The Evaluative Framework for the Sustainability of Urban Areas

A tool to evaluate urban sustainability and support the policymaking for a sustainable urban development

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Summary

One of the main reasons for the current, unsustainable model of development is the way in which a large and increasing segment of the global population lives in urban areas. Cities worldwide grow larger every year both in terms of size and population. The result of this (often) unregulated growth is the concentration of many environmental, social and economic issues in these urban areas. The need to adopt an integrated, comprehensive approach to sustainable urban development is increasingly evident and it has been recently promoted also by the United Nations in their 2030 Agenda for Sustainable Development.

In accordance with this approach, this research aims to develop and test a tool that urban planners could use to evaluate both the performances in terms of sustainability of their urban areas and the effects of their plans and policies on these performances. This tool, conceived to support and inform the policymaking processes of urban planning, is named the Evaluative Framework for the Sustainability of Urban Areas (EFSUA). Its development benefited from the review of existing tools designed for similar purposes, the recognized best practices in the Monitoring and Evaluation activity and the opinions of experts. The resulting framework is composed by a core of environmental, social and economic indicators, to be integrated by other indicators identified through the involvement of local stakeholders, allowing the adaptation of the EFSUA to different contexts.

The research proceeded with the first explorative application of the framework to a case study involving two suburban districts of the city of Milan, in Italy, that are object of an ongoing renovation plan. The explorative application of the EFSUA entailed the evaluation of both the current performances in terms of sustainability of the two districts and the potential impacts of the renovation plan on these performances, after having involved through interviews the relevant stakeholders in the design of local indicators. Given the large amount of diverse data needed to calculate the indicators, the evaluations have been performed using existing public, official and whenever possible, updated, databases from various sources. The evaluations provided information on the various issues affecting the two districts, as well as an integrated prediction of the effects of the renovation plan.

Moreover, the results of this first explorative application allowed the formulation of several policy recommendations and of some considerations about the potential and possible weaknesses of the EFSUA.

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List of acronyms and abbreviations	
ADAPT	Principles: Adaptive, Dynamic, Active, Participatory, Thorough
AdP	Accordo di Programma (Program Agreement)
AP	Absolute Poverty (SSE)
ARPA	Agenzia Regionale per la Protezione Ambientale (Regional Agency for the Environmental Protection)
ATU	Aree di Trasformazione Urbana (Areas of Urban Transformation)
C	Costs (SSE)
C40	C40 Cities Climate Leadership Group
CBA	Community-Based Approach
CPI	City Prosperity Initiative
CTDA	A City for Tomorrow and the Day After
D	Distance (SSE)
E	Energy (SSE)
EEA	European Environment Agency
EFSUA	Evaluative Framework for the Sustainability of Urban Areas
EIA	Environmental Impact Assessment
EPA	The US Environment Protection Agency
ERDF	European Regional Development Fund
ERP	Edilizia Residenziale Pubblica (Public Residential Building)
ESF	European Social Fund
ESUD	Ecologically sound urban development
EU	European Union
F	Food (SSE)
GDP	Gross Domestic Product
GHGs	Greenhouse gases
GIS	Geographic Information System
IOs	International Organizations
IPCC	International Panel on Climate Change
ISPRA	Istituto Superiore per la Protezione e la Ricerca Ambientale (The Italian Institute for Environmental Protection and Research)
Istat	Istituto nazionale di statistica (the Italian National institute of statistics)
ICLEI	ICLEI - Local Governments for Sustainability
ICTs	Information and Telecommunication Technologies
LPT	Local Public Transportation
M&E	Monitoring and Evaluation
MM	Metropolitana Milanese
NBSs	Nature-based solutions
NGO	Non-Governmental Organization
NIL	Nuclei di Identità Locale (Cores of Local Identity)
NOP METRO	National Operative Plan for Metropolitan cities
NRS	Non-Renewable Sources (SSE)

OAPCCM	Ordine degli Architetti Pianificatori, Paesaggisti e Conservatori della Provincia di Milano
OECD	Organisation for Economic Co-operation and Development
PAES	Piano d'Azione per l'Energia Sostenibile
PBL	Planbureau voor de Leefomgeving – the Netherlands Environmental Assessment Agency
PdS	Piano dei Servizi (Plan for the Services)
PGT	Piano di Governo del Territorio (Plan for the Government of the Territory)
PUMS	Piano Urbano per la Mobilitò Sostenibile
RES	Renewable Energy Sources
ROP	Regional Operative Plan
RP	Relative Poverty (SSE)
SC	Soil consumption
SDGs	Sustainable Development Goals
SEA	Strategic Environmental Assessment
SiSI	Sistema Statistico Integrato (Integrated Statistical System of Milan)
SNSS	Strategia Nazionale per lo Sviluppo Sostenibile (National Strategy for Sustainable Development)
SIE	Sustainability Impact Evaluation
SS	Soil sealing
SSE	Sustainability Status Evaluation
SW	Solid Waste (SSE)
T	Time (SSE)
TOD	Transit Oriented Development
UK	United Kingdom
UN	United Nations
UNDP	United Nations Development Programme
VALE	Vivere e Abitare Lorenteggio ERP
W	Water (SSE)
WCED	World Commission on Environment and Development
WM	Waste Management (SSE)
WR	Water Reuse

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1. Introduction to the Research

1.1 Research problem

The stability of the global climate is being compromised by the global emissions of greenhouse gases (GHGs). Indeed, not only are these not falling, like many international agreements prescribe, instead, they are increasing every year according to, among the others, the IPCC (2014), the Environment Protection Agency (US EPA, 2016) and the PBL[1] ("Trends in global CO2 and total greenhouse gas emissions - 2017 Report," n.d.). The resulting effects of the accelerating climate change are no longer threatening only the lives and wellbeing of future generations, they are starting to affect also our lives now (Steffen, Grinevald, Crutzen, & McNeill, 2011). Given the current and foreseen future trends in urbanization at the global level, the areas in which the effects of climate change are likely to produce most of the damage are cities, especially the largest ones. In fact, "many environmental problems have a local origin, while global environmental decay often manifests itself at a local level" (Mori & Christodoulou, 2012: 95). Cities are also the very places where a large and increasing portion of the global GHGs are being emitted and will be emitted in the decades to come, according to, among others, the World Bank (Livingstone, n.d.) and UN-HABITAT ("Climate Change – UN-Habitat," n.d. – 2018)[2]. Moreover, several environmental, social and economic issues tend to originate wherever large numbers of people concentrate in the same places. Consequently, cities, with their municipalities and stakeholders, could have a central role in the effort to build a sustainable model of development (Ahern, 2011).

As much as they are amongst the principal sources of problems, cities can also be the places to research, develop and test solutions, and in many cases their governments have started to realise this (Bloomberg, 2015). One of the main issues to be faced for achieving sustainable urban development lies in the availability of proper tools to measure the actual sustainability of urban areas. These tools should provide understandable and usable information to help policymakers design better, integrated plans which consider their cities as the complex systems they are (Shen, Jorge Ochoa, Shah, & Zhang, 2011; Mori & Christodoulou, 2012; Gil & Duarte, 2013; Pupphachai & Zudiema, 2017).

There are already many indexes, frameworks and tools in general but, too often, they lack the comprehensiveness that is needed to properly deal with sustainable urban development. **Cities are systems** ("The New Urban Agenda," n.d.), as they each have their unique environment, society and economy, and these, that are the three classic domains of sustainability, are both complex in themselves and strictly connected to each other. This means that the unsustainability of one domain's key element can jeopardize the whole domain, which, in turn, can affect the others, thus the sustainability of the whole urban system. The three domains of sustainability are also influenced by urban policies whose quality and results depend on the processes of urban governance, intended as "the ways in which governing is carried out" (Steurer, 2013) in the city. Whenever a tool focuses on only one or a few of these aspects it is failing in addressing the true complexity of sustainable urban

[1] Planbureau voor de Leefomgeving – the Netherlands Environmental Assessment Agency
[2] "more than 60% of all carbon dioxide and significant amounts of other greenhouse gas emissions, mainly through energy generation, vehicles, industry, and biomass use. At the same time, cities and towns are heavily vulnerable to climate change. Hundreds of millions of people in urban areas across the world will be affected by rising sea levels, increased precipitation, inland floods, more frequent and stronger cyclones and storms, and periods of more extreme heat and cold"

development. Furthermore, there are often other issues connected to various aspects of the design or use of these tools, from the choice of their indicators to the application in evaluations.

Given the context described so far, the research aim and questions can be introduced.

1.2 Research aim and questions

The aim of this research is, thus, the development of a tool, the Evaluative Framework for the Sustainability of Urban Areas (**EFSUA**), and its first explorative application to a case study, which concerns a suburban area formed by two adjacent districts of the city of Milan and their ongoing renovation plan. This case study was identified through my research internship in the consortium Poliedra – Politecnico di Milano ("Poliedra," n.d.).

The first aim: the development of the EFSUA

The core of the EFSUA is an index[3] used to measure both the performances of urban areas in terms of sustainability (environmental, social, and economic) and the impacts of policies on them. This index is composed of a set of **core indicators** applicable in every context, to be integrated with **local indicators** needed to adapt the tool to the specificities of the local situations.

The first key feature of the EFSUA is its comprehensive approach, which considers all the aspects of sustainability. This is reflected in both its theory and application. Such systemic approach is promoted by the UN 2030 Agenda and its Sustainable Development Goals, also at the urban level ("Goal 11 targets," n.d.).

The second key feature of this framework is its attention to the involvement of the local stakeholders. This is one of the consequences of the bottom-up approach to sustainable urban development which underlies this research[4]. This involvement has two main objectives. The first one is the adaptation of the EFSUA to the context in which it is used. The second one is the enhancement of the sense of participation of the local stakeholders to the activity of monitoring and evaluation (M&E) of urban sustainability, as well as their sense of ownership of the tool itself (Climate-Eval, 2015). This involvement is inspired by the Community Based Approach (CBA), meaning that the design of the **local indicators** "involves participatory M&E approaches, encouraging the principle of local ownership, community participation, and adaptation on a community level" (Climate-Eval, 2015: 11).

The potential for adaptability of the EFSUA to different contexts is its third key feature. Too often indexes, frameworks and similar tools are "standardized". They are presented as if they can be used everywhere, leaving little or no space at all for their adaptation to contexts that may be completely different[5] (Climate-Eval, 2015). The EFSUA, as previously explained, is different. It is a mixed tool which combines a series of elements that are indeed fixed (the **core indicators**), integrating them with **local indicators** which derive from the abovementioned involvement of the relevant local stakeholders and which should consider the specificities of the local context.

[3] "an aggregation of multiple indicators that produce a single measure" (Climate-Eval, 2015: 44)
[4] the importance of a bottom-up approach (promoted by the cities themselves) will be extensively addressed in section **2.2**
[5] how could the same tool be used both in a rich, developed city in the USA and a poor, underdeveloped city in Pakistan without any changes or adaptation to such different contexts?

The second aim: the explorative application of the EFSUA to a case study

The names of the two districts of the case study are Giambellino and Lorenteggio and the title of the renovation plan involving both districts is "AdP[6] Lorenteggio". There are several reasons for this choice, and they are extensively addressed in section **3.1**, the main one being my internship in Poliedra, which oversees the environmental evaluation of "AdP Lorenteggio". The first explorative application of the EFSUA entails two evaluations, respectively assessing the broad performances in terms of urban sustainability of the studied suburban area and the potential effects of the plan on these performances.

As the development of the EFSUA (resulting in section **4**) and its first test (in section **5**) are the aim of this research, the main research question is: how the EFSUA can help evaluate urban sustainability and what are the results of its first application to Giambellino and Lorenteggio and their renovation plan?

Here follows an outline of the sub-questions that guided this research:

- **a)** Which indicators can help evaluate urban sustainability?
- **b)** What are the results of the first evaluation of urban sustainability in Giambellino-Lorenteggio? What environmental, social or economic issues emerge through the chosen indicators?
- **c)** What impacts will the plan of urban renewal (AdP Lorenteggio) potentially have on urban sustainability in Giambellino-Lorenteggio? Which indications for a policy response can be derived from this evaluation?

The first one of these questions is answered in the second section, which presents the theoretical background of the research, and in section 4 presenting the EFSUA itself. The other questions will be answered in the fifth section, which addresses the first application of the framework to the chosen case study.

1.3 Societal and scientific relevance of the research

The societal relevance of this research lies precisely in the development of a tool, the EFSUA, that allows local evaluations of urban sustainability. This is connected to the main premise of the research. This premise is that the potentially most effective and efficient strategies of sustainable development are bottom-up, starting from the reform of the places where we live, our cities (van der Heijden, 2014; Bloomberg, 2015). Tools such as the EFSUA are crucial in this respect.

The M&E activity for projects of sustainable urban (re)development is indeed fundamental to gather information about the effectiveness and efficiency of the chosen initiatives and to learn lessons about best practices that should be replicated in future projects (Climate-Eval, 2015). The development of a framework that can evaluate the sustainability performances of urban areas and highlight the shortcomings is indeed a fundamental step in this effort. Such a framework could be used by urban planners to carry out these evaluations for their own projects. Furthermore, thanks to its flexibility, it

[6] Accordo di Programma, roughly translated as Program Agreement

can be easily adjusted to be used in very different contexts. Finally, it may also inform the knowledge basis needed, in the future, for potential projects of built-from-scratch sustainable cities.

More specifically for the present work, the first application of the EFSUA aims at providing the municipality of Milan firstly with a comprehensive evaluation of the current overall performances in terms of urban sustainability of the suburban area formed by the two districts Giambellino and Lorenteggio (**Sustainability Status Evaluation**: **SSE**). Secondly, it will also provide the Municipality with an evaluation of the possible impacts of the ongoing plan of urban renewal, AdP Lorenteggio, on the sustainability of this area (**Sustainability Impact Evaluation**: **SIE**). This plan includes actions belonging to different sub-plans and funded by different sources. The thorough description of AdP Lorenteggio and its components is presented in section **5**. What is important to remark, is that the systemic approach promoted by the EFSUA is still somehow innovative in a context, Italy, where the adjective "sustainable" is still too often bound solely to the domain of the environment. This is reflected also in the M&E activities, which are still mostly relying on those tools, like the SEAs and EIAs[7], that consider the social and economic aspects of urban sustainability only in a marginal way ("Il Catalogo obiettivi-indicatori 2011 — Italiano," n.d.).

The scientific relevance of this research lies in its role as a waypoint in the ongoing effort for further developing and analysing the concept of a sustainable city, whose starting point could be traced in the book of Ebenezer Howard "Tomorrow: A Peaceful Path to Real Reform", in 1898 (now entitled "Garden Cities of To-morrow"). Firstly, by further promoting the needed systemic, integrated approach to sustainable urban development, also by paying special attention to the interactions between the different dimensions belonging to the three sustainability domains. Secondly, by applying this systemic approach in the Italian context, which is an innovative step for the abovementioned reasons. Moreover, the EFSUA aims to be an innovative and fundamental step in **bridging the gap between science and policy making in the field of sustainable urban development**, as it is designed to be easily understandable for policymakers. This can be regarded as a novelty because so many similarly-labelled tools have been developed by scientist, experts, "technicians" and too often they are meant just for the use of their peers. Politicians and policymakers in general may have very different training and educational backgrounds and this fact often makes those tools hardly usable or even understandable for them. My personal background is closer to theirs, my studies in political sciences and more recently in urban management, in fact, may help me to understand what policymakers could comprehend and use better than, for example, an environmental engineer.

The first step of the research is the analysis of the theoretical and conceptual background on which it is based. This analysis from a literature review on the very concepts of sustainability, sustainable development and most of all, sustainable cities, and by looking at some of the existing tools that have been developed to measure urban sustainability.

[7] Strategic Environmental Assessments and Environmental Impact Assessments

2. Literature Review, Theoretical Framework and Conceptual Model

2.1 Literature Review

Sustainability and sustainable development are concepts that have been researched, defined, even reinvented, countless times during the past decades. For the sake of conciseness, one could start from what is probably the most widely known definition, given by the Brundtland Commission, formally known as the World Commission on Environment and Development (WCED), in its paper "Our Common Future" in 1987.

"Sustainable development is the kind of development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

From then on, many have tried to identify the perfect definition of sustainability and sustainable development. In fact, there are now so many definitions that it is possible to create typologies of them, like Andrew Dobson did in his "Environment sustainabilities: An analysis and a typology" (1996).

The existence of so many definitions of sustainable development perhaps reveals the inherent contradiction of giving a fixed definition to a dynamic process (Robinson, 2004). Maybe sustainability must indeed have a fixed definition, but we must recognise the procedural character of the "development". Moreover, recently, the term "resilience" is becoming more and more popular in this field, to the point that in many cases it is used as a synonym of sustainability, like in the case of the Planetary Boundaries theory (Rockström et al. 2009; Steffen et al. 2015). In section **2.2** I will provide the definitions of these concepts that have been used throughout this research, but firstly, I present the review of the literature on the general understanding of the concept of sustainable city and on various tools that have been developed and used in recent years to try and measure urban sustainability.

2.1.1 What is the general idea of a sustainable city

Arguably, the latest document summarizing the state of the art of the concept of sustainable cities is the 2030 Agenda with its SDGs developed by the UN in 2017. The eleventh Goal is, precisely: "Make cities and human settlements inclusive, safe, resilient and sustainable" ("Goal 11 targets," n.d.). Even if the choice to separate these concepts is criticisable, as in this research they are all intended as part of urban sustainability, this list, along with its related targets, provides valuable clues about some of the most widely accepted features of sustainable cities. These features are linked to the decades-long researches of UN-Habitat ("The New Urban Agenda," n.d.) and they have recently been accepted also in Italy. The Italian Institute of Statistics, Istat, started a project aimed at translating the 11th goal into a series of indicators to be used in comprehensive evaluations of urban sustainability and sustainability assessments in general. These indicators are also part of the new National Strategy for Sustainable Development[8].

[8] In Italian: SNSS ("La Strategia Nazionale per lo Sviluppo Sostenibile | Ministero dell'Ambiente e della Tutela del Territorio e del Mare," n.d.)

Another important source for identifying the features of sustainable cities is represented by the researches and documents of the EU and its European Environment Agency (EEA) on sustainable cities, like "Cities of tomorrow" (2011) and the Pact of Amsterdam of 2016, as well as the various promising means of transboundary cooperation between cities, like the Aalborg Charter and the Covenant of Mayors.

Other valuable sources are the numerous studies from experts and scholars on this subject, both treating sustainability as the holistic concept it is or addressing its three domains singularly or even single aspects of them (e.g. sustainable mobility). For example, from some of these studies and researches we know that sustainable cities have to be green, compact and energy-efficient (European Commission, 2011), they have to be responsible, living and participating (Tjallingii, 1995), they have to build inclusive stakeholder platforms that, independently from the mayor in office, ensures that the city keeps learning (Campbell, 2012), and watching over the public interest of its citizens[9], especially when their governments fail to do so because of political opportunities (van der Heijden, 2014). Moreover, sustainable cities must be socially inclusive and safe for all their citizens (Dempsey, 2008; Cozens, P. 2008 & 2011), since these two aspects are deeply intertwined. Finally, a sustainable city must become as self-sufficient as possible to become truly resilient, at least concerning the fundamental resources and services, such as water, food, energy, waste management and public transportation (UK National Archives, 2004; Kabisch, n.d.).

The work of collecting these many and sound findings was crucial for this research. In fact, many of such documents and researches grasp one or few aspects of urban sustainability. The systemic approach required to properly deal with sustainable (urban) development, though, demands a combination of these various insights and findings into one comprehensive theory and strategy (Martin, n.d.). Many others before me have tried to embed similar comprehensive approaches in the design and use of evaluative tools. The next section contains a review of some of these attempts, the lessons I have learned from them and then applied in the present research.

2.1.2 Existing tools to measure the sustainability of cities, the lessons they can teach and their shortcomings

There is already a wealth of frameworks and indexes attempting to measure urban sustainability. I have directly analysed six of these tools and I have also considered the review from Gil and Duarte (2013) and the best practices study by Climate-Eval (2015), which cumulatively reviewed more than 25 of such tools[10]. Four general considerations can be made about the most common issues of these existing tools:

1. most of them fail in addressing the connections between the various domains of sustainability and, consequently, between the various indicators as well;
2. some of them use too many indicators, consequently creating an unwieldly M&E tool which:
    a. "can burden the agency and interfere with program implementation" (Climate-Eval, 2015: 53);

[9] Throughout this research, the word citizen is used with the simple meaning of "inhabitant of the city", "city dweller", I am not referring to the legal jargon concerning the right of citizenship
[10] The complete list of researches and tools is in **appendix B**

    b. measures tens of different outcomes but says little or nothing about the causes and processes involved, not providing the policy-makers with adequate information on how to intervene;
3. many use indicators designed solely top-down, resulting in a lack of sense of ownership and participation by the local stakeholders. This could affect their willingness to accept the result of the M&E activity or even the performance of the activity itself (Climate-Eval, 2015);
4. the choice of indicators in some cases is quite inadequate, as some of them are hardly suitable to describe urban sustainability or they are not even related to it (for example 'per capita GDP', present in both the index by Arcadis and the framework by the OECD, is increasingly criticized by many experts).

The review from Gil and Duarte (2013) was influential in the development of the EFSUA, as the four final recommendations that the authors makes for the development of evaluative tools for urban sustainability: "collaboration, compatibility, customisation and combination" (Gil & Duarte, 2013: 322), have all been considered in the present research. Meaning that there should be:

a. **collaboration** between different institutions to reduce the theory/practice gap;
b. **compatibility**: linking a theoretical framework of sustainable urban development principles to the indicators and benchmarks will make the results of the evaluation more compatible and comparable;
c. **customisation** of the indicators and benchmarks to tailor them to the complexities and specificities of different local contexts;
d. **combination** of tools and methods, as long as they are compatible.

Moreover, other recommendations from other studies and evaluations of urban sustainability have been taken into account while developing the EFSUA. Some of these recommendations originated from the abovementioned direct analysis that I have performed of six researches and their tools and they can be summarized in a few points:

- it is important to have a set of core indicators to start the evaluation from, to be integrated in the long term with others related to new projects and resulting from a continuous learning process (Shen, Jorge Ochoa, Shah, & Zhang, 2011; L. Shen, Kyllo, & Guo, 2013);
- develop a framework that covers as many integrated components of sustainable urban development as possible, while minimizing the number of required indicators (Tanguay, Rajaonson, Lefebvre, & Lanoie, 2010);
- take future scenarios into account while choosing the indicators, identifying both a desirable future **and** possible undesirable outcomes (Boyko et al., 2012). This approach is needed to avoid "maladaptation" (Climate-Eval, 2015) and other possible unsustainable side-effects of urban development, renewal or planning in general[11];
- the framework should be based on the concept of "strong sustainability[12]" (Mori & Christodoulou, 2012) since the ecosystem services provided by nature are hard to replace (or not replaceable at all) by man-made devices, at least nowadays;
- to effectively inform the process of learning and adaptation, thus supporting adaptive governance, the indicators must:
    - be accessible and understandable,

[11] This recommendation in particular pushed me in developing the macro-objectives of the EFSUA presented in section **4**
[12] natural capital is non-substitutable by man-made capital, so it should be preserved (Barbier & Markandya, 2013)

- give account of policy performances and trends;
- be discussed both within and outside government authorities (Pupphachai & Zuidema, 2017).

All these points, the considerations on the shortcomings of existing tools and the characteristics of the sustainable cities identified in the previous section, are all comprised in the development of the EFSUA. They were extremely useful and influential in many respects: from the definition of a sustainable city presented in the next section, to the choice and description of the indicators, to the development of the macro-objectives of the EFSUA and the related desired trends of each indicator.

2.2 Theoretical framework

There are many theories about sustainable urban development underlying the concepts used in this research and the chosen **core indicators**. Before analysing them, though, it is crucial to provide the definitions of sustainability and resilience that will be used throughout the research. Sustainability, in its essence, will be intended as:

the capacity of a system to exist and endure without preventing other, related systems, from doing the same[13].

The concept of **resilience** plays an important role in the first part of this definition since it is a fundamental prerequisite for a system's ability to endure, adapting to changing conditions and reacting to shocks. The definition of resilience used in this research is:

the ability of a system to react to endogenous or exogenous shocks/disturbances of various kinds, absorbing them and evolving towards new equilibriums, while maintaining its fundamental functions[14] ("L'elasticità di resilienza | Accademia della Crusca," n.d.; "Resilience Alliance - Resilience," n.d.).

Resilience, hence, is a necessary but not sufficient condition for sustainability. In other words, a system must be resilient in order to be sustainable, but a resilient system could indeed be unsustainable (e.g. a city can use locally produced fossil fuels as a reliable source of energy, contributing to its capacity to withstand energy shortages but also causing major environmental externalities at the same time). The strong relation between these two concepts has already been highlighted before, one great example being the factsheet of the URBES project by Nadja Kabisch (Kabisch, n.d.) and it is increasingly accepted by experts and scholars.

This line of reasoning finally leads to the definition of a sustainable city that has been used in this research. Integrating the two concepts that have just been analysed:

a sustainable city is one which does not jeopardise its own resilience nor the resilience of the Earth System. This means that it is an urban system built and living in such a way that it can last indefinitely, having also the ability to react to both exogenous and endogenous shocks and evolve into a (new)

[13] This definition is the extension of the concept of "ecological sustainability" (Starik & Rands, 1995: 909)
[14] It is important to keep in mind that resilience is not a synonym for resistance. In fact, something resistant oppose or counteract the applied force until it brakes ("L'elasticità di resilienza | Accademia della Crusca," n.d.).

stable equilibrium, while preventing its existence and everyday life to endanger the endurance and health of the larger system to which the city belongs, our planet, with negative externalities of any sort.

Such shocks can be sudden, or they can incubate for long periods ("creeping") and they can belong to any of the sustainability domains. Examples of sudden ones could be major environmental hazards, terroristic attacks or great economic crises in specific sectors. The "creeping" ones could be connected, for example, to the effects of massive, continuous and unregulated immigration, or to the slow but steady exhaustion of local fundamental natural resources.

In accordance with the provided definition of a sustainable city, sustainable urban development brings improvements to the urban system while respecting the requisites of sustainability. Meaning that it does not compromise the system's resilience and it does not cause negative externalities, in any of the sustainability domains, affecting its own nor any related system.

It is commonly accepted that both the Earth System and our cities include three deeply interconnected domains. These are the environment, the society and the economy (Or Planet, People, and Profit - Arcadis, n.d.). Even if only one of these domains (that are complex systems in themselves) is unsustainable for any reason, so is also the whole system. This gives the measure of how holistic the concept of sustainability is. Moreover, and sadly enough, it is also known and commonly accepted that we are now in a situation of unsustainable development, and not because only one of the domains is unsustainable, but all of them are (Steffen, Grinevald, Crutzen, & McNeill, 2011).

Some of the reasons for this unsustainability, often, can be found in the field of governance. Heavy and cumbersome bureaucracy, inadequate policymaking and implementation processes, the impossibility to rely on adequate and available funds, the absence of appropriate processes of data collection, storage, use and sharing (for M&E activities), are all examples of hindrances that can and too often do, cripple or even arrest the efforts to achieve sustainable urban development (van der Heijden, 2014).

Now I present the reasons why and how are sustainable cities needed to build a sustainable model of development.

2.2.1 *Why* and *how* are sustainable cities crucial for a sustainable model of development

As it has recently been highlighted by numerous studies of many scholars, there is an apparently unbreakable impasses of the international efforts both to effectively address the threat of anthropogenic climate change and to build a global, sustainable model of development. The reasons for these impasses have been highlighted with exceptional clarity by Hale, Held and Young in their book "Gridlock" (2013) and by Dale Jamieson in his book "Reason in a Dark Time" (2014). While Prof. Held and his colleagues focus on the international political reasons for these stalemates, Jamieson goes into more depth analysing also the psychological and cultural reasons. What is most important for the present research is the resulting mistrust in the capacity of international initiatives, like the Paris Agreement, to effectively (or, at any rate, efficiently) tackle these issues. Other experts also showed how national governments and markets are often incapable of achieving meaningful

progress towards building a sustainable model of development. Van der Heijden (2014: 3) highlights three main reasons, particularly related to urban development, which can be summarised as follows:

- Due to the long time periods needed for developing and implementing legislation and regulations, governments are too slow to effectively tackle the issues related to urban sustainability and resilience;
- The introduction of new legislation is often inconsequential, due to the rapidity of urban development in developing countries and to its slowness in developed countries;
- There are several powerful market barriers which too often impede to capitalize the benefits of those interventions aimed at sustainable urban development.

Given this context, cities do have a crucial role in building a sustainable model of development (Bloomberg, 2015). On the bright side of this arduous effort, there is the fact that many cities worldwide have started to realise the importance of this role, taking the initiative in their own hands. Indeed, as Tim Campbell (2012), van der Hijden himself (2014) and Michael Bloomberg (2015) already highlighted in recent years, cities and their municipalities are slowly but steadily learning how to deal with all these issues related to sustainable urban development both by themselves and by building networks. Many of these networks are finalised at learning and sharing best practices to solve common problems (Campbell, 2012).

This new peer-to-peer approach between what could be called new "wannabe-city-states" is the one that, in the opinion of a growing number of experts and scholars, holds the most promise for building the needed global model of sustainable development. Cities, indeed, are the places where people live, thus their governments and local stakeholders are the ones that should be appointed with the task to adequately care for their inhabitants, looking after their safety, providing them with the necessary services and resources and efficiently managing these, all of this without destroying the surrounding environment nor their inner environment.

Whether these efforts will be successful or not, in the end, depends on every single city and on how much commitment they manage to dedicate to this crucial effort. The EFSUA is conceived as an instrument that could help those cities that have (or aspire to have) this commitment and believe that they should take the initiative of their development into their own hands, if they want to improve both themselves and the wider system in which they exist.

Cities, thus, are the places in which to research, develop and test solutions just as much as they are amongst the principal sources of problems. Indeed, many cities worldwide, even some of the largest, have begun to introduce new approaches to sustainable urban development in several areas, ranging from building "greener" infrastructures to devising more socially inclusive supplies of services, to establishing some aspects of circular urban metabolism. Sometimes these efforts are consequences of their adherence to certain international initiatives and networks of cities (the European Covenant of Mayors, the C40 movement and ICLEI are all examples of these).

Finally, municipalities and urban stakeholders may be in the best position to deal with all the issues related to sustainable urban development most effectively and efficiently because, as institutions, municipalities are much closer to their citizens compared to national governments and International Organizations (IOs). On the one hand, this provides them with the ability to better understand the specific issues and strengths of the local contexts, thus tailoring their policies more accurately. This

also means, on the other hand, that municipalities are more vulnerable to the effects of local politics and the demands of the electorate, which is precisely the reason why they should not be the only actors in charge of the processes of urban governance (Campbell, 2012; van der Heijden, 2014).

Indeed, the nature of politics in municipalities is one that puts in jeopardy the long-term projects, interventions and M&E processes needed for sustainable urban development. Mayors and their Councils usually remain in office for periods too short to allow them to effectively pursue ambitious projects of sustainable urban (re)development. The result is that, too often, those projects started by one Town Council will be probably abandoned, or otherwise will lose most of their funds and importance, if the successive Town Council belongs to a different political party with different ideas on urban sustainability (van der Heijden, 2014). This is one of the cases in which democracy as we know it could (and often does) cause the failure of policies aimed at taking care of the best interests of the citizens.

2.2.2 The promises and hindrances of urban governance

However, as many experts have already highlighted in the past, cities, their governments and the local stakeholders generally do have the means to build successful mechanisms of urban governance, even if this effort requires high levels of commitment and the will to look for innovative solutions (Campbell, 2012; van der Heijden, 2014; Bloomberg, 2015). A most interesting list of such (more or less) innovative mechanisms is present in the work of van der Heijden (2014), along with many related examples.

The necessity to build effective and efficient mechanisms of urban governance is being realised by an increasing number of cities worldwide, which often show their commitment by striving to develop or learn best practices to solve their issues (Campbell, 2012). Many other cities, though, are still lacking the will or the favourable conditions to follow their example. Several typical issues that affect urban governance are:

- heavy bureaucracy;
- the inability to thoroughly control the policymaking process;
- the impossibility of reliance on appropriate funds;
- the incapacity or unwillingness to involve other stakeholders or to provide the public with information about the content and objective of plans;
- the inadequate care devoted to the management of data needed for urban sustainability M&E.

These issues can quite easily make it hard or even impossible to build efficient or at least, effective models of sustainable urban development.

It is now time to gather everything that has been written so far, from the definition of sustainable city, to its features according to the literature, to the reasons why we need these cities and how they can make the difference in the decades to come, to finally describe how a City for Tomorrow and the Day After (**CTDA**), the sustainable city as intended by this research, should be, and how the EFSUA can help urban planners and managers in bringing their cities closer to this model.

2.3 Conceptual model: the features of the City for Tomorrow and the Day After (CTDA) and the theories behind the related core indicators

The first step is the description of the features of a CTDA, by looking firstly at the three main domains of sustainability: the environment (**1.**), society (**2.**) and the economy (**3.**). Secondly, by describing how a successful urban governance for a sustainable urban development should be (**4.**).

By integrating the theories and concepts analysed in the literature review, a CTDA, thus a sustainable city as it is intended by this research, should:

1. Be **green, compact** and **accessible**: the sustainable city must protect and integrate as much as possible its natural environment and the ecosystem services it provides: provisioning, regulating, cultural and supporting services (Millennium Ecosystem Assessment, 2005). This must be done through a careful urban planning process, one that contributes to the quality of green spaces (Konijnendijk et al. 2004) and promotes the densification of the urban area while reducing soil consumption and sealing. This planning process should be inspired by the "Ecologically sound urban development" (ESUD), which requires the formation of a planning strategy, to indicate steps which can be taken at the local level and to draw up priorities for research, design and policy (Tjallingii, 1995). The concept of "sustainable accessibility" is also fundamental to direct urban planning if we want to achieve all these objectives (Bertolini et al. 2005; Curtis, 2008);
2. Be **inclusive, just** and **safe**: to successfully address the social issues that undermine the sustainability of an urban area, new approaches to urban planning are necessary. Rethinking the link between the composition of districts and social inclusion, fostering an equal distribution of the access to fundamental services, promoting equal opportunities among its citizens, especially the worse-offs. The promotion of social justice is indeed paramount, because social segregation is inherently unsustainable (Dempsey, 2008). On all these aspects depends the overall safety of urban areas (Cozens, 2008) which, in addition, relies also on other elements, like the capacity to respond locally and appropriately to various kinds of crises;
3. Be **self-sufficient, circular** and **efficient**: if urban sustainability is to be achieved, a city needs to move even beyond a green economy (Barbier & Markandya, 2013). Given the worsening effects of climate change, urban population growth and land, water, and food consumption (Brown, 2012), the ability to be, at least potentially, self-sufficient concerning the fundamental resources is a crucial prerequisite. Circular urban metabolism (UK National Archives, 2004; Girardet, 2008) and the internalization of social and environmental impacts of the local economic activities must be the guideline for the life of the sustainable city. The promotion and localisation of employment is another target to be actively pursued, since unemployment brings many social issues that destabilize the urban system;
4. Have **proactive, committed, integrated and accountable** urban governance: municipalities must realise the potential importance of their role in the global effort to build a sustainable model of development. They must also act accordingly, taking the initiative to implement those policies that can make their own cities at least less unsustainable, without waiting for long periods of time and for mostly too feeble effects of national and international resolutions (Campbell, 2012; Hale, Held & Young, 2013; Jamieson, 2014). Once they have realised this and started reforming and renovating, they must remain committed both to the objectives of sustainable urban development

and to the completion of the related policies. This means that municipalities should follow their policies throughout their phases (van der Heijden, 2014), from the design of the projects, to the supervision of their implementation, to the M&E of the outcomes. Furthermore, the processes of governance should be as integrated as possible. Meaning that every policy should consider the wider context, especially the already decided plans and strategies, to avoid contrasts and maintain the coherence of urban planning ("The New Urban Agenda," n.d.). Moreover, this integration should also entail the involvement of as many relevant local stakeholders as possible in the urban governance processes, without compromising their effectiveness. This would allow the opening of urban planning to the many ideas, energies, knowhow and funds that are in the private and associative sectors. Finally, urban governance and all the related processes should be transparent, providing the citizens with accessible information. The aim should be the enhancement of the accountability of municipalities and their potential partners for the results of their policies, whether they will be positive or negative (Weston & Weston, 2013). This requires a further effort in both collecting and efficiently managing relevant data.

These features, which are similar to those enlisted by UN-Habitat in its CPI initiative for "prosperous cities" ("The City Prosperity Initiative – Brochure – UN-Habitat," n.d.), have guided me during the design of the **core indicators** of the index of the EFSUA. As will be thoroughly explained in section **3.1**, the indicators were chosen by considering studies on the best practices in M&E[15], their compliance with a set of pre-existing criteria, the indicators used by tools with labels, aims or targets similar to the ones of the EFSUA (section **2.1.2**), the opinions of experts from both Poliedra and other organizations, and the macro-objectives of the EFSUA (presented in section **4.1**).

The indicators, both **core** and **local**, provide a simple and reliable quantitative or qualitative measurement of particular phenomena or attributes (Boyko et al., 2012; Climate-Eval, 2015). The choice of having a fixed core of indicators, meant to be applicable in every urban context in which the EFSUA will be used, is due to the conviction that there are some general attributes that are necessary, even if not sufficient, for urban areas to be sustainable.

Assuming that a multi-dimensional approach is the best way to obtain a comprehensive view about sustainability performances (L. Shen, Kyllo, & Guo, 2013) and given the peculiar nature of some of the dimensions that they measure, the **core indicators** are mixed. Meaning that there are both quantitative and qualitative indicators (Climate-Eval, 2015). For each of them I will indicate whether it is already used in other tools (with particular attention to the ones used by Arcadis and the OECD).

Here follows the description of the **core indicators** in relation with the underlying theories about sustainable urban development. The complete and operational metadata tables of these indicators are presented in **annex 1**. The **local indicators** used in the first application of the framework to Giambellino-Lorenteggio, instead, will be presented in section **5**, since they pertain specifically to the case study.

At the end of every list of indicators I will also add some suggestions about possible **local indicators/**sub-indicators, applicable to adapt the index to various possible contexts. They could measure less generalizable dimensions of sustainability, like the preservation of cultural heritage

[15] The main one being the Climate-Eval study on best practices in the M&E activity related to climate change adaptation (2015), commissioned in the context of the EU initiative Mayors Adapt, now integrated in the EU Covenant of Mayors

("Goal 11 targets," n.d.), or the quality of education (Vitali et al. 2018) or others. From this moment onward, in this research, the name of the indicators will be reported 'between apostrophes' to distinguish them from the wider theories and concepts that their title might recall.

2.3.1 Environmental core indicators

The environmental core indicators are: 'greenness', 'compactness', 'accessibility', 'soil protection', 'green-development', 'mobility' and 'CO2 emissions'. They are related to the features of the CTDA: **green**, **compact** and **accessible**.

There are three main theories underpinning these features of the sustainable city and the related indicators. The first one, from which the 'greenness' is inferred, concerns the value of the ecosystem services (Millennium Ecosystem Assessment, 2005) which are fundamental for the equilibrium between the built environment and its natural background, as well as for other aspects influencing the resilience of the urban environment. The other two main theories are crucial for the physical shape of the city and its mobility. They are the theories of "sustainable accessibility" (Bertolini, le Clercq, Kapoen, 2005) and "green TODs (Transit Oriented Development[16] strategies)" (Cervero & Sullivan, 2011). Starting from the latter, the approach defined as green TODs "is a marriage of TOD and green urbanism" (Cervero & Sullivan, 2011: 210). The related theory of sustainable accessibility can be defined as "developing transport and land use conditions for as large as possible a share of environmentally friendlier transportation methods than the conventional car, while at the same time maintaining and possibly increasing the amount and the diversity of activity places that people can reach within a given travel time and/or cost" (Bertolini, le Clercq, Kapoen, 2005: 209). Here follows the description of the indicators.

- Quantitative core indicators:
  - 'Greenness' Almost every index or framework accounting for urban sustainability keeps track of the green areas in the city. Indeed, both the "Sustainable Cities Index" by Arcadis and the "Resilient Cities framework" by the OECD have similar indicators, the latter one accounting for the square meters of green surface per inhabitant. In EFSUA, 'Greenness' considers the presence of public and private green areas within the urban area. The reason is that while many ecosystem services (Millennium Ecosystem Assessment, 2005) are provided by both typologies of green, some others are accessible to the wider population only in the public areas (e.g. their function of socialization hubs). It is calculated as the percentage of public and private green areas compared to the percentage of grey areas and of brownfield sites, and their distribution across the urban area;
  - 'Compactness' The OECD's framework has a very similar indicator. Population density is a common indicator in evaluating urban sustainability, given the advantages of a high density in terms of efficiency in the use of resources and delivery of services. In EFSUA, 'compactness' is connected to the concept of TOD and it measures the population density and its concentration near intermodal transit nodes;

[16] "It typically features compact and mixed-use activities configured around light or heavy rail transit stations, interlaced with pedestrian amenities. TOD is one of the more promising tools for breaking the vicious cycle of sprawl and car dependence feeding off of each other, replacing it with a virtuous cycle: one where more and more trips shift from cars to transit and compact station-area development slows the spread of sprawl" (Cervero & Sullivan, 2011: 210)

- ‘Accessibility’ Such an indicator is absent from too many other frameworks and indexes, even though the importance of cumulative opportunities measures of accessibility is confirmed by many studies of urban planning specialized in this subject (among the others: Geurs & van Wee, 2004; Bertolini et al. 2005). This is a crucial indicator providing valuable information on the sustainability of both local urban mobility and planning. It measures the average space-time-costs distance between the citizens and the activities and services (shops, offices and workplaces in general, leisure activities and services, including public green spaces). In EFSUA ‘accessibility’ is calculated through location-based measures, the average space-time-cost distances calculated from the nearest and farthest resident with respect to the various places and destinations (Geurs & van Wee, 2004);
- ‘Soil protection’ Soil consumption and sealing are often tracked in environmental evaluation as SEAs and EIAs, by both national (e.g. ISPRA in Italy) and international agencies (like the EEA). This indicator streams directly from the concept of strong sustainability: natural capital is non-substitutable by man-made capital, so it should be preserved (Barbier & Markandya, 2013). The consumed soil is intended as all the soil that is not left natural or used for agriculture or dedicated to public green areas, while the sealed soil is all the soil artificially covered (“Il consumo di suolo — Italiano,” n.d.). In EFSUA, ‘soil protection’ will be calculated as the percentages of the soil consumption and soil sealing compared to the total surface of the urban area;
- ‘Green-development’ OECD has a similar indicator but accounting only for the percentage of new urban development near transit locations. Keeping in mind the concept of strong sustainability and the ‘soil protection’ indicator, ‘green development’ accounts only for urban renewal, as new development usually causes more soil consumption and sealing. In EFSUA, ‘green-development’ is calculated as the percentage of the surface of the area targeted by plans of sustainable urban renewal, guided by concepts like “sustainable accessibility” (Bertolini, le Clercq, Kapoen, 2005), “green TODs” (Cervero & Sullivan, 2011), promotion of energy efficiency and similar;
- ‘Mobility’ The modal split of journeys is often used as an indicator, for example by the EEA in its reports. Urban mobility can be among the most impactful sources of GHGs at the urban level, so keeping track of its composition is crucial from the perspective of sustainable urban development. In EFSUA, ‘mobility’ is calculated through the percentages of urban journeys divided per mode (mode splits): car, motorcycle, public transportation and bike;
- ‘CO2 emissions’ Environmental indicators accounting for GHG emissions are very common in environmental assessments. Furthermore, both the importance of the impacts of CO2 on global warming and their temporal reach are well-known (Steffen, Grinevald, Crutzen, & McNeill, 2011). In EFSUA, this indicator measures the amount of CO2 emitted annually in the urban area divided by source (transport, buildings, industry…).

The main advice for the integration of the environmental core indicators at the local level concerns the measurement of potential climate change adaptation strategies, since the principal threats in this respect may vary greatly from case to case. Another important indicator could measure the quality of water, according to the wider environmental conditions of the area or the potential presence of industries and pollutants.

2.3.2 Social core indicators

The social core indicators are: 'inclusiveness', 'equity', 'security', 'aggregation' and 'fairness'. They are related to the features of the CTDA: **inclusive, just** and **safe**.

The indicators 'inclusiveness' and 'aggregation' descend from the increasingly shared theory that poverty and its effects are one of the greatest threats to the achievement of a sustainable model of development (UNDP, OECD and EU all share this belief, just to cite some of the major IOs). Moreover, combined with the other social indicators and the first two environmental indicators, they are a reflection of the theory that a too wide and evident social divide between better-offs and worse-offs can easily create social tensions, putting in jeopardy the overall safety of the urban area, while a high quality sustainable urban development contributes to the citizens' safety (Cozens, 2008 & 2011). Here follows the description of the indicators.

- Quantitative core indicators:
  - 'Inclusiveness' The OECD's framework accounts for "poverty levels" in general, while the Index by Arcadis makes use of the Gini coefficient[17]. Both may give an account of the inequalities in income distribution, yet they provide no information about the territorial diffusion in the urban area. This means, in turn, that they also provide little or no direction to urban policymakers for possible interventions. In EFSUA, 'inclusiveness' is intended as an indicator accounting for the social divide in the urban area. Meaning that if the poor families are highly concentrated in a few (probably degraded) areas, this could be a clear indication of social segregation. This concentration leads to an increase in the social divide between better-offs and worse-offs, thus incrementing also the tensions between these groups that could, in turn, affect the overall safety of the urban area. The indicator is calculated as the density of poor families (number of poor families / total number of families) living in the whole urban area compared to the density of poor families living in poor neighbourhoods (those in which 2/3 of resident families are poor). The definition of poverty and its measurement should be determined by linking them to the local contexts (absolute and relative poverty in Milan, for example);
  - 'Equity' Arcadis in its "Sustainable Cities Index" (Arcadis, n.d.), for example, measures only the percentage of households having access to drinking water and improved sanitation, but there are other fundamental services from the perspective of urban sustainability as well. In EFSUA, 'equity' measures the diffusion of public services. It is calculated through the percentage of citizens who have the potential to directly access four fundamental services: water and energy supply, waste management and public transportation.;
  - 'Security' Istat has a similar indicator for the 11th SDG and more generally crime rates, or homicide rates (Arcadis, n.d.), are often used to evaluate urban sustainability. In EFSUA, it is calculated as the number of penal crimes reported from the police to the judiciary.;
  - 'Aggregation' This indicator aims at complementing 'inclusiveness' by keeping track of a phenomenon, gentrification, which tends to worsen the social divide in the urban area by forcing the worse-offs out of the requalifying neighborhoods and into suburbs that could easily turn into slums. The indicator measures the number of low-income people who moved to the

[17] "It is often used as a gauge of economic inequality, measuring income distribution or, less commonly, wealth distribution among a population. The coefficient ranges from 0 (or 0%) to 1 (or 100%), with 0 representing perfect equality and 1 representing perfect inequality. Values over 1 are theoretically possible due to negative income or wealth" (Staff, 2008).

area in the precedent year, so it is the opposite of gentrification rate. This indicator should be calculated, at the level of a whole city, averaging the values in the various districts, keeping these as sub-indicators. In this way, it could be easily used to verify in which districts the situation is worse;

- Qualitative core indicator:
  - 'Fairness' This qualitative indicator integrates the spatial information provided by 'inclusiveness' and 'aggregation', with information on a present or absent attention to issues and inequalities related to gender, minorities and poverty in the urban planning process and its official documents and guidelines. It measures to what extent are inequalities related to gender and minorities addressed in the local context. It ranges from 1 (not addressed) to 5 (extensively addressed).

The advice concerning the integration of these social indicators is, for example, to develop **local indicators** which consider the level of education or the capabilities of the local civil protection corps (firefighters and similar). Another important indicator could also consider the geographical distribution of penal crimes, to integrate the 'security' indicator with valuable spatial information. A potential integration of 'equity' could consider the coverage and quality of telecommunications (coverage may be more appropriate in remote areas or in less-developed countries, while the quality would be more relevant in more urbanized regions and in more developed countries).

2.3.3 Economic core indicators

The economic core indicators are: 'self-sufficiency', 'circularity', 'energy', 'localization' and 'diversification'. They are related to the features of the CTDA **self-sufficient, circular** and **efficient**.

The fist main theory underlying these indicators is the theory of circular urban metabolism, which foster the change from linear to circular of those flows of resources, people and goods that are vital for cities to live and prosper (UK National Archives, 2004; Girardet, 2008). The other main theory is inspired by the concept of "modularity" (Kabisch, n.d.: 4) and it concerns the necessity to ensure a certain degree of potential independence to urban areas and their components to face the increasing threats represented by the effects of local environmental changes and anthropogenic disasters in general, enhancing urban resilience. Here follows the description of the indicators.

- Quantitative core indicators:
  - 'Self-sufficiency' This indicator streams directly from the theory of circular urban metabolism (UK National Archives, 2004; Girardet, 2008) and from the concept of "modularity", which in an urban area means that "it has to be ensured that urban components […] have enough independence, to ensure that damage or failure of one part or component of a system has a low probability of affecting the other components" (Kabisch, n.d.: 4). This indicator measures how much of the demand for water, food and energy is satisfied by locally produced resources. This is one of the most innovative indicators of the EFSUA, but it derives from the obvious consideration that in the increasingly frequent case of major environmental calamities (or anthropogenic ones), the ability of a city to sustain itself with its own resources, without having to rely completely on external supply/aids, is a crucial step towards the achievement of effective climate adaptation and urban resilience. In EFSUA 'self-sufficiency' is calculated

through the percentages of the consumption of water, food and energy that is satisfied by their local production;

- ‘Circularity’ This indicator as well derives directly from the theory of circular urban metabolism (UK National Archives, 2004; Girardet, 2008). The percentage of waste recycling is generally used to evaluate the sustainability of cities. For example, Arcadis (n.d.) uses almost the same indicator. In the EFSUA, ‘circularity’ is calculated as the percentage of solid waste recycled, and wastewater treated and reused.;
- ‘Energy’ Arcadis (n.d.) uses the same indicator, which is fundamental to have information about the sustainability of the urban energy supplies and about the efficiency of energy use in the area. In EFSUA, it is calculated as the total energy consumption and its share by fossil or renewable energy sources (RES);
- ‘Localization’ the employment rate is usually used as an indicator for urban sustainability (for example by Arcadis, n.d.). ‘Localization’ differs because it gives an account of the interactions between local work demand and supply. It is calculated as the percentage of resident workers employed locally. Analyzing the interactions of this indicator with the data collected to calculate ‘diversification’ could provide valuable information on the features of the workforce in the city (its composition, average level of qualifications and so on), accounting also for the quality and sectorial distribution of jobs in the city.

- Qualitative core indicator:
  - ‘Diversification’ This qualitative indicator measures whether the local economy is heavily dependent on one or very few economic sector/s or even firms, or it is diversified. It ranges from 1 (very concentrated) to 3 (very diversified) The latter case is a clear indication of good economic resilience, since a highly diversified urban economy can shelter the city from the worst effects of potential economic crises in single industries/sectors. It is also a revealing sign of the attractiveness of the city for firms and investments (Ahern, 2011).

A possible **local indicator**, depending on the context, would be one accounting for the sustainability of tourism in the city, a comparison between the revenues it produces and its negative impacts.

One concluding remark about the integration with **local indicators** concerns the possibility to design some of them as additional sub-indicators for the **core indicators**. For example, in the case of ‘circularity’, one possible addition could be to also consider energy recovery.

It is important to keep in mind that the dimensions measured by these indicators are not independent and separate from each other. On the contrary, variations in one of these dimensions can bring changes in one or more of the others, as them and their related indicators are interconnected. These relations exist both within and between the sustainability domains and they are analysed in detail in section **4**.

The situation is quite different for the qualitative indicators addressing urban governance, since they describe the policymaking processes which have effects on all the domains. This relation is thus mediated by the policies. Indeed, the mechanisms of decision making, the ones of the implementation of policies, the learning processes, the budget management and other aspects of governance can indirectly have huge impacts on every strategy and plan for sustainable urban development. The importance of governance in this field has been highlighted by many scholars and experts, one being Jeroen van der Heijden in his “Governance for Urban Sustainability and Resilience” (2014). From this work it also appears evident that governance is on “another level” compared to the three domains

of sustainability. It influences all the strategies and plans that can have effects on the various components of the three domains of sustainability. This research agrees with this theory, thus it disagrees with those tools, like the "Resilient Cities Framework" of the OECD, which treat governance as, de facto, the fourth domain of urban sustainability on the same level as environment, society and economy.

At any rate, it is crucial to give an account of the "quality"[18] of urban governance, a description of its processes and mechanisms, because the success, or not, of the efforts made towards sustainable urban development depends on them. This important role of urban governance emerged also from the interviews that I have conducted during the research and it led me to design also a series of indicators for urban governance, which will be presented in section **4**.

3. Research Methodology

This section will now present the methodology of this research. The literature review, the theoretical framework and the conceptual model, presented in the previous section, will be now recalled and contextualized within the phases of the research.

3.1 Research Strategy: methods, data collection and analysis

The research is divided in four phases, thoroughly described in the next paragraphs:

1. the creation of the Evaluative Framework for the Sustainability of Urban Areas (EFSUA)
2. the first evaluation: the Sustainability Status Evaluation (SSE)
3. the interviews with the stakeholders and experts
4. the second evaluation: the Sustainability Impact Evaluation (SIE)

Building the EFSUA

The first phase of the research consisted mostly of a secondary analysis of books, scientific articles and papers, reports and dissertations (section **2.1**). The collected data have been combined and filtered with my own background knowledge and discussions with the experts of Poliedra to infer the definition and features of a sustainable city. These constituted the starting point for creating the evaluative framework. From these features, considering also the findings of similar studies and researches, I have deduced the **core indicators** that form the backbone of the index contained in the EFSUA, introduced in section **2.3**. The choice of relying on indicators is because "compared to many other feedback mechanisms, well-designed indicators have the advantage of providing easily comprehensible information. Thereby, they can form a factual basis upon which informed political decisions can be taken" (Figueiredo, Honiden and Schumann, 2018: 25).

I have selected most of the similar studies and researches and the related tools for evaluating urban sustainability through a topical search in Google Scholar. Meaning that I have searched explicitly for "tools to assess urban sustainability" and I have selected several recent researches (from the 2010

[18] Always remembering that this framework is not meant for comparisons or classifications, but to provide useful information to the local administrations and stakeholders involved in the urban policymaking processes.

onwards), which are referenced in section **2.1.2**[19]. Moreover, I have considered with special interest the "Sustainable City Index" by Arcadis (2016) and the Resilient Cities Framework by the OECD (2015) due to both their recent development and international recognition. Considering these tools and studies, I have then selected the dimensions that, in the light of the theoretical framework of this research, are the fundamental and most generalizable ones for urban sustainability, then I have selected the related set of **core indicators** of the EFSUA (section **2.3**). The selection criteria for the indicators were several. Mainly, the indicators I chose had to measure dimensions that are relevant for the achievement of the macro-objectives presented in section **4.1**, the main ones being the achievement of urban resilience and the prevention/mitigation of negative externalities[20]. Moreover, following one of the recognised best practices in the M&E activity, I selected these indicators according to existing criteria (Climate-Eval, 2015). These criteria are the ADAPT principles[21] (Villanueva, 2011). Some of these indicators were directly taken from other tools, especially the ones from Arcadis and the OECD, some others are adjustments of existing indicators, a minority of them derive directly from theories of sustainable urban development. The theoretical background of each indicator has been extensively presented in section **2.3**, which addressed the conceptual model of this research.

The first evaluation: the first SSE

The second phase of the research involved the first part of the explorative application of the framework to a case study. There are several reasons behind the choice of a single case study. Firstly, the application of EFSUA requires the acquisition of a vast amount of data to calculate several indicators which measure many different features and dimensions. Secondly, case studies easily allow "the employment of *both* quantitative and qualitative research" (Bryman, 2012: 68), which is appropriate in the present case, given the mixed nature of the approach and indicators. Thirdly, I agree with the opinion of Bryman (2012: 69) when he says that he "would prefer to reserve the term 'case study' for those instances where the 'case' is the focus of interest in its own right." In fact, in this case the city does not just provide a background for the research, it is the object of it and it is intended to be an "*exemplifying* case" that "will provide a suitable context for certain research questions to be answered" (Bryman, 2012: 70). Furthermore, before applying the EFSUA to more cases, it is crucial to verify its performances and adequacy with this first application. Finally, the mechanisms embedded in the involvement of the local stakeholders can implicate long time periods and difficulties in the arrangements of the necessary interviews, again contrasting with the limited time available for the research. These mechanisms are needed to avoid the tendency to generalize the M&E activity, which entails the application of the same standardized and pre-packaged tools even in completely different contexts[22].

The chosen case study is a suburban area of Milan composed by the two districts of Giambellino and Lorenteggio. The two neighbouring districts have been treated like a single area (Giambellino-Lorenteggio), aggregating their data, because they are both affected by the plan whose impacts are

[19] Shen, Jorge Ochoa, Shah, & Zhang, 2011; L. Shen, Kyllo, & Guo, 2013; Tanguay, Rajaonson, Lefebvre, & Lanoie, 2010; Boyko et al., 2012; Mori & Christodoulou, 2012; Pupphachai & Zuidema, 2017

[20] The macro-objectives of the EFSUA are thoroughly described in section **4**

[21] According to these principles, the tool and its indicators should be **Adaptive** (flexible) **Dynamic** (capturing changes) **Active** (incorporating local contexts) **Participatory** (involving those affected) **Thorough** (use generic and specific indicators and accounting for maladaptation)

[22] which is a bad and still too common practice (Climate-Eval, 2015)

the object of the second evaluation. The choice of these districts is principally due to three reasons. Firstly, Giambellino and Lorenteggio, together with the related ongoing plan AdP Lorenteggio, form an exemplary case of degraded suburban areas interested by renovation plans in Milan. Indeed, several suburban districts of Milan suffer from various issues involving all the three domains of sustainability. Consequently, in the last decades, the municipality has been undertaking a series of plans of urban renewal targeting precisely the suburbs, especially those hosting complexes of public housing[23], like the one located in Giambellino. The second reason is the involvement of Poliedra (my host organization) in the environmental assessment of the actions of this renovation plan. It provided an excellent opportunity to both have access to relevant documents and data and facilitate the contacts with the local stakeholders involved in the policymaking process. The third reason is the very fact that the ongoing plan is explicitly aimed at sustainable urban development ("Asse V Sviluppo Urbano Sostenibile," n.d.).

This first part of the application of EFSUA is an evaluation of the status of the sustainability of the urban area of interest, which I named **SSE**: Sustainability Status Evaluation. The data have been collected and used to calculate the indicators using diverse sources and methods. I have mostly used already existing databases to gather the raw data, which in most cases I have further elaborated myself through diverse calculations, as illustrated below for each indicator. The reliability of these sources lies in their public and official nature. Many of the data, as explained below, were retrieved from institutional sources. Whenever possible, given the focus of the EFSUA on cities, I have used directly the data provided by the municipality of Milan through its statistical web database, the SiSI ("SISI - Sistema Statistico Integrato del comune di Milano," n.d.) or through its official documents. When these were unavailable, I relied on those provided by Lombardy Region, its agencies or, mostly for the economic indicators, on the sustainability reports of the companies providing the services in the studied area. For some indicators I had to rely also on data provided by the Italian National Institute of Statistics (Istat). The complete list of the data sources used for the SSE is contained in **appendix B**. The thorough description of the methods used to calculate the **core indicators** for the first evaluation is presented hereby. Again, remember that the names of the **core indicators** are reported 'between apostrophes' to distinguish them from the wider concepts and theories which they might recall.

The data for '**greenness**' were retrieved from the Geoportal of Lombardy Region in the form of shapefiles. I have later processed and analysed these files through a GIS software, extracting the necessary data to calculate the percentage of surface in Giambellino-Lorenteggio that is devoted to public and private green areas. The indicator was fully calculated.

The calculation of '**compactness**', instead, has been much simpler, given that the municipality in 2016 produced a document, as part of its PGT (Plan for the Government of the Territory), which addresses the characteristics and peculiarities of each of the 88 districts in which the city of Milan is divided. The extension of Giambellino and Lorenteggio and their respective populations were both present as data in this document. I merely combined them in the calculation of the indicator providing the aggregate measure of the population density for the whole area. The concentration of the population density around the intermodal transit nodes was not possible, since I had the positions of

[23] "housing provided for people on low incomes, subsidized by public funds." ("public housing definition - Cerca con Google," n.d.)

the nodes, but I didn't find such detailed geo-referenced information about the territorial distribution of the population density within the single districts. The indicator was partially calculated

To calculate 'a**ccessibility**' I have used the routing service provided by Google Maps. I have calculated the distances, time and costs needed for the closest citizen and the farthest[24] in Giambellino-Lorenteggio to reach the various destinations, applying the concept of location-based measure of accessibility (Geurs & van Wee, 2004) as indicated in the metadata table of the indicator. Successively, I calculated the averages of these distances and aggregated them whenever needed[25]. I followed a series of methodological assumptions during the calculation of this indicator:

- Population density was consciously ignored in the calculation of the averages, in order not to attribute less importance to the citizens living in more isolated locations;
- The costs that I have considered are exclusively those required for journeys via LPT. The choice not to consider the costs of journeys by private vehicles (car/motorcycles) was due to the consideration that these costs vary greatly according to the fuel, the model of the vehicle and its maintenance. Moreover, the choice to concentrate only on the costs of the transportation mode that is accessible for the largest part of the population appeared to be more sensible.
- I have consciously ignored the places of worship in the calculation of the sub-indicator concerning culture due to the presence of citizens of different religions. Indeed, a catholic church would be meaningful in this calculation for a Catholic inhabitant, while it would be meaningless for a Muslim one. I choose to focus only on major neutral cultural activities/places, like public libraries and museums.
- The space-time-costs distances of journeys by bike have not been measured. There are still very few bike lanes in the area (in many parts of Giambellino-Lorenteggio there are none) and the routing service of Google Maps itself could not specifically calculate journeys by bike. The resulting assumption is that these journeys are following the same routes as those performed by car, travelling for the same distances but spending more time. This means that the space-time-costs distances of journeys by bike are comprised somewhere in between those on foot and those by car.

Following these assumptions, the indicator was fully calculated.

The calculation of '**soil protection**' required a partially more approximated procedure. Starting from one of the same shapefiles used for 'greenness', "DUSAF 5.0" ("Metadati - Geoportale della Lombardia," n.d.), I calculated the percentage of soil consumption by subtracting from the whole surface of the two districts all the public green areas and the natural and agricultural land. The more approximated part was the calculation of the sub-indicator for soil sealing (SS). I have applied a study precisely aimed at calculating this dimension starting from the DUSAF database (Corticelli, Guermandi, Mariani, 2008). This study related every category of land use belonging to the DUSAF database with the corresponding average percentage of soil sealing. I have used these percentages to calculate the related sub-indicator (the approximation entailed in this procedure is also indicated in

[24] In most cases, the closest inhabitants were the ones living in the very buildings where the activities/shops/services were located. In the other cases (hospitals, school, police and so on) I have manually verified the closest households in the districts with the routing service of Google Maps.

[25] In the case of schools, I have calculated the average between the distances from kindergartens, primary, secondary and high schools

the **table 5.1**, which summarizes the SSE). The indicator was fully calculated but the sub-indicator for soil sealing is an approximation.

'**Green-development**' was calculated through a proxy indicator, using the data retrieved from the web page of the OAPCCM[26], which displays on various maps of Milan the projects of urban (re)development, including the areas that are object of ongoing plans of urban renewal (these areas are named ATU, Areas of Urban Transformation). The only one located in Giambellino-Lorenteggio that is aimed at sustainable urban redevelopment is currently the one of the requalification and enhancement of the rail station San Cristoforo, with the further addition of the last stop of a new metro line (Milan has already 4 lines). The website reported the surface involved in this project as indicated in the approved plan. This area constitutes 2,48% of the total surface of Giambellino-Lorenteggio. The indicator was calculated using a proxy.

Finally, to calculate '**mobility**' and '**CO2 emissions**' I have used the data from previous official scientific studies of the municipality, contained respectively in the PUMS (Urban Plan for Sustainable Mobility) and in the PAES (Plan of Action for Sustainable Energy), both approved in 2013. This decision was due to several reasons. Firstly, more recent and updated data were unavailable. Secondly, these dimensions were extremely difficult to calculate first-hand, as they are the mode splits of urban journeys and the estimated total emissions of CO2 in Milan. Finally, the fact that these studies formed the scientific bases for two of the major plans of urban renovation in the city contributes to the reliability of their findings. Both the indicators were fully calculated, even if using non-updated data.

Concerning the social indicators, with great disappointment I found many difficulties in calculating '**inclusiveness**'. I made various attempts, but the truth is that even general information about the incidence of poverty of households is relegated to abstract averages mostly calculated by Istat. This resulted into a rather approximated calculation of the actual concentration of poor families in the area, which is of utter importance in a context where poverty and social issues are so strong (as confirmed by both the interviews with the stakeholders). I used the data provided by Istat on the average incidence of poverty among the families with the majority of foreign components in suburban areas in the North-West of Italy and I have compared them with the records contained in the SiSI on the number and composition of such families in Giambellino-Lorenteggio. I have chosen this as a proxy indicator for two main reasons. These families are particularly numerous in this area and their economic situation tends to be worse than that of the average of families with a majority of Italian components, making this an acceptable approximation of the actual concentration of poverty in this area. Indeed, despite the approximation of the method, the concentration of poor families in the area is higher than the average in Milan, but the value still underestimates the gravity of the real situation as it was described by the interviews with the local stakeholders. The indicator was calculated using a proxy.

'**Aggregation**' was calculated through a proxy indicator as well. It is connected to the one used for 'inclusiveness' to preserve the coherence of the evaluation. It tracks the variation in the number of foreign inhabitants in the two districts during the last years (the focus on foreign inhabitants as an

[26] Ordine degli Architetti Pianificatori, Paesaggisti e Conservatori della Provincia di Milano

approximation of the worse-offs is due to the reasons explained in the previous paragraph). This indicator was calculated using a proxy.

The calculation of '**equity**' was carried out with two different methodologies. The sub-indicators accounting for the potential access to the distribution of water and energy and to waste management were calculated by consulting the data contained in the "sustainability reports" and the yearly reports of the two companies managing the water and energy distribution networks (respectively: Metropolitana Milanese – MM and A2A Energia) and of AMSA, the company in charge of waste management in Milan. For the sub-indicator accounting for the distribution of LPT, instead, Google Maps was required to check that all the households in the area have a bus/streetcar/metro stop within 250 meters. The indicator was fully calculated.

For '**security**' I have directly used the data from Istat on the number of penal crimes reported from the police to the judiciary and the related penal crime rate. Such data were available for the whole city of Milan but, sadly, not for the single districts. The indicator was fully calculated.

Finally, the score of '**fairness**' was calculated by examining the official document of the Municipality on integrated urban planning for sustainable urban development in Milan (Strategie di Sviluppo Urbano Sostenibile, 2015). This document presents the guidelines for the current and future development of the city, including the necessary information concerning the attention payed to the issues of minorities and worse-offs, and it has been considered also during the policymaking process of AdP Lorenteggio, as the Agreement itself reports (AdP Lorenteggio, 2016). The indicator was fully calculated.

The data needed to calculate '**self-sufficiency**' were collected in accordance with the various dimensions measured by the sub-indicators. The data for the economic value of the local production and consumption of food were retrieved from the web page of the Municipality addressing the "food policy" of Milan. The ones concerning water harvesting are contained in the sustainability report of MM, while those about the local energy production had to be gathered through the consultation of the website of Terna (the national manager of electricity networks). Indeed, since the energy market is now open to competition, A2A could provide just the data for the diffusion of the service (as it manages the local network) but it could not provide the cumulative data on the consumption and production, since these involve the activities of the other energy companies. The downside is that the data for the single cities were not available, so I had to use the data concerning the whole metropolitan area. The indicator was fully calculated, with the highlighted issue concerning the sub-indicator for local energy production.

In the case of '**energy**' the source was still another, a quite outdated yet detailed study, named SiReNa, carried out by Infrastrutture Lombarde (Infrastructures of Lombardy) addressing the energy consumption, divided per energy vector, of the cities in Lombardy. The indicator was fully calculated, even if using non-updated data.

'**Circularity**' was calculated combining the data on water distribution, treatment and reuse contained in the "sustainability report" of MM, with those contained in both the reports of AMSA and the Regional Agency for the Environmental Protection (ARPA Lombardia) regarding the recycling of solid waste. The indicator was fully calculated.

'**Diversification**' was calculated by combining and evaluating the data on the number of employees in the different economic sectors in the metropolitan area of Milan (more recent but not focused on the city nor its districts) with those on the number and size of enterprises working in the different sectors in the city of Milan (outdated, 2011, but more focused on the city). The indicator was fully calculated.

Finally, the data needed to calculate '**localization**' are directly available in the SiSI, which reported the number of people both living and working in Milan. The indicator was fully calculated.

The choice of relying on public documents and databases whenever possible is aimed at making it easier to verify the results and assessments of both the evaluations, since anyone can access the relevant data and their sources without clearance barriers. Another aim is to highlight the possible shortcomings in the public management of the relevant data, so that the municipality of Milan (as well as every other municipality that will potentially rely on this framework in the future) can obtain information about what needs to be improved in its data-related processes and services. Finally, the choice to base the calculation of the indicators principally on already collected and organized data is also linked to the consideration that acquiring them by other means would have made the process too long and difficult for a single person, considering also the limited time available to conduct the research. Such comprehensive evaluations, indeed, are usually performed by teams of people.

The interviews

Proceeding with the third phase of the research, I have used the connections of the host organization, Poliedra, to arrange one round of interviews, carried out in Italian, divided into two groups. The first group included two semi-structured interviews (Bryman, 2012) with the representatives of the identified most relevant local stakeholders: the Lombardy Region and obviously, the municipality of Milan. They were chosen because of their weight in the administration of the urban area and because of their cooperation in the design of the plan (co-planning) whose impacts have been evaluated through the SIE in section **5**. These interviews had the main objective of involving them in the M&E process and of acquiring information and data that were necessary for the successive phase of the research. Both the interviews were preceded by the provision, by e-mail, of the questions to the interviewees, allowing them to express their opinions about:

- the main issues of the urban area of interest (the districts Giambellino and Lorenteggio in Milan);
- potential policies needed to tackle these issues;
- the adequacy/appropriateness of the current action plan (AdP Lorenteggio) compared to the first two points;
- which dimensions should be monitored to measure the results of the plan and through which indicators this should be done;
- the identified features of a sustainable city and the associated core indicators;
- if there are people belonging to other stakeholders that should be contacted and interviewed.

The questions addressed the above-listed topics and are reported in **annex 3** together with the answers. The data collected from these interviews (referred to as **Int.Plan.1** and **Int.Plan.2**) have been used for the development of the **local indicators**. These reflect the opinions of the stakeholders as much as possible, according to the already mentioned CBA approach (Climate-Eval, 2015),

considering and including their views about the local issues and related objectives of sustainable urban development.

The second group consisted of two interviews as well. These had the more general purpose of discussing the validity of the proposed tool, its components and theoretical background, with experts of sustainable development and urban resilience. These interviews have been preceded by the provision of the relevant information needed to describe the research and tool to the interviewees. These framework-related interviews followed different modalities. In the first case, with a representative from Legambiente[27] (**Int.Frame.1**), the information concerning more specifically the identified features of the sustainable cities and the **core indicators** were provided in hard copy during the interview and they have been the main focus of the discussion. The principal reason to interview a member of Legambiente is that this organisation in 2017 released its own report on cities ("Ecosistema Urbano 2017 | Legambiente," n.d.), based on an index which included some indicators that are similar to the **core** ones, so the discussion could really benefit from the knowledge of this NGO concerning urban sustainability. For the second interview (**Int.Frame.2**) some segments of the theoretical framework of the research were delivered in advance to the interviewee, Professor Colucci, in order to let her analyse more in-depth the appropriateness of the use that is made in this research of the concept of resilience, which is her field of expertise. She was chosen as an interviewee precisely for her deep knowledge of this subject, as she is a member of REsilienceLAB and a professor in the University Politecnico in Milan. Given the more conversational nature of this second group of interviews, these were not structured. They simply followed the order of the observations of the interviewees as they expressed them.

The second evaluation: the first SIE

The successive phase of the research, the fourth, involved the evaluation of the impacts of AdP Lorenteggio on the sustainability of this urban area, using both the **core indicators** and the **local** ones. This evaluation is named **SIE**: Sustainability Impact Evaluation. Its results are summarized in a series of tables showing the potential impacts of the plan registered by each indicator through the use of colours and symbols. These indicate whether the plan (its actions) potentially has a negative impact, a negligible impact/no impact at all, or a positive impact. The evaluation of these impacts has been based on the description of the actions, the data collected from the masterplan and the latest available report of the Supervisory Board in charge of the plan (whose meetings are attended also by Poliedra). These tables reporting the expected impacts of the single actions have been successively aggregated in four tables summarizing the effects of each "sub-plan" belonging to AdP Lorenteggio[28]. Finally, these evaluations have been combined in a single table summarizing the effects of the whole AdP. Only the latter table is reported in the main body of the research (section **5.2.2**), while the other tables are in **annex 4**. The main purpose of this SIE was to verify if the plan could eventually uphold its title[29] and declared objectives.

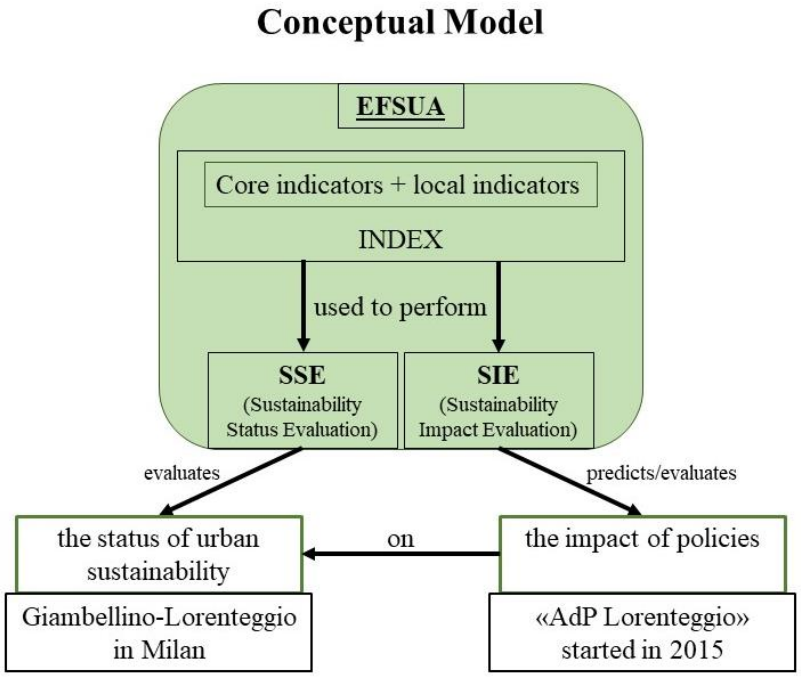
Figure **3.1** below resumes both the composition and application of EFSUA

[27] Maybe the most important and renown Italian NGO advocating environmental protection and sustainable development

[28] Further clarifications about the structure of this plan and its sub-plans are contained in **section 5**

[29] ("Asse V Sviluppo Urbano Sostenibile," n.d.) translated as "V Axis Sustainable Urban Development"

Figure 3.1: The conceptual model of the research



3.2 Validity, reliability, replicability and ethics

It is important to underline that the final aim of this research is not to produce a universally accepted definition of sustainability, sustainable cities and development, for many others possessing much more knowledge and expertise have been dedicating themselves to this task for decades (still, without success). The true aim of this research is, instead, to provide those who share my vision, understanding and (growing) concerns about the threats that human kind is facing by its own hand, with a tool that could help in reforming our cities in a way that will potentially allow us and the next generations to live a "meaningful life" (Jamieson, 2014) in the world of tomorrow and the day after.

The validity and reliability of the present research has been actively and persistently pursued by using public and whenever possible, official sources for the collection of data. This is especially true for the sources used to calculate the indicators in the SSE of the case study (**section 5.1.1**). As already stated, this will allow cross-checking the results of the evaluations and the pertinence of the conclusions more easily. The replicability, on the other hand, is tied to the very results of the first application of the EFSUA. If the framework proves to be not only adequate, but also flexible enough to be applied in different contexts, the replicability of the evaluation will be possible (and encouraged), although the necessary data could be easier or even harder to collect in different contexts. The choice to have just one case study may indeed result in low representativeness of the findings of the research (Bryman, 2012). But the reasons for this choice are several and they have already been explained in the previous section. As far as ethics are concerned, the data collected by means of interviews with both the experts and the representatives of the local stakeholders have been gathered, processed and used in such a way not to twist the meaning of their contributions.

In the next section the EFSUA will be thoroughly described in its components and uses. This should be regarded as the answer to the first half of the main research question. The other half will be answered in section **5**, addressing the application of the EFSUA to the case study.

4. The Evaluative Framework for the Sustainability of Urban Areas (EFSUA)

4.1 The macro-objectives of the EFSUA

The first step in the development of the EFSUA was the definition of the sustainable city and of its features, extensively addressed in section **2**.

"A sustainable city is one which *does not jeopardise its own resilience* nor the resilience of the Earth System. This means that *it is an urban system built and living in such a way that it can last indefinitely, having also the ability to react to both exogenous and endogenous shocks and evolve into a (new) stable equilibrium*, while preventing its existence and everyday life to endanger the endurance and health of the larger system to which the city belongs, our planet, with negative externalities of any sort"

This definition was the source of the macro-objectives that should guide the urban (re)development process according to the point of view of this research. The macro-objectives can be divided into two types: the **general macro-objectives**, which can be easily inferred by the definition itself, and the **domains-related macro-objectives**, which belong to the single domains of sustainability and "serve"[30] the general ones. Here I report the definition itself, followed by the list of the general macro objectives and domains-related macro-objectives, together with the **table 4.1** summarizing the relations between them.

The **general macro-objectives**:

- *Urban Resilience*
- Prevention/mitigation of negative externalities

The explanations for these two macro objectives are in the very definition of the sustainable city reported above, where the parts concerning *urban resilience* have been written in *italics*, while those related to the prevention/mitigation of negative externalities have been underlined.

The **domains-related macro-objectives** are schematically grouped under the three domains of sustainability, but the single objectives have effects and spillovers also into the others. They are:

- **Environment:**
  - **Climate change adaptation**: intended as the capacity of the urban area to withstand the effects of extreme weather events and natural hazards associated with global climate change and the related local environmental changes;

[30] We could say that the domains-related objectives are intermediate, as they contribute to the achievement of the general ones, as highlighted in table **4.1** below

    - **Environmental quality**: this macro-objective has many aspects, including the reduction of pollution (air, water, soil, light and noise), the preservation of habitats, the provision and safeguard of local ecosystem services;
- **Society**:
    - **Safety**: this objective too has many aspects, because it summarizes the overall safety of the urban environment for its inhabitants. It is affected by the crime rate in the city and the quality of the healthcare and civil protection systems, but also by the environmental context, specifically if the area is prone to flood-risk, if there are periodic droughts or hurricanes, if there is seismic activity or extreme cold during the winter and so on. Potential local indicators accounting for the countermeasures taken to tackle these situations will definitely measure a dimension related to the **safety** of the urban area;
    - **Social justice**: the overall achievements in terms of equity, fairness, integration and solidarity, all crucial contributors to the quality of the life of all the citizens. These achievements inspire in the inhabitants the feeling that they live in a strong, united community, of belonging to a cohesive social fabric. This positively influences their psychological resilience to shocks and disturbances in general;
- **Both: socio-economic**
    - **Employment**: the potential of the urban area to offer adequate employment to its inhabitants;
- **Economy**:
    - **Resources efficiency**: an efficient management of the resources and the related services in the urban area. This implies a minor dispersion of them, by adopting more efficient processes and materials and by recycling and reusing larger quantities of solid wastes and wastewater;
    - **Urban metabolism**: the objective in this respect is to eventually establish a circular urban metabolism, steering it away from the unsustainable linear model;
    - **Attractiveness**: the appeal of the urban area for firms and enterprises. It is influenced by many factors, including the overall quality of the urban area, the ease of doing business there and the ability to welcome and promote innovations.

Table 4.1: The relations between general and domains-related macro-objectives

General macro-objectives	Macro-objectives related to the sustainability domains	
• **Prevention/mitigation of negative externalities** • **Urban resilience**	• Climate change adaptation • Environmental quality	Environment
	• Safety • Social justice	Society
	• Employment	both
	• Resources efficiency • Urban metabolism • Attractiveness	Economy

Urban planners must pursue these objectives for their cities to have the features described in section **2.3**. Those features have been considered during the choice of the **core indicators** of the EFSUA and they should always be considered during the design of the **local indicators**, because the dimensions measured by the index must be functional to evaluate the progresses towards (or the regressions from) these objectives[31].

The connections between the dimensions measured by the indicators and the macro-objectives must be reported in the metadata tables of the indicator themselves (**annex 1**). The macro-objectives also have a fundamental role in guiding the evaluations, as they provide the parameters to assess if the status of an indicator is positive or negative (SSE) and if a policy is going to have positive or negative impacts (SIE).

In order to pursue these macro-objectives, integrated strategies are required in urban planning for all the sustainability domains. A complete list of such strategies would require extensive research on its own, so here I only provide some examples. From the perspective of urban environment, good strategies for a sustainable, integrated urban planning range from stopping and reversing soil consumption and sealing, to planning districts according to the principle of sustainable accessibility, to extensively using Nature-Based Solutions (NBSs). From a social perspective, it would be fundamental to build/renew districts in order to foster mixed use and housing, to make more services easily available to all the citizens while avoiding gentrification and the consequent concentration of poverty in a few areas. Other strategies could be the promotion of principles of solidarity, fairness, equity and integration in every policy field, from housing to employment, or the development of adequate local civil protection and law enforcement, to help safeguarding the safety of the citizens. Finally, from an economic perspective, the strategies should aim at enhancing the recycling of solid wastes and the reuse of water, the localization of production (with the consequent local creation of jobs), the diversification of urban economy and the promotion of eco-innovation, for example through the extensive use of RES (Renewable Energy Sources).

[31] Remember the best practice identified in section **2.1.2** while analyzing the other frameworks: take future scenarios into account while choosing the indicators, identifying both a desirable future **and** possible undesirable outcomes (Boyko et al., 2012)

4.2 The desired trends for the indicators of the EFSUA

As the evaluations contained in the next section are the first, explorative application of the EFSUA, there is no other evaluation, performed with this tool, to compare the results of the evaluations to. For the same reason there is no existing ranking of cities or districts based on the EFSUA to provide updated benchmarks and highlight the relative performances of the present case study compared to others. Moreover, as there is no univocal definition of a sustainable city, "importing" benchmarks from evaluations performed with other tools, based on different theoretical backgrounds (such as different definitions of urban sustainability), could be both inaccurate and arbitrary. In my initial opinion, however, this was a secondary problem. I was not designing the EFSUA to compare cities and different contexts. As already stated, the final objective is to develop a tool capable of providing reliable, comprehensive and intuitive information to policymakers in building a sustainable model of urban development, in every possible context with its distinctive features.

This objective, together with the consideration that a truly sustainable city currently does not exist[32], led me to individuate the trend that each indicator should have if the urban area is to become sustainable (SSE) and if the evaluated interventions/plans/policies are to promote urban sustainability (SIE). These **desired trends** were elaborated considering also the macro-objectives presented in section **4.1,** and together with them, they provide indications for the two types of evaluations. They contribute in judging whether the value of an indicator is positive or negative in the SSE and whether the impacts of a policy on the indicators are positive or negative in the SIE. These trends are summarized for the **core indicators** in table **4.2** below, which highlights whether the single indicators should be maximized or minimized and the related reasons. Keeping in mind the systemic approach that this framework promotes, it is important to notice that the trends of the indicators can influence each other. Meaning that the trends of the single indicators must not be considered as completely independent from one another. Such shortsightedness could cause unintended negative results[33]. One example could be the attempt to maximize 'compactness' without considering the maximization of 'greenness'. This could easily lead to the sacrifice of many green areas in the effort to concentrate the population within a minor surface. All the desired trends can and **must** be balanced. For the provided example, one solution could be the widespread use of Nature Based Solutions (NBSs).

Table 4.2: The **core indicators** and their desired trends

Indicator	Desired trend	Reasons
'Greenness'	Maximize	Given that green areas provide fundamental services to the urban environment, the more green areas there are and the more spatially distributed they are, the better the environmental quality of the urban area will be. Regarding the maximization of this indicator, a

[32] there is, however, an increasing number of very interesting experimental projects of eco-districts/towns in many parts of the world. Examples are the Aldinga Arts EcoVillage near Adelaide, Austraila, the Vauban and Rieselfeld districts in Freiburg, Germany, the district of Hammarby Sjöstad in Stockholm, Sweden, or Masdar city in the Emirates (labelled "sustainable city"), just to mention some of the most famous ones

[33] Remember page 9: take future scenarios into account while choosing the indicators, identifying both a desirable future **and** possible undesirable outcomes (Boyko et al., 2012) also to avoid "maladaptation" (Climate-Eval, 2015)

		future possible widespread use of green roofs and surfaces in general could lead to very high values of 'greenness'
'Compactness'	Maximize	A higher population density results in improved efficiency of public services as energy/heat/water distribution, waste collection and public transportation, while also potentially contributing to improve the overall 'accessibility'. The more people live closer to each other, the more they will have easier-quicker-cheaper access to the local services and activities (see 'accessibility' below).
'Accessibility'	minimize	A minor space-time-cost distance between activities and citizens means that the urban environment is becoming more accessible and its districts/neighborhoods have mixed uses. Keeping in mind the concept of sustainable accessibility, policymakers should aim at reducing these space-time-cost distances particularly for those journeys relying on sustainable modes of transportation, such as public transportation and bike, not those by car (with the exceptions of the sub-indicators 'healthcare', 'police' and 'civil protection') or motorcycles (again, the trends of the single indicators interact with each other: in this case with 'mobility' below)
'Soil protection'	minimize	The less soil consumption and soil sealing there are, the higher 'greenness' will be, positively affecting both the environmental quality of the urban environment (limited soil consumption) and the urban resilience (limited soil sealing) through a better adaptation to the more intense weather events caused by climate change
'Green-development'	Maximize	The more an urban area can develop and improve itself through renovation plans (instead of building new areas and consuming more soil) the better. This renewal must be guided by those concepts like energy efficiency, green TODs, and sustainable accessibility, which promote the sustainable (re)development of the urban area
'Mobility'	Maximize minimize	Maximize the share of urban journeys carried out by sustainable modes of transportation while minimizing the unsustainable ones
'CO2 emissions'	minimize	Low-carbon cities are crucial for the mitigation of climate change
'Inclusiveness'	minimize	Minimize the number of poor families living in poor districts. Concentrating poverty in a few districts, instead of spreading it over the wider urban area, easily leads to the rise of several environmental, social and economic issues. All the city districts should be as mixed as possible both in terms of use and housing, allowing people with different income levels to live next to each other, reducing the social divide and the resulting tensions that are present wherever the worse-offs are clearly secluded from the better-offs (favelas, banlieues, barrios, townships, "shanty towns" in general)
'Equity'	Maximize	Quite obviously, for a city to be truly sustainable, all its citizens should be granted at least the potential to access the fundamental services, namely electricity and water distribution, waste management and public transportation. Scoring 100% in at least three of these sub-indicators could be quite easy for many cities in developed countries, but in some degraded districts this may not be the case (remember the interactions with 'inclusiveness'). Sadly, in many cities in developing or under-developed countries too often this access is not granted
'Security'	minimize	Obviously, the lower the crime rate is, the safer and more attractive the urban area will be. This desired trend too could be greatly

		influenced by 'inclusiveness', as concentrating poverty in "ghettos" almost automatically leads to an increase in the local crime rate
'Aggregation'	variable[34]	Minimizing the gentrification rate positively influences 'inclusiveness', because if the worse-offs are not forced to leave when the area they live in gets regenerated (and the prices of real estate start rising), they will not have to move in mass towards cheaper neighborhoods/districts. A positive value of this indicator shows a **potentially** positive phenomenon, opposite to gentrification
'Fairness'	Maximize	A truly sustainable city must be livable for all its citizens, including the ones who suffer from various setbacks related to their ethnicity and culture, physical conditions or difficult economic situation. The higher the score of 'fairness' the more attention is given to the issues related to these disadvantaged inhabitants in urban planning and the more livable the urban environment should be for them
'Self-sufficiency'	Maximize	The higher the share of fundamental resources produced locally (on the administrative area of the municipality) the less GHGs will be emitted to import these resources from afar and less of these resources will be lost in the process. At the same time, being able to produce locally what is indispensable for everyday life considerably increases urban resilience. In the case of major natural or anthropogenic disasters affecting communication lines or infrastructures providing these resources from afar, the local supply could still provide them to the population, sheltering the citizens from the effects of their shortages. Moreover, the ability to produce/harvest locally the fundamental resources is a crucial step in changing the urban metabolism from linear to circular
'Circularity'	Maximize	Maximizing the recycling of solid waste and treatment and reuse of wastewater is an important step in establishing a circular urban metabolism. It is also fundamental to protect the urban environment and in the case of water reuse, its vital resources. Furthermore, higher percentages of recycling and reuse result in a better, more efficient management of resources, while potentially having positive impacts on the diversification of urban economy and the local employment rate as well
'Energy'	minimize Maximize	Considering the efficient and sustainable management of resources, the total energy demand should be minimized while maximizing the share of this demand met with energy produced by RES. These two variations together could have tangible effects on the energy sub-indicator of 'self-sufficiency' while also bringing massive reductions in the GHGs emissions related to energy production[35]
'Diversification'	Maximize	A highly diversified urban economy shelters the city from the worst effects of a potential crisis in particular sectors or firms, while contributing to the attractiveness of the urban environments for enterprises and investments. It potentially contributes also to

[34] The desired trend of 'aggregation' is highly dependent on the situation of the area that is being evaluated. In the case of a district object of regeneration a process, the objective should be to keep this indicator neutral or even positive, to keep/promote the mixed housing in the district

[35] An example of benchmark here, at least at a district level, could be the amazing energy performances of the Vauban district in Freiburg, Germany, which produces more energy than it consumes, thanks to both the high energy efficiency of its buildings and the extensive use of renewable energy sources (diffused use of solar panels and eco-friendly district heating)

		'localization' by allowing more diversified jobs to be available for the inhabitants in loco, without forcing them to travel elsewhere
'Localization'	Maximize	To maximize the share of inhabitants working in their own city has positive repercussions on the entity of daily journeys from the inside of the city towards the outside (reducing GHGs emissions), while also benefitting the social life of the workers, who have the possibility to spend less time travelling, saving it for their other activities or family life.

Nevertheless, further reflections on the ability of the EFSUA to provide easily understandable information for policymakers led to the conclusion that the identification of specific targets and benchmarks could be valuable and should be researched further. These benchmarks could provide a paragon to which policymakers could compare the performances of their own cities.

It should be kept in mind that these desired trends refer to the long-term development of the urban area. Meaning that they are difficult to achieve with a few plans developing over few years and that they are adaptive to the changing context of the city, with a special consideration for the innovations that could be introduced over the decades. One example being the abovementioned interactions between 'greenness' and 'compactness' in the case of the widespread use of NBSs, or the potentially huge impacts of Information and Communication Technologies (ICTs) in many aspects of urban services and activities.

The metadata tables of the **core indicators**, containing the more practical information needed to use the indicators in the evaluations, are in **annex 1**. In the next section I explain how to apply the index (both the **core indictors** and the **local** ones) in the two types of evaluations that can be carried out with the EFSUA.

4.3 How to apply the EFSUA: the Sustainability Status Evaluation (SSE) and the Sustainability Impact Evaluation (SIE)

The EFSUA includes two types of evaluations, namely the Sustainability Status Evaluation (SSE) and the Sustainability Impact Evaluation (SIE).

The SSE is intended to keep track of the general sustainability performances of the urban area. If correctly repeated on a yearly basis, firstly, it can provide extremely useful information about the possible issues in the various domains of sustainability, indicating the potential targets for future policies. Secondly, it can help to keep track of the cumulative effects of past and ongoing policies on the overall sustainability of the urban area, whether they may be explicitly aimed at sustainable urban development or not.

The SIE has a complementary function. It is designed to evaluate the effects of the various policies on the sustainability of the urban area. It should be carried out both before the implementation of the plan (ex-ante SIE), to try and predict its effects on urban sustainability, then it should be repeated at

the end of the plan (ex-post SIE), to verify its overall effects compared to the initial expectations[36]. The latter evaluation could provide valuable information for the policymakers to learn best practices and improve future policies. In the case of actions having effects that are diluted in the long term (like many of those targeting the social domain), the assessment of these policies' impacts could be delegated to the yearly SSE. Sadly, it has not been possible to perform an ex-post SIE for the case study of this research, since the predicted completion of the plan is still years away.

To summarize, the SSE consist of the measurement of the current status of the indicators at the city/district level, while the SIE evaluates the possible (ex-ante SIE) and later, the actual (ex-post SIE) impacts of the evaluated policies on these indicators.

4.3.1 The SSE

It entails the calculation of the indicators based on the most updated data, normally those pertaining to the precedent year. The indicators are then collected in summary tables organized as shown by **table 4.3** below. They contain the name of the indicator, its value, the pertinent and relevant data concerning that indicator, the value of the sub-indicators (if present), the source/s of the data, their accessibility (if they are public and easily readable by everyone, or if there are barriers like the necessity to use a GIS software or to have clearance) and a final judgement on the value of the indicator, with the pertinent reasons and potential critical issues, based on the desired trends described in the previous section (**4.2**).

Such judgement will be expressed also with colours:

- **Positive**: **green**
- **Negative**: **red**
- **Critical issues: Dark red**

The reasons on which these judgements are based are explained in detail in the next section (**4.2**).

Table 4.3: model for the **SSE** tabs

Sustainability domain of the indicators					
Name of the indicator	Value of the indicator	Relevant data/sub-indicators	Source/s of data	Accessibility of data	Judgement reasons Critical issues

4.3.2 The SIE

It entails the evaluations of the impacts of plans and their actions. These will be summarized in the tables of the SIE, through both symbols (capital letters) and colors.

Plans and their actions could have a:

- Negative impact: symbol – /**red color**

[36] To keep track of the ongoing effects of the evaluated policies, in-itinere SIE could be carried out as as the various actions/plans are carried out. This would allow for corrections and adaptations before their completion.

- Negligible or no impact: symbol **0** / **grey color**
- Positive impact: symbol **+** / **green color**

These judgements are based on the desired trends described in section **4.2**.

As already mentioned in section **3.1**, while performing a SIE, the impacts of each action of the plan should be evaluated singularly and, in the end, these evaluations should be combined into a single table summarizing the total (expected or actual) impacts of the plan on the indicators.

Table 4.4: the model of the **SIE** tables and example of evaluation of a potential action

'Indicator'	+	0	–	Reasons for the evaluation and relevant data (if available)

Example: hypothetical action of sustainable urban development evaluated through some indicators of a SIE:

Action 1 – the requalification of the large brownfield site located in […] for the creation of a public park		
'Greenness'	+	See 'soil protection' – this action will have a particularly positive impact on this indicator since it is increasing the total green surface at the expense of a brownfield site
'Compactness'	**0**	The target area is a brownfield site, so this action is not causing the relocation of any resident and consequently, no impacts on the population density in the area
'Accessibility'	+	The creation of a new public green area will likely have a positive effect on the sub-indicator measuring the 'accessibility' of green areas
'Soil protection'	+	Similarly to 'greenness', this action will have positive effects both on the reduction of consumed soil and potentially, on the reduction of sealed soil
'Green-development'	+	The percentage of the surface of the district which is object of sustainable urban redevelopment will improve accordingly with the size of the green area that is replacing the previous brownfield site
'CO2 emissions'	+ **0**	Green areas can contribute to the local capacity of carbon sequestration, depending on their composition
'Inclusiveness'	**0**	The action does not impact the presence of poor families in the area….

It is important to perform the comprehensive evaluation for every action, even if it is expected to have an impact on only one or two indicators. The first reason is that this comprehensive evaluation provides the opportunity to reflect on possible indirect effects of the actions, positive or negative, on indicators related to the ones that are affected directly. The second reason is related to the fact that the EFSUA is also an instrument of **support to the decision** in the policymaking process, when two alternative actions are being weighed up to see which one could bring the most benefits. Such comparisons should always consider the macro-objectives presented in section **4.1** and the desired trends for each indicator, presented in section **4.2**. This is one of the major differences there are between a policymaking process that focuses only on few issues at the time and remains mostly oblivious to the related ones, and a new type of integrated policymaking which tries to exploit every opportunity to bring benefits in as many aspects of urban development as possible.

4.4 The comprehensive, integrated approach of the EFSUA

It is fundamental to underline whether and how the various indicators interact with each other, also to realise how changes in the dimension measured by one of them could affect the others, directly or indirectly. In this section I will analyse these interactions between the various indicators and represent them graphically. Such links between the **core indicators** have been reported also in the metadata tables (**annex 1**). These interactions between the dimensions measured by the indicators are self-evident in many cases, while in others they derive from the theories underlying the indicators that have been presented in section **2.3**. These interactions will be mostly visible in the **SIE** of AdP Lorenteggio, in section **5.2.2**.

I will carry out the analysis of these inter-indicator relationships firstly by highlighting the **intra-domain** interactions of the **core indicators**, so the relations between those core indicators belonging to the same sustainability domain. Secondly, I will address the **inter-domains** interactions, those between core indicators belonging to different sustainability domains. I will summarize these relations with a series of four schemes (below, **figures** from **4.1** to **4.4**), physically illustrating these, sometimes mutual (two-way arrows), influences.

I will also indicate whether the influences of the indicators on each other are direct (continuous arrows), meaning that a change in the first indicator automatically results in a change in the affected one, or indirect (dashed arrows), so the change in the first indicator could affect the second one in the presence of certain conditions. It's worth underlining that when an indicator influences another, it is also indirectly influencing all those indicators which are affected by the second, sometimes creating feedback loops. For example, 'aggregation' directly influences 'inclusiveness', which in turn affects 'security' and indirectly 'equity', so 'aggregation' is also influencing indirectly both 'equity' and 'security'. 'Equity' has also an indirect influence on 'aggregation', so these and 'inclusiveness' form a feedback loop. One last important remark is to recall here that the indicators are written 'between apostrophes' to distinguish them from the theories and concepts that their title in some cases recall. Therefore, the relations existing between the indicators I have developed do not necessarily exist also between the theories and concepts that they may recall.

4.4.1 Intra-domain relations between the core indicators

The core environmental indicators are strongly related to each other, they are the most interconnected among the **core indicators**. Starting from '**green-development**' which is the one whose changes potentially have positive impacts on the all the other core environmental indicators. The ability of a city to renew itself following criteria and theories of sustainable urban development, instead of constantly expanding itself with the construction of new districts, is indeed crucial. It avoids more soil consumption and sealing, instead it tends to bring benefits both in term of 'greenness' and 'compactness', while enhancing 'accessibility' and positively affecting 'mobility', when such renewal is inspired by theories such as "sustainable accessibility" (Bertolini, le Clercq, Kapoen, 2005) and "green TODs" (Cervero & Sullivan, 2011). Most of the measures of sustainable urban redevelopment generally have positive impacts on 'CO2 emissions' as well.

‘**Soil protection**’, in turn, directly affects ‘greenness’ and ‘compactness’. Indeed, limiting soil consumption and soil sealing positively affects the availability of green areas in the urban area and their quality, while also limiting the land used to accommodate the growing urban population and forcing urban planners to reuse the buildings that are already in place, improving population density in the already existing built-up area (“Il consumo di suolo — Italiano,” n.d.).

‘**Greenness**’ and ‘**compactness**’ mutually influence each other, in the sense that too much green could negatively affect the population density (as often happens in northern cities: Netherlands, Denmark, Sweden…) but, at the same time, a too high ‘compactness’ could negatively affect the amount of green areas in the city. Moreover, variations in both ‘greenness’ and ‘compactness’ have direct effects on ‘accessibility’. The denser the urban area is, the more people will live next to the activities and services, including public transportation stops, diminishing the space-time-cost distance between them and their destinations (Geurs & van Wee, 2004). The amount and diffusion of green areas influences ‘accessibility’ even more directly, since one of its sub-indicators measures the accessibility of public green areas. Furthermore, ‘compactness’ influences also ‘mobility’ in the sense that the more people are living next to intermodal transit nodes, the more those people will tend to use the (sustainable) transport modes available in those nodes.

‘A**ccessibility**’ both influences and is influenced by ‘**mobility**’. Its influence resides in the fact that the more accessible the activities/services are to the citizens through sustainable and cheaper means of transportations, the higher the share of journeys carried out through these means will tend to be (Bertolini, le Clercq, Kapoen, 2005). The influence that mobility has, in turn, on accessibility, is related to the fact that the choices of citizens concerning the transportation mode they choose for their journeys has a direct impact on the space-time-cost distances between them and their destinations.

The particularly strong relationship between ‘soil protection’, ‘compactness’, ‘accessibility’ and ‘mobility’ is worth underlining. Indeed, there are several feedback mechanisms involved among this quartet.

Finally, ‘**CO2 emissions**’ is directly influenced by ‘mobility’ and ‘green-development’ and it is also indirectly influenced by ‘greenness’ due to the carbon sequestration capacity of green areas.

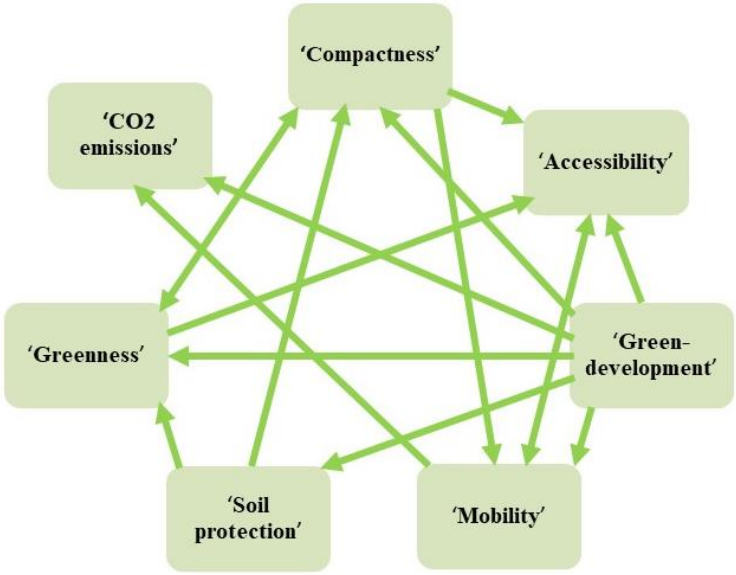


Figure 4.1: Intra-domain relations between the environmental **core indicators**

Moving to the **core indicators** of the social domain, it is important to notice that, given the peculiar nature of social interactions, most of the influences that connect the various social indicators are indirect. This, of course, does not mean that they are less important or that they should be granted less consideration during the design, implementation and M&E of policies. This is the case for the qualitative indicator '**fairness**' and its indirect influence on the indicator 'inclusiveness'. In fact, too often the higher concentrations of poverty in some specific zones of an urban area is connected to the scarce consideration given to minority issues. This is the situation, for example, in many cities in South Africa, as well as (still to this day) many others in the USA, in which the poor neighbourhoods are often the ones in which ethnic minorities are concentrated. The second influence of 'fairness', it is a direct one on 'aggregation'. Indeed, more attention given to the issues of minorities helps to avoid the process of gentrification as the city (re)develops.

'**Aggregation**' has an important direct influence on 'inclusiveness', since a high gentrification rate will have a strong negative impact on the concentration of poor families in the city, driving them out of the regenerating areas and into those districts/neighbourhoods that are already poorer. In addition, 'aggregation' also has an indirect mutual influence on 'equity'. If it is true that gentrification could push the worse-offs out of those districts which have good access to fundamental services, towards others that may not be served properly by those services, it is also true that the diffusion of the fundamental services is precisely one of the ways in which districts are regenerated, thus resulting in higher real estate prices and in a higher gentrification rate, if this process is not designed and implemented with the necessary caution ("Managing the Potential Undesirable Impacts of Urban Regeneration: Gentrification and Loss of Social Capital | Urban Regeneration," n.d.).

'**Equity**', other than having this mutual relation with 'aggregation', is also indirectly influenced by '**inclusiveness**' in a similar way. This influence is in fact related to the supply of the fundamental services in the poor districts as well. The more people live concentrated in poorly served areas, the more of them will risk lacking the fundamental services, negatively impacting 'equity'.

Every social indicator affects, directly or indirectly, '**security**', which, instead, affects none of the others. Indeed, the crime rate in the city is highly dependent on the social conditions of its inhabitants (Cozens, 2011), but it tends to be the result of the other dimensions of the core social indicators, not the cause.

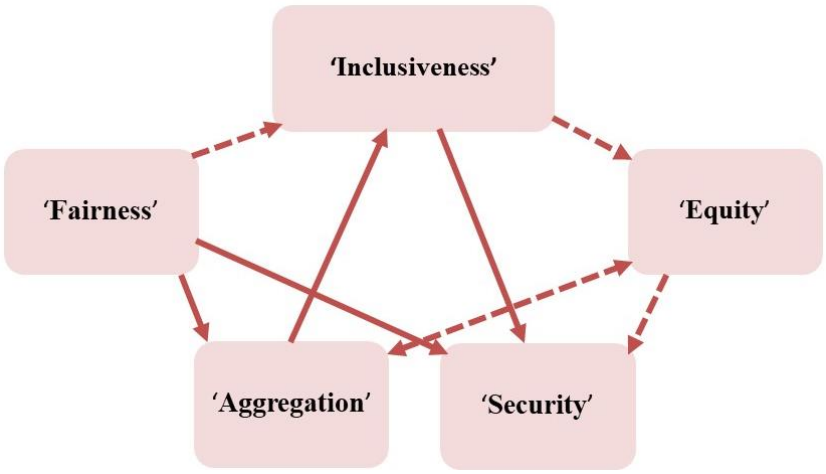


Figure 4.2: Intra-domain relations between the social **core indicators**

Finally, for the intra-domain relations, the core economic indicators are the ones with the lowest number of influences. Starting with '**energy**', which has just a mutual relation with 'self-sufficiency', given that the higher the demand is for energy in the city, the more difficult it will be to supply it just using local sources/resources. It is also true, though, that the more energy produced locally by RES, the higher the sub-indicator of 'energy' addressing RES consumption will be.

'**Self-sufficiency**' is also affecting indirectly 'diversification', since the more localised the production of the fundamental resources will be, especially food, the more people will be working to supply them, thus impacting on the number of workers in these different sectors and contributing to diversify the city's economy. '**Diversification**' has also a direct link with 'localization'. In fact, the more jobs and the more diverse jobs that are created through the local production of fundamental resources, the more the inhabitants will have access to these jobs without having to move elsewhere (having the possibility to get the job that one seeks in his/her hometown is obviously preferable to being forced to travel far away every day to reach the workplace).

'**Circularity**' is, not surprisingly, the economic indicator with more connections with the others. Indeed, it can have strong impacts on 'self-sufficiency' wherever there are high percentages of both recycling of solid waste and treatment and reuse of the wastewater. Organic wastes can be recycled to produce organic fertilizers to be used in the local agriculture and the more wastewater is treated and reused locally, the lower is the demand for new water to be collected/harvested (UK National Archives, 2004). 'Circularity' can also positively and directly influence 'localization', because where there are high investments in the recycling, treatment and reuse of wastes, usually many satellite activities tend to develop, which increase both the number of jobs available and the diversification of the local economy. The degree of '**localization**' tends, thus, to be a result of the performances of the other economic indicators and more, as it has also inter-domains relations with indicators in other domains, at least with another core indicator, 'accessibility'.

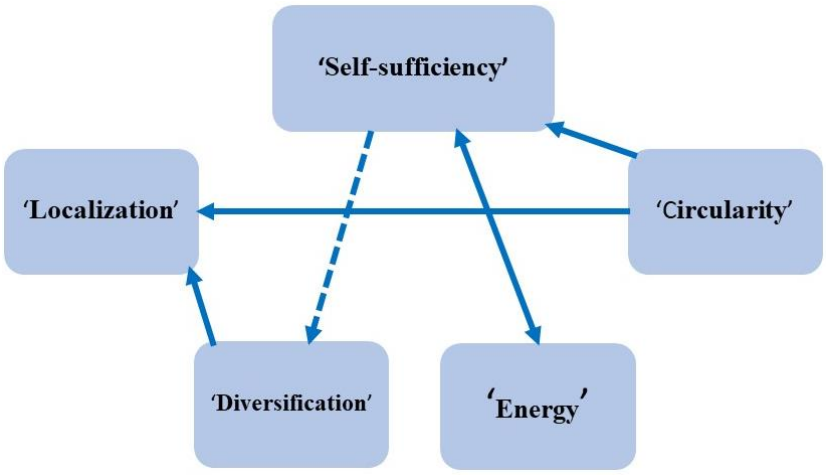


Figure 4.3: Intra-domain relations between the economic **core indicators**

4.4.2 Inter-domains relations between the core indicators

Starting from the indication of this inter-domain relation, we can now analyse how indicators belonging to different sustainability domains influence each other. 'Accessibility' has indeed a considerable weight in relation with 'localization' since, while measuring the distances between the activities and services and the citizens, it is also implicitly giving an account of their accessibility as workplaces for the inhabitants (Geurs & van Wee, 2004). If in the urban area there are no hospitals, or libraries, or schools, or sport centres, all the jobs related to these places are evidently not available locally, so all the inhabitants who seek these jobs must travel to another area, maybe far away, to access them. 'Localization', consequently, has a sort of rebound effect on 'mobility', given the possible consequences on the urban journeys and their modes caused by the number of inhabitants who must travel to another location every day to reach their workplaces.

Also 'equity' can have a similar effect on 'mobility'. Wherever some percentage of the inhabitants is not directly served by the fundamental services, especially LPT, they will be forced to travel by other means, for example, to get access to freshwater or methane tanks or other fossil fuels. 'Equity', though, is itself influenced by other indicators, namely 'compactness' and 'self-sufficiency'. A higher 'compactness' (a higher population density, mainly concentrated near intermodal transit nodes) makes it easier to reach a higher percentage of the population with all the fundamental services, while also positively impacting on the efficiency of the delivery of energy and water, reducing their dispersion/loss during this phase, thus slightly influencing also 'energy' and the water-related sub-indicator of 'self-sufficiency'. The latter also influences 'equity', because being able to produce locally the fundamental resources facilitates (or, at least, should facilitate) their distribution among the inhabitants.

In the economic domain both 'Energy' and 'self-sufficiency' influence 'CO2 emissions' as the energy sources change from fossil to RES and as the local production/harvesting of water, food and energy saves the emissions related to their transport from other places.

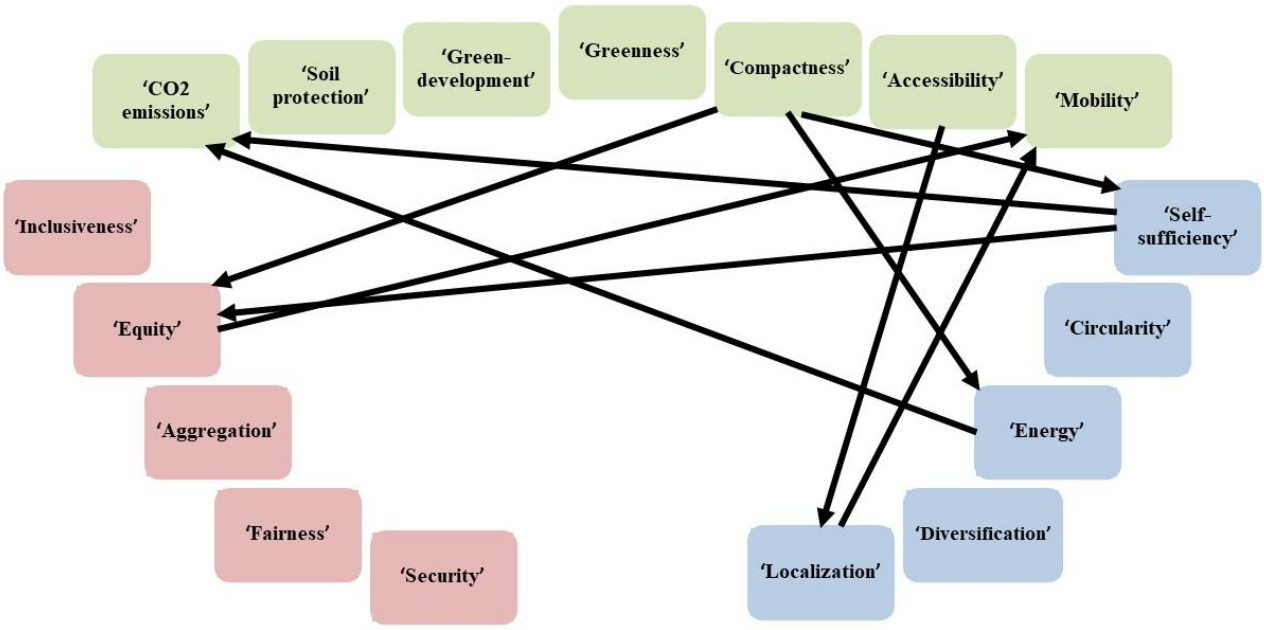


Figure 4.4: Inter-domains relations between the **core indicators**

Finally, we must remember that, as previously explained, an indicator which influences another, automatically has an indirect influence on all the indicators affected by the second, making the whole picture of the inter-domains relations much more complex. Policymakers and evaluators should always be aware of these interactions if they really want to design, implement and monitor comprehensive and integrated policies aiming at sustainable urban development.

Remember that in addition to these interactions between the **core indicators** there are also the contributions of the dimensions they measure to the macro-objectives presented in section **4.1**. These contributions, reported in the metadata tables (**annex 1**), further highlight the fact that many indicators belonging to one sustainability domain have effects and "spill-overs" concerning also macro-objectives in other domains, providing an even more complete analysis of the interconnections between the three domains of sustainability.

4.4.3 Urban governance and its indicators

As already stated in the previous sections, urban governance has a fundamental role in the effort to pursue and establish a sustainable model of urban development. Governance, indeed, directly affects the effectiveness, efficiency, speed and overall quality of the policymaking processes at the urban level (van der Heijden, 2014). These features, in turn, influence the effects of the decided policies on the three domains of urban sustainability.

Again, it is crucial to underline that the importance of the governance processes must be reflected in the M&E activity. The indicators proposed below to analyse urban governance can provide two, related, kinds of insights for the two types of evaluations. In the **SSE**, these qualitative indicators describe the general situation of the urban governance in the studied urban area. This description can provide the "lenses" through which the evaluator can look at the general sustainability performances of the urban area, relating them to the underlying processes of urban governance. In particular, the

evaluator could gather information on whether these processes appear to be functioning or not, what could be the possible causes for the eventual ineffectiveness and which alternative approaches to urban governance could be explored to improve the situation. For the **SIE**, the indicators for urban governance should focus on the policymaking processes related to the plans and actions whose effects are being evaluated. This will provide the evaluator with a contextual analysis that could be very helpful in fostering whether the objective of the plan could be eventually met or not (ex-ante SIE) or in identifying the institutional/procedural reasons for their eventual failure or success (ex-post SIE).

As already explained in the end of section **2.3.3**, governance is on "another level" compared to the three domains of sustainability, as it influences all the strategies and plans that can have effects on the various components of the three domains of sustainability. For this reason, the evaluations of urban governance should be carried out before the evaluations of the three domains.

This is the set of qualitative indicators used to describe the features and processes of urban governance.

- 'Budget' – the municipal budget and the budget for the evaluated policy:
    - its situation – plainly, if the budget is in a situation of surplus, balance or deficit;
    - its management – whether the budget is available for the municipality to use it as it pleases, or if there are restrictions imposed by the region, state, supranational/federal authorities or even IOs. It is indeed crucial for a city to be able to rely on adequate and available funds to promote its own policies for sustainable urban development, without having to wait for the approval of regional/national authorities or for the availability of international funds to implement them. In these latter cases the city could be held hostage of the top-down approach to sustainable development that has often proved to be ineffective or at least too inefficient. This could happen because the objectives imposed to access these funds could differ greatly from the ones that the municipalities would pursue of their own will. It is also true, on the other hand, that these international/regional funds can represent a valuable opportunity for those municipalities which do not have consistent funds of their own, to find the resources needed to carry out their initiatives. The key to maximizing the utilisation of such funds may be in selecting the appropriate funds (those that promote the right goals) at the right moments.
    - its permeability to private capital[37] – the ability, or at least the willingness, of the municipality to involve private investors and their capital in its projects and plans[38]. This private capital permeability is especially connected to the following indicator;
- 'Participation' – the ability of the municipality to involve other stakeholders in the policymaking processes:
    - the participatory processes[39] – their number and quality. This last point refers to the nature of these participatory processes, whether they are just informative meetings or if the participants actually have the possibility to influence the outcomes of such processes;

[37] As these evaluations will be repeated over time in the same municipality, it will be possible to include this indicator in the yearly SSE, giving a more general account of the number of plans that involved also private capital compared to those which did not.
[38] always remembering that private actors like firms and investment funds have their own objectives that can be very different from those of the public administration (and usually the main one is to profit from their investment).
[39] Again, an account of the number of policies involving participatory processes over a year could be included in the yearly SSE.

    - the number and nature of the actively involved stakeholders – the ones whose opinions and contributions actually had a weight in the policymaking process;
- 'Implementation management' – the ability of the policymakers to effectively control/oversee their policies throughout the whole processes of design, implementation, M&E:
    - The nature and degree of control exerted by the municipality on the various phases of the process, from the design to the implementation to the M&E (how is this control actually carried out? Is it a direct control? Is it entrusted to privates? If yes, who are they?);
    - Number, periodicity of and participation in meetings between the stakeholders involved in the process, concerning the implementation of the policies;
    - Continuity of information provided to the inhabitants affected by the policies, about their status, possible changes and effects;
- 'Learning'[40] – the effort made by the municipality to seek out innovative solutions and best practices, by using internal resources or joining networks of cities or starting twinning programs, or organizing study trips for its employees in other cities:
    - The development of internal knowledge – the investments made by the municipality in researching and developing new and sustainable solutions within the city itself: it could be through the local universities or firms, owned by private companies or public ones;
    - Peer-to-peer relations – the participation in networks of cities sharing knowledge and best practices among each other, also twinning programs;
    - Study trips – whether the municipality organizes visits to other cities for its employees to train and learn first-hand about possible solutions to common problems;
- 'Data availability' – the collection, management and accessibility of data:
    - data collection – the amount of data collected on how many subjects;
    - data management and transparency – the frequency of the updates of these data and the modality of their storage: is there a website section which just contains the final elaborations and reports? Is there a dedicated research engine? A statistics engine? Are they easy to use? Are they accessible to the wider public?

The next section contains the first explorative application of the EFSUA.

5. The Case Study: the districts of Giambellino and Lorenteggio in Milan and the ongoing plan of urban renewal

As previously anticipated, the case study for the first application of the EFSUA is a suburban area in the city of Milan, one of the major Italian cities, located in the Lombardy Region, in the North-West of Italy. This suburban area is composed of two of the 88 NIL (Nuclei di Identità Locale: Cores of Local Identity – Comune di Milano, 2016) into which Milan is divided, Giambellino and Lorenteggio. A NIL is a "historical" district (not an administrative entity) about which some data are periodically

[40] in SIEs, the ability to apply these "lessons" to local projects could be verified, but there needs to be a verified connection between them, which could make this assessment quite difficult.

collected by the statistical office of the municipality (SiSI). They are in the South-Western suburban area of Milan.

Figure 5.1: Satellite image of Milan. Retrieved from Google Maps, 27/09/2018

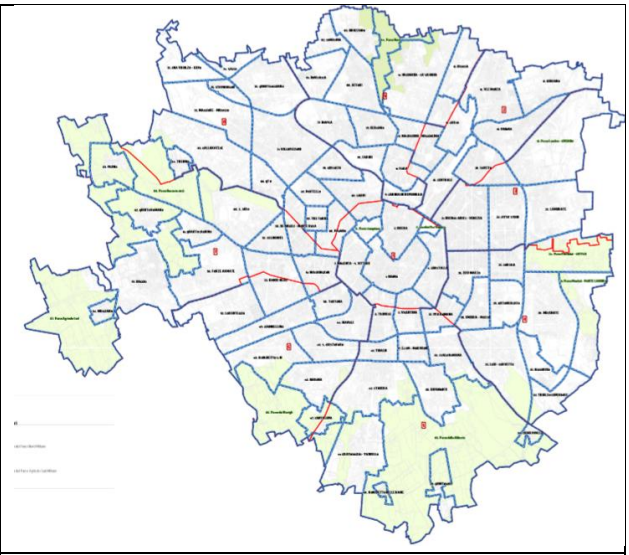


Figure 5.2: The city of Milan divided in its 88 NIL and 9 administrative areas: "Zone di decentramento" (Comune di Milano, 2016)

Before reporting the two evaluations carried out for this case study, it is important to present some more details about the local context and about the structure of the plan. Throughout this section there will be insights, data and contributions deriving from the two plan-related interviews with the representatives of Lombardy Region and the Municipality of Milan (referred to as Int.Plan.1 and Int.Plan.2), the two relevant local stakeholders involved in the design of the **local indicators** used for the first SIE of the EFSUA.

5.1 Giambellino and Lorenteggio: the metropolitan city of Milan and its suburbs

Figure 5.3: Satellite image of Giambellino-Lorenteggio. Retrieved from Google Maps, 27/09/2018, and elaborated

The city of Milan is now also the head of its metropolitan area, one of the largest, both in terms of size and population (over 3.200 million – "Popolazione residente al 1° gennaio," n.d.), among the fourteen officially recognised metropolitan areas in Italy. It is also one of the more advanced cities in Italy in many respects. It is its major financial centre (the economic capital), located in one of the richest regions of Italy[41] and it also has one of the highest percentages of foreign inhabitants among the Italian cities, almost 20% of the total population ("SISI - Sistema Statistico Integrato del comune di Milano," n.d.).

As previously mentioned, several suburban districts of Milan suffer from various issues. One is connected to the past and present uncontrolled immigration. Past migratory flows were principally made up of Italians coming from the southern (poorer) regions and seeking workplaces in this city's growing industrial sector. More recently, these flows have been replaced by masses of foreign immigrants, mostly coming from developing countries. To accommodate the past immigration many new districts were built and many of them included public housing complexes (in Italian Edilizia Residenziale Pubblica: ERP). These complexes that once hosted the southern labourers, have recently started to be "colonised" by the poorer foreign immigrants (Int.Plan.1 and Int.Plan.2). The main reasons lie in the substantially lower prices of these public tenements compared to the average housing prices in Milan (which are already considerably higher than those of many other Italian cities – "Casa," n.d.), and in the generally low incomes of these foreign immigrants.

The pronounced differences in the housing prices, together with the continuously rising costs of real estate in the central districts of the city and the consequent phenomenon of gentrification, led to a concentration of worse-offs and immigrants in the suburban districts, including Giambellino and

[41] In terms of per capita GDP (S.r.l, n.d.)

Lorenteggio. This is also due to the presence of a large[42] public housing complex at the border between these two districts. It comprises six city blocks and it has been suffering from a situation of severe physical and socio-economic degradation for some decades now (Int.Plan.1 and Int.Plan.2).

Figure 5.4: The public housing complex in Giambellino-Lorenteggio. Image from (Masterplan: Lorenteggio, 2015: 3)

This is mostly due to inadequate maintenance, which is also the result of the troubled economic situation of the regional agency, ALER[43], which manages these structures in Lombardy (Int.Plan.2). Moreover, such a concentration of poverty and cultural minorities caused the worsening of several social issues, among which there are widespread illegality and a pressing demand for social services of various nature, from housing to elderly assistance to cultural mediation (Int.Plan.1 and Int.Plan.2). Indeed, many of the apartments are in terrible structural conditions, are hosting lone elders or are overcrowded due to their inadequate dimensions, which are even below the current minimal law requirements (Int.Plan.1 and Int.Plan.2). According to the Municipality, similar situations are present in other suburban districts of Milan as well (Int.Plan2).

The broad picture in terms of urban sustainability of Giambellino-Lorenteggio is provided by the SSE, carried out with the **core indicators** and presented below.

5.1.1 The SSE of Giambellino-Lorenteggio

The main results of the SSE are contained in the next paragraph and successively summarized in **table 5.1**. Detailed lists of both the data sources and methods used for the calculation of the indicators have been reported respectively in **appendix B** and in section **3.1**. Some of the indicators were calculated for the whole city of Milan due to the unavailability of the necessary data at the district level. This will be indicated in the evaluation and will also be evident from the analysis of the results, as they will refer to the situation of the whole of Milan.

[42] It hosts over 4200 inhabitants and more than 1700 of them are foreigners according to the civil registry of the municipality (Masterplan: Lorenteggio, 2015).
[43] ("HOME - Aler Milano," n.d.)

The indicators for urban governance have not been calculated for this first SSE due to both the limited time available and the difficulty to gather the necessary data for most of the indicators.

The general performances in terms of urban sustainability of Giambellino-Lorenteggio are mostly negative[44], but there are some important exceptions. I will start the analysis of the results of the SSE precisely from these few positive performances.

The only environmental **core indicator** with a positive performance is 'accessibility'. Thanks to the economic wealth of the city, even these two tendentially residential district benefit from the widespread presence of activities, shops and services. The exceptions are related to three strictly residential areas which include only homes. These areas are the public housing complex targeted by many actions of the AdP (the only activity present within those six city blocks is a post office), the neighbourhood called "Villaggio dei Fiori" located to the North-East of the complex, and the "spontaneous" condos (Turolla, 2017) along Via Inganni, to the North-West.

From the social perspective, the only indicator with a positive score is 'equity', thanks to the widespread diffusion in Milan of the potential access to the four fundamental services, including the LPT[45] even in this suburban area.

The best results (as expected) have been registered through the economic indicators. Three out of five scored positively in the SSE. Firstly, there are the praiseworthy achievements in both the recycling of solid wastes, as Milan has one of the highest percentages of recycling among the large cities in Europe ("Ecosistema Urbano 2017 | Legambiente," n.d.) and in the wastewater treatment and reuse for agriculture. Secondly, the economic wealth and importance of the city is reflected by the positive scores in both 'diversification' and 'localization'. The high score of the former is connected to the variety of the distribution of the workforce in the economic sectors, while the latter is a consequence of the fact that so many activities and workplaces are available in loco that most of the inhabitants work in their city (which also attracts hundreds of thousands of workers from the neighbouring towns and from even further afield, causing some issues).

Moving to the analysis of the negative performances, I will start from the environmental indicators. The performances of 'greenness', 'compactness' and 'soil protection' are intertwined. The situations in the two districts Giambellino and Lorenteggio are very different, as Giambellino is more densely populated than Lorenteggio, at the expense of much higher soil consumption and sealing. One consequence is that most of the green areas included in the final score are in Lorenteggio, though the few ones in Giambellino are well distributed across the district. The general picture of these three indicators, thus, is negative. The two different situations are two extremes that should be balanced. The overall percentage of green areas is too low, while the percentages of soil consumption and sealing are too high.

Concerning 'green-development', the percentage of the districts' surface that are the object of sustainable urban redevelopment is too low compared to the actual need for renovation deriving from decades of scarce maintenance and absence of renovations (Turolla, 2017; Int.Plan.1 and Int.Plan.2). The mode splits of urban journeys in Milan show on the one hand that an important percentage is

[44] As already stated in section **4.3.1**, the judgements are based on the desired trends of the indicators described in section **4.2**
[45] The map of public transportation in Milan, available on the website of ATM, the company managing public transportation in Milan (www.atm.it/en), verifies this aspect

carried out by LPT while, on the other hand, the number of journeys by car is still too high. This is also related to the excessive car density and to the fact that too many of these cars are still relying on fossil fuels. This last aspect influences 'CO2 emissions' whose main source of issues is, still, the overall low energy efficiency of private and public buildings.

The major social issues registered by the **core indicators** in the area concern the high number of crimes ('security') and the excessively high concentration of poor families in the area compared to their average distribution in Milan ('inclusiveness') which is aggravated by the fact that low-income people keep moving into the area ('aggregation'). This growing concentration is even more negative if we consider the score in 'fairness', which shows how institutions seem to not pay adequate attention to the issues of minorities and worse-offs in urban planning.

Finally, the economic **core indicators** registering negative performances are 'energy' and 'self-sufficiency'. The energy consumption in Milan is excessive also for the abovementioned low energy efficiency of buildings, and it still mostly relies on fossil sources. This is also connected to the scarce local production of energy, which is way too low compared to the consumption (as shown by the energy's sub-indicator of 'self-sufficiency'). The local production of food is also very low but the municipality is trying to protect and improve it through its new food policy ("Food Policy Milano," n.d.). According to the company in charge of water management in Milan, Metropolitana Milanese (MM), all the water in Milan is harvested from the local water table through wells.

In **table 5.1** below there is the summary of the SSE, hereby I present some symbols and colours that have been used in the table itself to provide further information:

* – data referring to the whole city of Milan, due to the difficulties in retrieving these data about the specific districts.

(P) – Proxy indicator[46]: this indicator has been calculated considering a dimension different from the one contained in the metadata tabs but related to it. Due to this relation, this dimension was deemed appropriate enough to provide a suitable approximation of the original indicator.

Red value – due to the approximation of the calculation, this indicator undervalues the actual situation. This happened especially for those indicators whose calculations have been based on averages or not locally-referred data.

Date – the data used for the calculation are quite old due to the unavailability of updated ones.

The graphic representations of some of the indicators are in **annex 2**.

Table 5.1: The SSE of Giambellino-Lorenteggio

[46] "Proxy indicators are often applied, in CCA M&E and elsewhere, when no data exist or are easily available. They are also used for highly complex parameters, as when using rainfall volume as a proxy indicator for precipitation or population density per x unit as an indicator for overpopulation" (Climate-Eval, 2015: 44)

'Indicator'	Value	Relevant data/sub-indicators	Source	Access	Judgement, reasons, critical issues
Environment					
'Greenness'	Tot: 37,26% Publ: 28,17% Priv: 9,09%	Total surface: 4,601 km^2 Total green areas: 1,714 km^2 Public green areas: 1,296 km^2 Agricultural land: 0,094 km^2 Other private green areas: 0,324 km^2	DUSAF 5.0 (2015) DBT – Vegetazione (2017)	Public (GIS software required)	**Negative** – the overall percentage could be much higher, and the distribution is heavily imbalanced. Most of the green areas are in Lorenteggio, while in Giambellino the higher population density comes at the expense of the natural environment
'Compactness'	9793 res/km^2	Total population: 45.059 Total surface: 4,601 km^2	NIL (2016)	Public	**Negative –** connected with the previous indicator, Giambellino has a higher population density at the expense of the natural environment and Lorenteggio is in the opposite situation, it is a much greener district but with a much lower population density
'Accessibility'	D: 1,15 km T: 9' 15" C: 0,30 €	Healthcare: 3,23 km, 21' e 30" 0,50€ Police: 1,16 km, 9' e 42" 0,25€ Civil protection: 3 km, 22' 15" 0,50€ Education: 0,7 km, 6' 0,25€ Social services: 0,35 km, 4' 0,25€ Markets: 0,74 km, 7' 30" 0,25€ Green spaces: 0,26 km, 3' 30" 0,25€ Administration: 1,36 km, 11' 0,37€ Culture: 1,25 km, 10' 0.25€ Sport: 0,46 km, 4' 30" 0,25€ Commerce and generic services: 0,25 km, 2' 30" 0€	NIL (2016) Google Maps (2018)	Public	**Positive** but there are some **critical issues**: • The only major cultural activity present in the two neighborhoods is the library "Biblioteca Lorenteggio" and even though a considerable part of the residents are Muslim, there is only one official mosque, this could cause several social issues. • Hospitals and firefighters' HQ are quite distant from the evaluated area, this is reflected in the much more consistent space-time-cost distance between the inhabitants and these places The overall accessibility is quite good, many services and activities are well distributed in the area and the public transportation is quite pervasive
'Soil protection'	SC: 69,79%[47] 3,211 km^2 SS: 53,62% 2,467 km^2	"natural land": 0, 088 km^2 Agricultural land: 0,094 km^2 Estimated permeable soil: 2,134 km^2	DUSAF 5.0 (2015)	Public (GIS software required)	**Critical** – soil consumption is excessive, especially in Giambellino, where the soil sealing is also the highest between the two districts, potentially facilitating floods in case of extreme rainfalls
'Green-development' (P)	2,48%	ATU (Areas of Urban Transformation) for urban sustainability: 0,1142 km^2	OAPCCM (2017)	Public	**Negative** but there are new positive initiatives. The percentage is too low compared to the need for sustainable redevelopment in the area, but the new plans may improve this indicator significantly

[47] The remaining 30,21% includes public green areas, agricultural and natural land (according to the definition of soil consumption used by ISPRA – "Il consumo di suolo — Italiano," n.d.)

'Mobility'*	car[48]	43%	Only 1,3% of the cars are electric or hybrid, while the 5,6% are bi-fuel, 34,4% are diesel and the 58,7% are fueled by gasoline	PUMS (2013) Istat (2016)	Public	**Negative** – still too many journeys are made by car, there are too many cars in general and too many of them are still fueled by gasoline and diesel. Journeys by LPT and bike could improve with the new plans
	mc.	6%				
	LPT	48%				
	Bike	3%				
'CO2 emissions'*	5977 kilotons/year		Buildings: 3209 kilotons/year Public lighting: 37 kilotons/year Use for Industry/services: 1797 kilotons/year Transports: 935 kilotons/year	PAES (2013)	Public	**Critical** – the worst of the emissions of CO2 is connected to the low energy efficiency of the buildings, both residential and non, generally in the whole city of Milan
Society						
'Inclusiveness' (P)[49]	AP	5,37% 1095	Total families: 22.665 Families majority foreigners: 4368 19,27% of the total families The average in Milan is 17,71% while the incidence of AP and RP so calculated is 4,94% and 5,74 %	Istat (2016) SiSI (2016)	Public	**Critical** – due to sum of past phenomena of massive immigration of low-income people from other cities and countries and the continuous gentrification of the central districts, too many poor families have ended up concentrated in the suburbs of Milan. Giambellino and Lorenteggio are no exceptions in this respect, due also to the presence of a large and problematic complex of public housing
	RP	6,24% 1203				
'Equity'	W	100%	There is no recorded area in the city of Milan which is not served by these four fundamental services, so every citizen has been granted the potential to access them.	MM (2016) A2A (2016) AMSA (2018) Google Maps (2018)	Public	**Positive** – Milan is one of the most advanced cities in Italy in the distribution of services. This is reflected locally on the positive situation of the widespread potential access to the four fundamental services in these two districts
	E	100%				
	WM	100%				
	LPT	100%				
'Security'*	149295		Crime rate: 11.069,5 penal crimes reported by the police to the judiciary every 100.000 inhabitants	Istat (2016)	Public	Negative – many other cities in Europe with a similar population have far less penal crimes than the ones in Milan. This situation may be linked to the both the massive presence of foreign immigrants and the social segregation that is more evident in some districts like Giambellino and Lorenteggio
'Aggregation' (P)	-1,13%		Foreigners in 2017: 10.076 Foreigners in 2016: 9963 Foreigners in 2015: 10.000	SiSI (2017)	Public	**Negative** – in this case, a negative value means that number of foreigners who are concentrated in this area is increasing. Since they were chosen as proxy

[48] Car density: 512 cars per 1000 inhabitants

[49] Another clear indication of the poverty in this area could be the average price of the houses in these neighborhoods (1962,36 €/m^2), which is considerably lower than the average price of the houses in Milan (2684 €/m^2) ("(Milano): Osservatorio quotazioni immobiliari (2018) - Listino Valori Prezzi mq," n.d.)

			Foreigners in 2014: 9.906			for the worse offs (given their general economic conditions in the suburbs), this means that the concentration of poverty is increasing here as well
'Fairness' *	3		various minorities-related issues are mentioned and some of them are addressed in urban planning policies	Municipality (2015)	Public	**Negative** – given the particular socio-economic situation also in similar areas, these issues should be among the main focuses of local urban planning
Economy						
'Self-sufficiency'*	F(P)	10,58%	Food consumption: 3.252 MM € Food production: 344 MM €	Municipality (2015) MM (2016) Terna (2016)	Public	**Negative**, except for the sub-indicator Water – both the local productions of food and energy are almost negligible. On the other hand, the municipality of Milan is focusing on its food policy recently, trying to safeguard the only large surviving agricultural area on its southern border
	W	100%	All the water is harvested locally			
	E	Very low	The metropolitan area produces only 5.292,4 GWh/year of energy, of which only 972,8 GWh/year from RES			
'Circularity'	SW	53,8%	Total Solid Waste produced: 673.360 t Total Solid Waste recycled: 362.331 t Incinerated waste with energy recovery: 41,4% (2016)	AMSA (2017) ARPA L. (2016)	Public	**Positive** – Milan is among the most advanced cities in Europe of this size in the recycling of solid waste ("Ecosistema Urbano 2017 | Legambiente," n.d.), the reuse of treated wastewater for agricultural purpose is indeed praiseworthy and the percentage of water losses is among the lowest compared to the other major Italian cities.
	WR	36,4%	Total distributed water: 223.890.508m^3 Water losses: >11,5% Wastewater treated (100%) and reused for irrigation: 86.478.068 m^3	MM (2016)		
'Energy'*	NRS	90,87%	Total consumption: 27.422,113 GWh/year Estimated RES consumption: 2502,605 GWh/year	SiReNa (2012)	Public	**Critical** – the energy consumption is way too high and still almost completely relying on fossil sources, this also affects negatively the air quality in the area and the health of the citizens
	RES	9,13%				
'Diversification'*	3		Percentage of employee in the sectors: Agriculture - 0,01% / Industry – 13,26% Constructions – 4,33% / Commerce 18,46% / Services – 63,94%	SiSI (2011) Metropolitan City (2017)	Public	**Positive** – Milan is the economic center of the Lombardy Region and the economic capital of Italy, this is reflected in the high diversification (thus resilience) of its economy
'Localization'*	79,84%		470.939: residents employed in Milan 589.850: total residents employed	SiSI (2014)	Public	**Positive** – many of the workers residing in Milan also work in their city. **On the other hand**, with Milan being the economic heart of its region, it attracts hundreds of thousands of workers from near (and far away) cities and towns every day, causing congestion within and around the city

5.2 The ongoing plan of urban renewal: AdP Lorenteggio

The Program Agreement, as repeatedly stated in the document of its approval, is aimed at promoting sustainable urban development in the area Giambellino-Lorenteggio, with particular attention paid to social inclusion and public housing issues (AdP Lorenteggio, 2016). The AdP includes actions belonging to different sub-plans and founded by diverse sources. They are divided into actions based on European funds, which belong to the ROP ERDF, to the ROP ESF (European Social Fund) and to the NOP METRO ("National operational programme 'Metropolitan cities 2014/2020' – Pon Città Metropolitane 2014-2020," n.d.). Moreover, there are actions directly funded by the Municipality of Milan and by Lombardy Region with its own resources. These distinctions are presented in the document of the approval of the AdP (AdP Lorenteggio, 2016) and will be reported in the SIE.

The targets of the various actions are diverse:

- the renovation and recovery of the public tenements that are in the worst structural conditions,
- the requalification of the area surrounding the public housing complex, including the adjacent park,
- the improvement of the energy efficiency of public lighting and houses,
- the enhancement of the social services supporting the worse-offs in the area.

The Municipality of Milan has the responsibility for the implementation of most of these actions, even those funded by the Region (mostly through the abovementioned European funds) except for the action aimed at renovating the public housings which is responsibility of Lombardy Region (AdP Lorenteggio, 2016).

The full list of the actions and their description is presented in **annex 4**, together with the evaluations of their impacts on the indicators.

5.2.1 The involvement of the local stakeholders and the local indicators

The interviews with the representatives from the identified relevant local stakeholders had the objectives highlighted in section **1.2** and **3.1**. The enhancement of the sense of participation and ownership of the M&E activity from the local stakeholders and the adaptation of EFSUA to the local context. The latter target is achieved through the development of **local indicators**, aimed at integrating the **core** by addressing the dimensions highlighted by the local stakeholders. Moreover, these interviews had also the objectives of collecting more data about the local major issues, of letting the stakeholders express themselves on the adequacy of the ongoing plan and about potential issues that arose during the policymaking process. The opinions about the local issues have been already reported in section **5.1**, while the latter observations are more relevant for the analysis of the processes of urban governance involved in the development and implementation of AdP Lorenteggio, which is performed before the rest of the SIE.

Thanks to the answers provided by the representatives about the objectives of the stakeholders and the main issues they wanted to tackle with the AdP, it was possible to identify three **local indicators** to adapt the EFSUA to the particular context of Giambellino-Lorenteggio. Significantly enough, and coherently with the objectives of the plan itself (AdP Lorenteggio, 2016), two of them belong to the

social domain and the third both to the social and economic one. They are presented here through their metadata tables.

Metadata tables of the local indicators

Table 5.2: Metadata table of the local indicator 'social support'

Name of the indicator	**'Social support'**
Description	The number of social, non-profit enterprises present in the area that support the worse-offs
Typology and unit of measure	Quantitative – number of enterprises
Thematic area/sustainability domain	Society/People
Macro-objectives to which the dimension measured by the indicator contributes	Prevention/mitigation of negative externalities, urban resilience, safety, social justice, employment
Indicators affected	'*security*' – 'aggregation'
Affected by	'*Inclusiveness*' – '*equity*' – '*fairness*'
Type of representation	absent
Source/s of the indicator	Interviews with Lombardy Region and Municipality of Milan (Int.Plan.1 and Int.Plan.2)

Table 5.3: Metadata table of the local indicator 'public housing'

Name of the indicator	**'Public housing'**
Description	The supply of public housing compared to its demand, both in terms of quantity and quality
Typology and unit of measure	Quantitative/qualitative – number of public housings and their average quality expressed with a grade ranging from 1 (unacceptable) to 5 (state-of-the-art)
Thematic area/sustainability domain	Society/People
Macro-objectives to which the dimension measured by the indicator contributes	Prevention/mitigation of negative externalities, urban resilience, safety, social justice, resources efficiency, attractiveness
Indicators affected	'Compactness' – '*green-development*' – 'inclusiveness' – '*equity*' – '*security*' – 'aggregation'– 'energy'
Affected by	'*security*'
Type of representation	absent[50]
Source/s of the indicator	Interviews with Lombardy Region and Municipality of Milan (Int.Plan.1 and Int.Plan.2)
Sub-indicators	• Number of available public housings • Average quality of available public housings

[50] Although a map showing the position of the buildings of public housing with the indication of their quality could provide very useful information to urban planners about potential specific or more comprehensive interventions

Table 5.4: Metadata table of the local indicator 'employment rate'

Name of the indicator	**'Employment rate'**
Description	The employment rate in the area
Typology and unit of measure	Quantitative – percentage
Thematic area/sustainability domain	Society & Economy/People & Profit
Macro-objectives to which the dimension measured by the indicator contributes	Urban resilience, social justice
Indicators affected	'*Aggregation*' – 'localization'
Affected by	'*Fairness*' – 'diversification'
Type of representation	Pie chart
Source/s of the indicator	Interviews with Lombardy Region and Municipality of Milan (Int.Plan.1 and Int.Plan.2)

5.2.2 The SIE of AdP Lorenteggio

The first step to take was the qualitative analysis of the governance processes implied in the policymaking of AdP Lorenteggio. In this case as well, the two interviews with the local stakeholders provided important information about the issues raised during the policymaking process. Their insights have been included in the following analysis.

Urban governance in the SIE of AdP Lorenteggio:

- 'Budget' – These are the available funds as reported in the AdP:
  - €52.700.000 – ROP ERDF (conditioned by the EU[51])
  - €1.950.000 – ROP ESF (conditioned by the EU[52])
  - €5.000.000 – NOP METRO (conditioned by the EU[53])
  - €20.000.000 – Municipal budget for the renewal of public areas
  - €11.699.171 + €4.957.604[54] – Regional budget for the requalification of public housing, the asbestos reclamation and the relocation of current inhabitants.
- 'Participation' – The Municipality of Milan is part of the Supervisory Board (Collegio di Vigilanza, in Italian) which decides and oversees the actions of the AdP. The other members of the Supervisory Board, so the other most relevant stakeholders, are Lombardy Region and ALER, the regional public company taking care of public residential buildings. Poliedra participates to the meetings as it oversees the environmental M&E of the plan. The masterplan of the intervention was also influenced by bottom-up research carried out by several local associations in the public housing complex, resulting in a report of over 350 pages named VALE, which included much information about the structural issues in the complex, as well as the opinions of the inhabitants concerning the socio-economic issues in the area. Parts of this report have been included in the masterplan itself (Masterplan: Lorenteggio, 2015).
- 'Implementation management' – The original agreement prescribed periodic meetings of the Supervisory Board to keep track of the implementation of the AdP. In fact, the parties almost

[51] (Regulation (EU) No 1301/2013 of the European Parliament and of the Council of 17 December 2013 on the European Regional Development Fund and on specific provisions concerning the Investment for growth and jobs goal and repealing Regulation (EC) No 1080/2006, 2013)

[52] (Regulation (EU) No 1304/2013 of the European Parliament and of the Council of 17 December 2013 on the European Social Fund and repealing Council Regulation (EC) No 1081/2006, 2013)

[53] ("National operational programme 'Metropolitan cities 2014/2020' – Pon Città Metropolitane 2014-2020," n.d.)

[54] Enhancement decided during the meeting of the Supervisory Board on the 12th of April 2017 ("Asse V Sviluppo Urbano Sostenibile," n.d.)

stopped meeting for a while. This happened because, as both the Plan-related interviews have confirmed, the co-planning of the AdP between the Municipality and the Region proved to be troublesome, with delays, misunderstandings and other issues confirmed by both the institutions. They also blame the suffocating bureaucracy involved in this experimental project and the inadequacy of some of the objectives and indicators imposed by the European Commission to allow access to the funds (Int.Plan.1 and Int.Plan.2). The plan initially encountered fierce resistance from the inhabitants of the area, also as a result of the lack of proper renovation plans in the past. The Municipality initially tried to soften this mistrust by means of informative meetings with the inhabitants. Sadly, these meetings have stopped and with them the process of trust-rebuilding between the citizens and the institutions (Int.Plan.2).

- 'Data availability' – The relevant local data were collected before the plan started, more than three years ago. It appears that no serious effort is being made to update them as the implementation proceeds. This could become a serious issue, since without uploaded data it will be difficult to correct the potential mistakes during the implementation of the plan. Nonetheless, general information about the implementation is being provided mostly on the website of Lombardy Region ("Asse V Sviluppo Urbano Sostenibile," n.d.), while some information concerning the calls and competitions involved in the implementation are on the website of the Municipality of Milan ("Quartiere Lorenteggio," n.d.).

As anticipated in section **3.1**, the thorough description of each action and the single evaluations[55] of their impacts are in **annex 4**. Here I provide the summary of the evaluation of the impacts of the whole AdP. The actions can be grouped according to their principal objective, even if in some cases they have potentially contrasting effects. These principal objectives can be summarized in a few points:

- Improving the quantity and quality of the available public housings and supporting people both accessing these homes and taking care of them through dedicated social services. These actions have positive impacts mostly on 'public housing' and 'security', with a chain reaction of positive impacts on 'compactness', 'energy' and 'CO2 emissions', positively responding to some of the issues identified with the SSE. These actions, though, will also have a negative effect on 'aggregation' and 'inclusiveness' as they will most likely lead to an even greater concentration of worse-offs in Giambellino where many people suffering from socio-economic distress are already concentrated, potentially aggravating one of the issues identified with the SSE.
- Enhancing the social services in the area and supporting the people suffering from economic hardships: The positive effects are mostly visible for the indicators 'fariness', 'security' and 'social support', which scored negatively in the SSE.
- Improving the energy efficiency of public buildings and lighting, by renovating the old appliances and adopting new energy-saving technologies. However, one of the actions based on the municipal budget entails also the construction of a new library. Its energy consumption will have to be weighed against the energy savings achieved with the other interventions. The main positive effects of these actions could be on 'green-development' and 'energy', which have scored negatively in the SSE.
- Finally, the remaining actions aim to improve both the security in the area by enhancing public lighting (which, on the other hand, could cause higher energy consumption) and the sustainable

[55] As already stated in section **4.3.2**, the judgements are based on the desired trends of the indicators described in section **4.2**

mobility by creating a new bike lane. These positive effects are important given that both the related indicators ('security' and 'mobility') scored negatively in the SSE.

Here follows the table summarizing the total expected impacts of AdP Lorenteggio.

Table 5.5: Ex-ante SIE of AdP Lorenteggio

Ex-ante SIE of AdP Lorenteggio		
'Greenness'	+ / –	The uncertainty is due to the contrasting impacts of the actions based on the municipal budget (the first action entails the recovery/creation of some new green areas for urban decoration, while the second action includes the construction of a new library in the public green area in Via Odazio)
'Compactness'	+	See 'public housing' – several actions from the ROP ERDF, the ROP ESF and The NOP METRO all contribute in recovering/improving the supply of public housing thus the availability of homes for new inhabitants to move into, increasing the population density in Giambellino-Lorenteggio
'Accessibility'	**0**	No action has significant impacts on any of the sub-indicators of accessibility
'Soil protection'	–	The construction of the new library in the public park near Via Odazio will have negative impacts on both soil consumption and sealing
'Green-development'	+	The surface involved in the several actions aiming at sustainable urban (re)development will most likely be larger than the one that will be occupied by the new library
'Mobility'	+	The positive impact is connected to the realization of the new bike lane
'CO2 emissions'	+ / –	See 'energy' – the reduction in these emissions caused by the energy savings and by the abovementioned impacts on 'mobility' will have to be compared with the increase in these emissions connected to the new energy consumption caused by the enhancement of public lighting and by the new library
'Inclusiveness'	–	See 'aggregation' – the concentration of poor families in Giambellino-Lorenteggio is already higher than the average in Milan. Those actions can worsen the situation considerably
'Equity'	**0**	No action affects the potential access to the four services
'Aggregation'	–	Several actions are aimed both at increasing the number of social housing units available and at helping the worse-offs having access to homes in the area. This further immigration of people suffering from socio-economic difficulties in districts that are already hosting a high number of them is not positive
'Fairness'	+	Overall, many actions are focused on supporting the worse offs in the area (see 'social support'), on providing them with a more adequate stock of public housing (see 'public housing') and on helping them training and hopefully finding new jobs (see 'employment rate'). More attention should have been paid o the integration of cultural minorities, which are numerous in the area
'Security'	+	There are actions focusing on ameliorating public lighting, actions focused on improving the supply of social services and actions aimed at providing (legitimate) homes to those in need. The cumulative effects of all these actions should have positive impacts on the penal crimes in the area, surpassing the potential negative impacts of the worsening of 'inclusiveness' and 'aggregation' on this indicator

'Social support'	+	The target of several actions is precisely to improve the quantity of social enterprises and services for the inhabitants
'Public housing'	+	The increase of the quantity of available public housing units is the aim of action **V.9.b.1.1**, while the improvement of the overall quality of public housings is the aim of several actions
'Employment rate'	+	Between the new jobs available with the new library and the various actions instituting social services or paid training courses, it is legitimate to expect an improvement of this indicator, at least in the long term
'Self-sufficiency'	+ –	See 'energy' – depending on the final energy balance, this plan could have either a positive or negative impact on the sub-indicator accounting for energy
'Circularity'	**0**	No action impacts significantly the recycling of solid waste nor the treatment and reuse of wastewater
'Energy'	+ –	The energy savings promoted by the actions of the ROP ERDF and the requalification of the old library and the municipal market will have to be compared with the increase in the energy consumption caused by the enhancement of public lighting (action **B**) and by the new library
'Diversification'	+	See 'employment' – the new job opportunities will also represent the chance to further diversify the local economy
'Localization'	+	See employment and 'diversification' – these new and diverse job opportunities will potentially have also the positive effect of making themselves available locally for the inhabitants.

The considerations about AdP Lorenteggio that emerge from this final evaluation are conflicting. On the one hand, the will to renovate this suburban area in the direction of sustainability emerges from several actions: from the enhancement of energy efficiency in public buildings and lighting with new technologies, to the realization of the bike lane, to the several actions aimed at supporting the worse-offs in the area and improving the social services and support. On the other hand, though, precisely these latter actions, together with the expected impacts on 'aggregation' and 'inclusiveness', present a troubling picture of the opportunities potentially lost with this policy and of the potential future scenario.

Indeed, considering also the possibilities brought by the forthcoming opening of the new metro line, with 4 stops in this suburban area, the choice to keep this large complex of public housing as a single entity at the heart of Giambellino is, in my opinion, questionable. The metro line will open in a few years and it will finally link these two districts with the rest of the city with stronger bonds. The benefits will extend from the improvement of the overall life quality of the inhabitants, to a renewed impulse for further renovations of almost the totality of this suburban area. The reason for this is that the complex of public housing will most likely preserve its closed nature of "ghetto" while this renovation happens. In fact, both the buildings that will be demolished and rebuilt and those which will only be targeted by interventions of maintenance and asbestos reclamation will preserve their nature of public housings. They will host the same categories of people suffering from socio-economic distresses, given that a family/person must meet certain conditions in terms of low income to be eligible for public housing ("Case popolari," n.d.). These people, besides, will most likely

increase in their numbers because many of the housing units that were inhabitable before this plan[56] will be made habitable and the demand for these public housings is very high. As repeatedly stated in the SIE, these districts are already hosting a concentration of poor families higher than the average in Milan. Moreover, because of the requirements in terms of low income needed to access public housing, the concentration of poor families in the complex is 100%. So, in the end, not only is the number of poor families in the area already (too) high, but it is also extremely concentrated and will most likely remain as such in the future.

Another major issue which threatens the completion of this plan is the actual ability of the stakeholders to spend the European funds involved in the implementation of AdP Lorentggio. Italian public administrations have repeatedly failed in using most of the European funds, mostly due to the heavy bureaucracy involved in using such exogneous funds. The Lombardy Region has expressed the concern that this may also occur in this case (Int.Plan.1). If it does, this could completely cripple the implementation of AdP Lorenteggio, given that so many of its actions depend on EU funds, as shown in the beginning of the evaluation.

6. Conclusions

Answering the research questions

In the end, this research aims to be a significant step in fostering the systemic approach to sustainable urban development promoted by so many scholars and experts and by the UN with its 2030 Sustainable Development Agenda (Rosa, 2017). This approach is embedded in an updated tool to measure the sustainability of urban areas. The Evaluative Framework for the Sustainability of Urban Areas, in fact, includes and embodies some of the more updated theories, studies and guidelines in both the fields of sustainable urban development, and in the activity of Monitoring and Evaluation, the main ones being the UN 2030 Agenda (Rosa, 2017), the New Urban Agenda (n.d.) and the best practice study performed for the EU Mayors Adapt initiative (Climate-Eval, 2015). At the same time, this tool promotes the involvement of the local stakeholders, aiming to improve their awareness of the issues of their cities and their participation to the effort for a local sustainable development.

The extensive review of the existing tools developed and used with similar purposes, performed through the lenses provided by the studies of best practices in the field of M&E, allowed the development of an innovative, mixed index to form the backbone of the evaluative tool. The identified **core indicators** which compose the index answer the first research sub-question presented in section **1.2**. These indicators have been identified among the ones used by existing evaluative tools, they were adapted from others or developed from the theories and concepts of sustainable urban development and they were deemed suitable to keep track of those dimensions that are necessary, but not sufficient, to measure urban sustainability. The less generalizable dimensions are left to the integration of the **core indicators** with **local indicators** to be designed through the involvement of the relevant local stakeholders. This innovative approach is in accordance with the Community-Based

[56] In 2015, 555 out of 2.667 tenements were uninhabited because they were defined as under maintenance, not accessible, or "below the requirements" (less than 28,8 m^2) and as such they were not assignable according to the law requirements in force (Turolla, 2017)

Approach described by the best practice study in M&E (Climate-Eval, 2015), which is deeply related with the bottom-up approach to sustainable urban development promoted by an increasing number of experts and scholars (just to cite some of them: Campbell, 2012; van der Heijden, 2014; Bloomberg, 2015).

The second sub-question has been answered in section **5.1.1**, where the first SSE performed with the **core indicators** of the EFSUA highlights several issues in Giambellino-Lorenteggio related to all the three domains of sustainability. Most of the issues were registered through the environmental and social indicators, showing once more how improving only some aspects of urban sustainability without promoting integrated strategies as fostered by the UN Agenda (Rosa, 2017), easily condemns the efforts made to build a sustainable model of development.

Finally, the last sub-question was answered through the first SIE performed with both the **core indicators** and the **local indicators** developed through the involvement of the relevant local stakeholders in the M&E activity. The results of the evaluation of AdP Lorenteggio have already been presented in section **5.2.2**, together with their analysis. The issues highlighted by these results also led me to formulate some recommendations for improving the ongoing plan or future interventions.

Further comments on the evaluations and policy recommendations

Looking at both the SSE and SIE, it results that AdP Lorenteggio could ameliorate the score of some of the indicators, but, despite its declared focus on tackling social issues, it is at least partially failing in addressing precisely the major issues in the social domain, which are related to the(too) high concentration of poor families in the area. In fact, analysing the expected effects of the plan with the SIE, the most probable outcome is that the overall quality of the two districts will ameliorate over the next decade, while the public housing complex will mostly remain as it is, a potential concentration of socio-economic distress. Even the various actions focusing on improving the number of social enterprises and improving social services in general appear to be the preventive reaction planned by the policymakers to accompany this outcome. In other words, it seems that the strategy of the policymakers followed this reasoning: since the number of the worse-offs in the area will keep increasing, the natural reaction is to enhance the social services that they will increasingly need in their everyday life. Consequently, the main advice that the SSE and SIE could produce for the stakeholders involved, is to consider the possibility to break this social isolation, spreading the high concentration of poor families at least over the whole area of the two districts[57] instead of keeping them segregated all together in the same six city blocks.

Other minor suggestions should be to consider also the inclusion of nature-based solutions in the actions aiming at the requalification of both public houses and buildings. NBSs could have positive impacts on both ‘greenness’ and ‘energy’. The enhancement of energy efficiency could also be pursued through a more decisive improvement in ‘self-sufficiency’, for example by adding RES installments like solar and photovoltaic panels on the renovated buildings. All these improvements could also lead to a more decisive decrease of ‘CO2 emissions’. A more innovative action could

[57] But the best thing to do would be to distribute them also in those districts that have been experiencing a massive process of gentrification in past years and decades, keeping in mind the promotion of mixed-housing to avoid the worsening of the social divide in urban areas, with the consequent creation of ghettos

involve the integration of a phytodepuration plant in the public housing complex, to allow for the reuse of wastewater for those purposes which do not need drinkable water. Other recommendations concern the need for a major commitment in keeping the inhabitants affected by the plan constantly informed about its progression, as well as the necessity to improve the mechanisms of co-planning to strengthen the coordination between the stakeholders and reducing their contrasts.

Other considerations concern the very M&E activity. Through the interviews with the stakeholders I have registered different attitudes regarding the EFSUA as a tool to support the policymaking process. Indeed, it appeared evident during both the interviews that neither the setting of precise objectives nor the verification of their achievement are considered important components of the policymaking process. This influences also the way in which relevant data are collected and managed. The data concerning too many crucial dimensions are not regularly updated, sometimes nor even present, on the statistical website of the municipality. Indeed, committed and sound data management is crucial for tools such as the EFSUA to fulfil their role of informing the policymaking processes and keeping track of their outcomes (Climate-Eval, 2015).

One important advice for the **commitment** of urban governance is that partial evaluations should also be carried out during the implementation phases of plans, then after their conclusion. The final, ex-post SIE should summarize the cumulative impacts of all the actions of the plans that have been actually carried out, paying attention to the interactions between the potential contrasting impacts of the various actions. Such an evaluation is crucial both to verify the eventual effects (positive or negative) of the plans on the urban area and to allow the city to keep learning, adapting and improving. Successively, further evaluations should be carried out at regular intervals to keep track of the long-term impacts of the plans (although this task could be delegated to the yearly SSE, depending on the scale of the impacts). Sadly, it has not been possible to perform the ex-post SIE in the present research because the time frame for the internship was far shorter than the time needed for the implementation of the analysed plan.

The interactions between the indicators

Another important aspect to be addressed concerns the relations between the indicators, which were theorized and described in section **4.4**. Many of the interactions resulted evident from the SSE of Giambellino-Lorenteggio and they also played an important role in the SIE of ADP Lorenteggio, helping me to formulate a more complete and integrated prediction of the potential impacts of this plan on the situation in the area.

Starting from the inter-domain relations in the SSE, the first evident interaction was the one between ‘greenness’ and ‘compactness’. These indicators scored negatively because, as already highlighted in the evaluation, in both the districts there is an evident trade-off between these indicators. In Lorenteggio there is a higher percentage of green areas at the expense of a much lower population density, while in Giambellino there is a higher population density at the expense of a much lower presence of green areas. This latter situation is obviously also a result of the negative score of ‘soil protection’. Anyhow, the good spatial distribution of public green areas across the districts is positively reflected by the related sub-indicator of ‘accessibility’, confirming its connection with ‘greenness’.

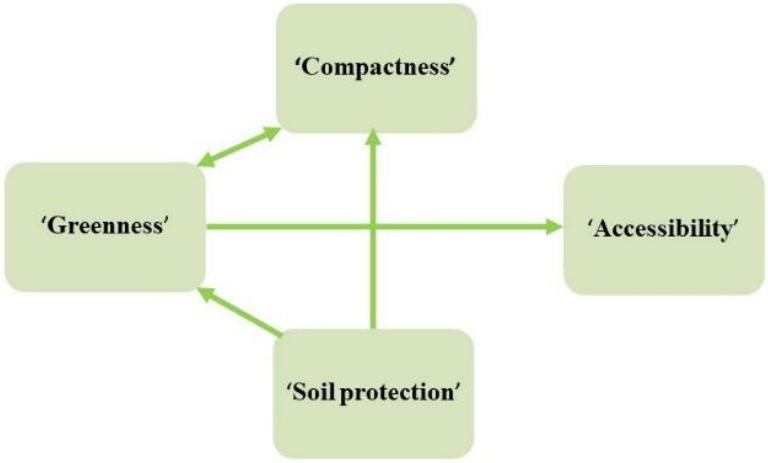


Figure 6.1: First intra-domain relations between the environmental **core indicators** resulting from the SSE

The relations between 'compactness', 'accessibility' and 'mobility' were confirmed in the SSE as well, with the positive influence of the population density on most of the sub-indicators of 'accessibility', whose positive score influences also 'mobility', especially in the high share of journeys carried out by LPT. The still too low share of journeys by bike and the resulting too high share of journeys carried out by car is, in my opinion, mostly related to the overall absence of bike lanes in the area. The relation between 'mobility' and 'CO2 emissions' was confirmed as well, as the high share of travels carried out by car is reflected in the high emissions of CO2 caused by transports.

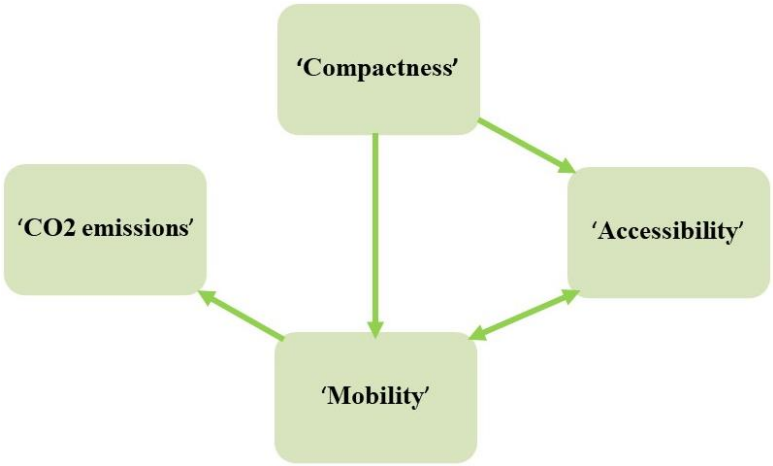


Figure 6.2: Second intra-domain relations between the environmental **core indicators** resulting from the SSE

Moving to the social indicators, their inter-domain relations were harder to prove, given the indirect nature of many of them. Anyhow, the most evident ones were the one between 'aggregation' and 'inclusiveness', since the increasing number of worse-offs moving into Giambellino-Lorenteggio resulted in a higher concentration of poor families in the area. According to the relations theorized in section **4.4**, this should also be connected to the just sufficient score of 'fairness'. This troublesome situation in the social domain is also reflected in the too high crime rate registered in 'security', again confirming the relations between these social indicators.

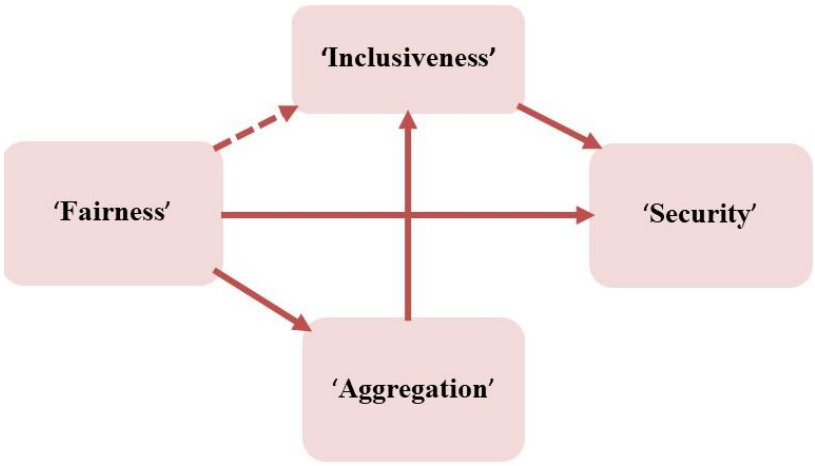


Figure 6.3: Intra-domain relations between the social **core indicators** resulting from the SSE

The economic inter-domain relations were more evident. Firstly, the one between the high energy consumption ('energy') and the consequent low value of the related sub-indicator of 'self-sufficiency'. Secondly, the one between 'diversification' and 'localization', with a very high percentage of inhabitants working in their own city thanks to the diverse offer of workplaces that are available locally.

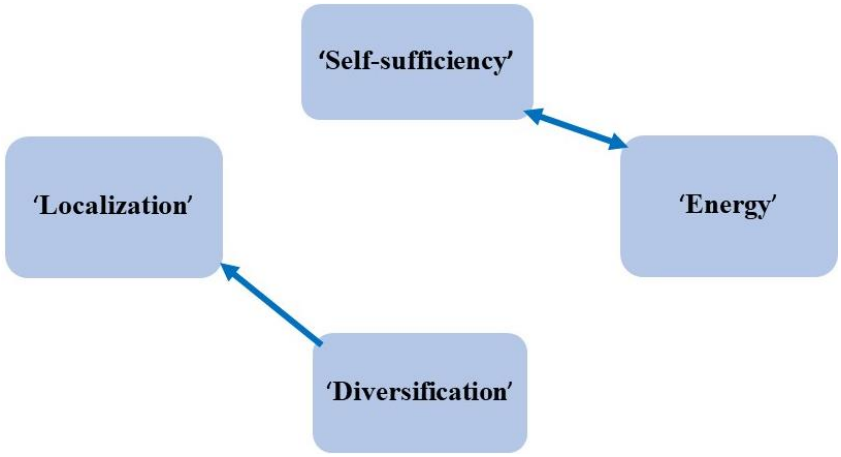


Figure 6.4: Intra-domain relations between the economic **core indicators** resulting from the SSE

Moving to the inter-domains relations, one of the most evident interaction that is visible in the SSE is the one between 'compactness' and 'equity'. The high population density in the area, indeed, favours the widespread diffusion of the potential access to the four fundamental services. Another evident relation is the one between 'CO2 emissions', 'self-sufficiency' and 'energy', since the high energy consumption and the low energy production from RES result in relevant emissions of CO2, particularly due to the low energy efficiency of buildings.

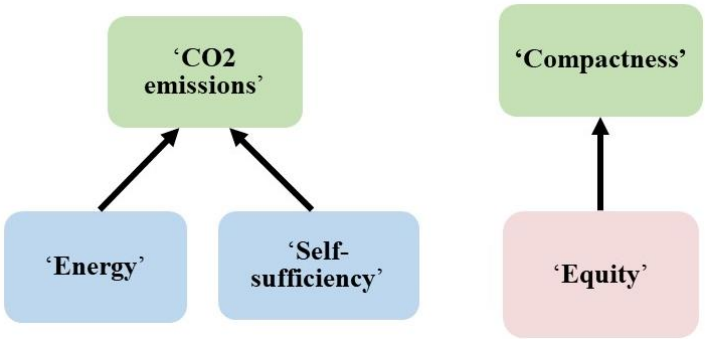


Figure 6.5: Inter-domains relations between the **core indicators** resulting from the SSE

For the SIE, these intra-domain and inter-domains relations were already highlighted in table **5.5**, where the interactions between the various indicators have been reported in the column containing the reasons for the evaluation, whenever the explanations started with a reference to another indicator.

Final considerations on the EFSUA, limits of the research and recommendations for further research

In the end, the EFSUA resulted to be applicable and flexible enough to adapt to the context of the case study, and it can provide sensible information on both the status of the sustainability of the urban area and on the impacts of the analysed plan. Its applicability is heavily influenced by the availability of reliable, updated and accessible data to calculate the indicators. Indeed, how can the feedback generated by the evaluations be "regular" and "objective" (Figueiredo, Honiden and Schumann, 2018: 25) if the data on which they are based are old or imprecise or difficult to access? How can they provide reliable information for policymakers, if the data themselves are not reliable? The necessary data could be easier or harder to collect in different contexts. In Milan, where I conducted this research, I encountered several issues in this respect during the evaluations, as I had to calculate some of the indicators using non-updated data or approximations[58]. Probably, this was also due to the limited time available for the research and to the fact that I had to take care of the evaluations mostly on my own. Concerning the flexibility of EFSUA, from the explorative application it resulted that the local indicators were suitable to adapt the tool to the specificities of the local situation, and that the involvement of the local stakeholders was necessary to identify them.

For further improvements and future applications of the EFSUA, firstly, it would be useful to identify a series of targets and benchmarks for the indicators, to make the information provided by the evaluations more objective and easily understandable. These targets and benchmarks should be added to the desired trends identified in table **4.2**, to integrate them. However, to be really useful, the identification of benchmarks must consider the different contexts and the different sizes of the evaluated cities/districts. For example, it could be profoundly wrong and useless to consider as a benchmark the performances in terms of 'energy' of a small town in the Netherlands while evaluating those of a large city in China.

[58] As indicated both in section **3.1** and in the SSE in section **5.1.1**

Secondly, I would recommend assigning the evaluation of each domain to experts in the specific field, appointing a central figure with a versatile, polyhedral expertise to coordinate their tasks and maintaining a larger perspective. This was not possible for the present research because of the limited time available and of the fact, as previously mentioned, that only one person performed the entire M&E activity.

Thirdly, further research should be conducted for the identification of additional core indicators for urban areas belonging to more developed contexts. Such indicators could consider qualitative aspects of the dimensions measured by the current **core indicators** (e.g. the quality of green areas). Another aspect that could be elaborated is the scalability of EFSUA regarding urban areas with different sizes in terms of territory and population.

Maybe the main feature of the EFSUA, its comprehensiveness, is also one of its greatest limits. As this tool aims to consider the larger picture in terms of sustainability of the evaluated urban area, it does not allow to focus and investigate in-depth single aspects or features of interest. However, as already stated, a broad, systemic approach is crucial for a successful integrated sustainable urban development.

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Appendices

Appendix A - List of the reviewed studies and tools to measure urban sustainability, divided in those that I have directly analysed, those reviewed by Gil and Duarte (2013) and those reviewed in the study on best practices in M&E by Climate-Eval (2015):

- Studies and tools analysed directly:
    - Shen, L.-Y., Jorge Ochoa, J., Shah, M. N., & Zhang, X. (2011). The application of urban sustainability indicators – A comparison between various practices. *Habitat International*, *35*(1), 17–29. https://doi.org/10.1016/j.habitatint.2010.03.006
    - Shen, L., Kyllo, J. M., & Guo, X. (2013). An Integrated Model Based on a Hierarchical Indices System for Monitoring and Evaluating Urban Sustainability. *Sustainability*, *5*(2), 524–559. https://doi.org/10.3390/su5020524
    - Tanguay, G. A., Rajaonson, J., Lefebvre, J.-F., & Lanoie, P. (2010). Measuring the sustainability of cities: An analysis of the use of local indicators. *Ecological Indicators*, *10*(2), 407–418. https://doi.org/10.1016/j.ecolind.2009.07.013
    - Boyko, C. T., Gaterell, M. R., Barber, A. R. G., Brown, J., Bryson, J. R., Butler, D., … Rogers, C. D. F. (2012). Benchmarking sustainability in cities: The role of indicators and future scenarios. *Global Environmental Change*, *22*(1), 245–254. https://doi.org/10.1016/j.gloenvcha.2011.10.004
    - Mori, K., & Christodoulou, A. (2012). Review of sustainability indices and indicators: Towards a new City Sustainability Index (CSI). *Environmental Impact Assessment Review*, *32*(1), 94–106. https://doi.org/10.1016/j.eiar.2011.06.001
    - Pupphachai, U., & Zuidema, C. (2017). Sustainability indicators: A tool to generate learning and adaptation in sustainable urban development. *Ecological Indicators*, *72*, 784–793. https://doi.org/10.1016/j.ecolind.2016.09.016

- Studies and tools reviewed by Gil and Duarte (2013):
    - **Citycad** (http://www.holisticcity.co.uk/)
    - **Duurzaamheids Profiel van een Locatie** (DPL) (http://www. ivam.uva.nl/index.php?id5560)
    - **EcoCity Book 2** – Gaffron P, Huismans G and Skala F (eds) (2008) *EcoCity Book 2: How to Make it Happen*. Facultas, Vienna, Austria.
    - **Index** (http://www.crit.com/)
    - **Leadership in energy and environmental design neighbourhood development** (**Leed-ND**) (http://www.usgbc.org/ DisplayPage.aspx?CMSPageID5148)
    - South East of England Development Agency (Seeda) **sustainability checklist** (http://southeast.sustainabilitychecklist.co.uk/)

- **Sistema de Indicadores y Condicionantes para ciudades grandes y medianas** (SIC) – MMAMRM and BCN (Ministerio de Medio Ambiente, y Medio Rural y Marino and Agencia de Ecologia Urbana de Barcelona BCN) (2010) *Sistema de Indicadores y Condicionantes para ciudades grandes y medianas*. Ministerio de Medio Ambiente, Madrid, Spain.
- **Shaping Neighbourhoods** (**SN**) – Barton H, Grant M and Guise R (2010) *Shaping Neighbourhoods: A Guide for Health, Sustainability and Vitality*. Spon Press, London, UK.
- **Sustainability of land use and transport in outer neighbourhoods** (**Solutions**) (http://www.suburbansolutions.ac.uk/)
- **Sustainable project appraisal routine** (**Spear**) (http://www. arup.com/Projects/spear.aspx)
- **Sustainable urban landscapes** (**SUL**): the site design manual for BC communities (http://www.jtc.sala.ubc.ca/projects/ DesignManual.html)

- Studies and tools reviewed in the study on best practices in M&E by Climate-Eval (2015):
  - **UNDP CCA M&E FRAMEWORK** – UNDP (United Nations Development Programme). 2007. UNDP Monitoring and Evaluation Framework for Adaptation to Climate Change." Draft for comment, UNDP, New York
  - **Making Adaptation Count** – Spearman, M., and H. McGray. 2011. Making Adaptation Count: Concepts and Options for Monitoring and Evaluation of Climate Change Adaptation. Eschborn: German Federal Enterprise for International Cooperation (GIZ).
  - **Learning to ADAPT** – Villanueva, P.S. 2011. "Learning to ADAPT: Monitoring and Evaluation Approaches in Climate Change Adaptation and Disaster Risk Reduction—Challenges, Gaps and Ways Forward." SCR Discussion Paper 9, Institute of Development Studies, Brighton, UK.
  - **Adaptation Fund Results Framework and Baseline Guidance: Project-level** – AF (Adaptation Fund). 2011. Results Framework and Baseline Guidance: Project-Level. Washington, DC: Adaptation Fund. UKCIP AdaptME Toolkit – Pringle (2011); UKCIP
  - **AMAT** – GEF (Global Environment Facility). 2012. "LDCF/SCCF Adaptation Monitoring and Assessment Tool (AMAT) Guidelines and Tracking Tool." Washington, DC: GEF.
  - **Adaptation Made to Measure** – Olivier, J., T. Leiter, and J. Linke. 2013. Adaptation Made to Measure: A Guidebook to the Design and Results-Based Monitoring of Climate Change Adaptation Projects. 2nd edition. Eschborn: German Federal Enterprise for International Cooperation (GIZ).
  - **TAMD Framework** – Brooks, N., S. Anderson, J. Ayers, I. Burton, and I. Tellam. 2011. "Tracking Adaptation and Measuring Development (TAMD)." Working Paper 1, International Institute for Environment and Development, London. / —. 2013. "TAMD, an Operational Framework for Tracking Adaptation and Measuring Development." Working Paper 5, International Institute for Environment and Development, London; IIED
  - **TANGO Resilience Assessment Framework** – Frankenberger, T.R., T. Spangler, S. Nelson, and M. Langworthy. 2012. "Enhancing Resilience to Food Security Shocks in Africa—Discussion Paper." TANGO International; FAO; World Food Programme
  - **IISD Climate Resilience and Food Security Framework** – Tyler, S., M. Keller, D. Swanson, L. Bizikova, A. Hammill, A.N. Zamudio, M. Moench, A. Dixit, R.G. Flores, C. Heer, D. González, A.R. Sosa, A.M. Gough, J.L. Solórzano, C. Wilson, X. Hernandez, and S. Bushey. 2013. Climate Resilience and Food Security: A Framework for Planning and Monitoring. Winnipeg: International Institute for Sustainable Development; IISD
  - **PROVIA** – Hinkel, J., S. Bharwani, A. Bisaro, T. Carter, T. Cull, M. Davis, R. Klein, K. Lonsdale, L. Rosentrater, and K. Vincent. 2013a. PROVIA Guidance on Assessing

Vulnerability, Impacts and Adaptation to Climate Change: Consultation Document. Nairobi: PROVIA. / —. 2013b. PROVIA Guidance on Assessing Vulnerability, Impacts and Adaptation to Climate Change: Summary. Nairobi: PROVIA.

- **PPCR** – CIF (Climate Investment Funds). 2012. Revised PPCR Results Framework. Washington, DC: CIF. / —. 2013a. PPCR Guidance on the Work Plan for Monitoring and Reporting on the Core Indicators. Washington, DC: CIF. / —. 2013b. PPCR Work Plan for Monitoring and Reporting on the Core Indicators. Washington, DC: CIF. / —. 2014a. PPCR Core Indicator Monitoring and Reporting Tools. Washington, DC: CIF. / —. 2014b. PPCR Monitoring and Reporting Toolkit. Washington, DC: CIF.
- **CoBRA** – UNDP (United Nations Development Programme). 2014a. Community Based Resilience Assessment (CoBRA): Conceptual Framework and Methodology. New York: UNDP. / —. 2014b. Community Based Resilience Analysis (CoBRA): Implementation Guidelines. New York: UNDP. / —. 2014c. Understanding Community Resilience: Findings from Community-Based Resilience Analysis (CoBRA Assessments). New York: UNDP.
- **PMERL** – Rossing, T., J. Ayers, S. Anderson, and S. Pradhan. 2012. CARE Participatory Monitoring, Evaluation, Reflection & Learning (PMERL) for Community-Based Adaptation (CBA). Chatelaine, Switzerland: CARE International. / CARE. 2014. PMERL—A Revised Manual for Local Practitioners. Chatelaine, Switzerland: CARE International.

Appendix B – Database index for the SSE of Giambellino-Lorenteggio (section 5.1.1), in alphabetical order:

- A2A (2016) – Bilancio di Sostenibilità Milano 2016: https://s3-eu-west-1.amazonaws.com/a2a-be/a2a/gbb-uploads/pSS0Xb-bil-territoriale-milano-2016.pdf
- AMSA (2017) – AMSA website, Dati e Documenti: http://www.amsa.it/gruppo/cms/amsa/cittadini/milano/servizibase/normative/
- ARPA L. (2016) – report di dettaglio sulla gestione dei rifiuti nei comuni: http://ita.arpalombardia.it/ITA/servizi/rifiuti/grul/estrattoGRUL2016/ReportComuniDett_Milano2016.pdf
- DBT – Vegetazione (2017) – Database Topografico Regionale (DBTR) Milano: http://www.geoportale.regione.lombardia.it/download-pacchetti?p_p_id=dwnpackageportlet_WAR_geoportaledownloadportlet&p_p_lifecycle=0&metadataid={1CE0E71B-6451-4B5D-8E4D-BC0FF6E0A46F}
- DUSAF 5.0 (2015) – DUSAF 5.0 – Uso del suolo 2015: http://www.geoportale.regione.lombardia.it/download-pacchetti?p_p_id=dwnpackageportlet_WAR_geoportaledownloadportlet&p_p_lifecycle=0&metadataid={8A509A02-97FD-458A-84D1-280F81A96640}
- Google Maps (2018) – Used to calculate 'accessibility', providing the space-time-cost distance between the closer and the further inhabitant from the considered services/activities/places. It was also used to verify that all the inhabitants in the studied area were actually living within 250 meters from a LPT stop during the calculation of 'equity'.
- Istat (2016)
  - Ambiente urbano – Mobilità urbana 2016 – Tavola 5.1 - Autovetture circolanti nei comuni capoluogo di provincia/città metropolitana per tipo di alimentazione - Anni 2014-2016 (composizioni percentuali): https://www.istat.it/it/archivio/207482
  - Condizioni economiche delle famiglie e disuguaglianze – Povertà – Povertà nuove serie – Famiglie povere – Tipo comune di residenza: http://dati.istat.it/

    - Giustizia e sicurezza – Giustizia penale – Delitti denunciati dalle forze di polizia all'autorità giudiziaria – Tipo, identità dell'autore, commessi durante l'anno - Grandi comuni: http://dati.istat.it/
- Metropolitan City (2017) – Camera di Commercio, addetti alle sedi di impresa per classi di addetti - anno 2017: http://www.milomb.camcom.it/i-numeri-delle-imprese-per-addetti
- MM (2016) – Bilancio di Sostenibilità 2016: https://www.milanoblu.com/wp-content/uploads/2012/10/Bilancio-sostenibilit%C3%A0-2016-web_definitivo.pdf
- Municipality (2015)
    - Strategie di Sviluppo Urbano Sostenibile (2015). Comune di Milano, document of the Municipality, April 2015, https://osservatorio.urbanit.it/wp-content/uploads/2016/06/Allegato_3_Strategie_UrbanePON.pdf.p7m.pdf
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