments:
- o benefit the creation of new district businesses, nonprofits and jobs
- o enhance existing or new commercial activities
- o facilitate the competitiveness of existing businesses
- Work towards ensuring that the built domain facilitates safe living environments with access to land, shelter and services to cover the basic human needs at the bottom of the Maslow's pyramid in Figure 2.
- 4. Leverage technology to improve and sustain social equity.

Specific targets:

- 1. Ensure affordable housing and health care with access to services and public facilities.
- 2. Plan to secure the development or transformation of district neighborhoods into inclusive and supportive communities:
- reduce or mitigate social inequalities with social programs and by attracting business and nonprofits with tax incentives if necessary
- o food security and healthy nutrition (mainly at the early stages of life and in children)
- care for the elderly (aging communities)
- o incorporate visitors and non-permanent residents into community life
- o support in-school and out-school activities to generate opportunities for all
- \circ invest in social housing and public facilities in the more deprived district areas
- o engage citizens in community activities and voluntary work
- 3. Decrease the technology gap in vulnerable populations; bridging the digital divide.
- 4. Leverage technology in ways that increase opportunities across social and economic demographics.
- 5. Approve policies and regulations for urban planners to incorporate social equity and quality of life requirements in their planning strategies and projects, in addition to environmental and economic impacts.
- 6. Adapt current urban and tax regulations to facilitate and promote district initiatives for urban equity (*i.e.,* reducing the gaps for inequalities in health and poverty).

Keywords with anatomy labels:

o Structure

Infrastructure: homogeneous urbanization

Built domain: public space, dwelling, building, block, neighborhood, land use

o Interactions

<u>Functions</u>: housing, co-housing, education, health, public facilities, voluntary work, security, safety, food security

<u>Economy</u>: wealth generation, wealth distribution, redistribution, resilience, tax incentives, education, integration,

o Society

<u>Citizens</u>: engagement, participation, empowerment, capacity development, social startups, district businesses, aging community, social justice, solidarity, equality, inclusion, dissent, protest, dialogue, reconciliation

Government: community goals, regulations, gender equality programs, planning, policies

4.2.10 Governance

District/city management is highly dependent on context. From the point of view of this document, administrative structures of management are considered responsible for completing all processes and tasks involved in planning, executing and evaluating any transformational or optimization project, including administration, finances, communication, engagement, legal, training, construction, operation, and maintenance. On the other hand, governance is as complex as the city itself since it involves the process of decision making in a context of reconciling competing and sometimes antagonistic interests.

More recently, urban development has entailed the integration of policymaking with service delivery. This has impacted the organizational structure of government, decision making and the planning process (*e.g.*, breaking the inner city silos). Policy integration and integrated governance have emerged simultaneously and diversely in several cities around the world. More information can be found elsewhere²⁹.

Regardless of the degree of policy integration, livable districts need to be supported by a participatory governance that engages citizens in a continuous and transparent community conversation or dialogue about equity, economics, environmental health, district structure and functions, quality of life and well-being (*i.e.*, livability). This shared ownership of livable district development, which is applicable to any city or district, should be supported with information, awareness and education materials.

All actions and specific targets listed in the previous nine domains for action fall into the responsibility domain of governance. The characteristics of participation and shared responsibilities should be present at all stages of the cyclic methodology for livable district

²⁹ Integrated City Making. Governance, planning and transport. Urban Age Programme. London School of Economics and Alfred Herrhausen Society. Berlin (2008). ISBN 978-0-85328-304-1

development that starts by observing the reality and sharing a vision (Figure 7) and will probably end with new relationships between decision-making power and citizens (*i.e.*, with open politics). These are more clearly highlighted in the guidelines provided in the urbanization and land occupation action domain (subsection 4.2.3) because it is at this first layer of city/district development that tensions between the interests of citizens, stakeholders, private developers, public agencies and service providers, emerge and manifest themselves.

Actions:

- 1. Integrate policymaking with service delivery.
- 2. Deliver accountability.
- 3. Integrate governance to facilitate management of all district infrastructures in accordance with service delivery.
- 4. Enhance citizen empowerment and engagement by establishing a participatory governance structure,
- 5. Manage all finances in an integrated manner to increase economic health in the public administration, facilitate project agglomeration to attract investments either directly or by means of Public, Private, People Partnerships (PPPP).

Specific targets:

- 1. Engage in community conversation with citizens and stakeholders:
- o Provide open and public access to information regarding projects and policies
- o Establish an ombudsman office to mediate and manage conflicts
- Meet with citizens regularly
- o Involve citizens in the decision making process
- o Accountability and responsibility
- Develop information material about district activities, ongoing projects and initiatives, and results of completed ones. Include information on the channels that are open for participation. Disseminate information via social media, apps and also in printed format.
- 3. Develop educational hands-on materials to increase knowledge and awareness about district operation, risks and opportunities of managing open, complex and adaptive systems. The same evidence will trigger different emotions in different persons due to values, beliefs, and other intangibles that ultimately define diversity.

Keywords with anatomy labels:

Structure
Infrastructure: integrated infrastructure

o Interactions

Functions: education, open education, training,

<u>Economy</u>: circular economy, competitive, resource-efficient, economic health, P4, integrated finances, alternative economy, crowdfunding, crowdsourcing, social entrepreneurship

Information: communication portal, open source, open data, open systems

o Society

<u>Citizens</u>: awareness, participation, cooperation, activism, association, collaborative social responsibility, bottom-up, social emancipation, citizen initiatives <u>Government</u>: accountability, transparency, open politics, reporting, policy integration, administrative structures, co-responsibility, participatory governance, shared vision, participatory decision-making, mediation, consensus, integrated governance, policy making, empowerment, engagement, representation, legislation, adhocracy, middle out process, institutions, mayor, deputy mayor, mayor's office, ombudsman, tactical urbanism, emergent urbanism

5. Proposed Definition to Inform Livable District Creation or Transformation

A livable district, in Urban Ecology terminology, is a densely populated and geographically cohesive urbanized area located within a city that has:

(i) economic, environmental and social health (*i.e.*, is sustainable);

(ii) good balance between structural elements (environment, infrastructure and built domain) and city functions to deliver quality services and improve social interactions;

(iii) efficient metabolic cycles and mobility (*i.e.*, employs technologies and design elements to reduce resource use and pollution, and improve productivity);

(iv) participatory governance with well-connected social networks and informed citizens who feel ownership of their district future; and

(v) human scale and safe living with attractive public spaces for socializing and improving quality of life and well-being.

6. Copyright Statement

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Contributions: Chairs, co-chairs and contributors of the CPAs City Anatomy, Anatomy Indicators and Anatomy Ontology.

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7. ANNEXES

Annex A. Building the cities of the future with green districts

Annex B. Indicators for Sustainability

Both Annexes can be downloaded at: http://cityprotocol.cat/publications/green_districts; http://cityprotocol.cat/publications/indicators_sustainability