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Making Sustainability Development Goals (SDGs) Operational at suburban Level: Potentials and Limitations of Neighbourhood Sustainability Assessment Tools

Abstract

Urban sustainability plays a central role in the implementation of the UN Sustainable Development Goals (SDGs) at the local level. The emphasis on major interventions, and large projects and infrastructures may overlook the cumulative beneficial impacts of widespread smaller urban transformations at the neighbourhood level. However, there is insufficient research on how to operationalise the SDGs at such suburban scale. This study aims to contribute to fill this gap by examining the usefulness of Neighbourhood Sustainability Assessment (NSA) tools for operationalising the 17 SDGs. The comparative analysis between the three NSA tools examined in this paper – LEED, BREEAM and ITACA – reveals their differences and complementarities with respect to different targets of the SDGs. In general, the findings of this study show that the main scopes of interest of these tools are related to general urban issues (SDG11), climate action (SDG 13), responsible production and innovation (SDG 9 and 12), and in part also to goals on social wellbeing (SDG 3, 8, 9), whereas other SDGs are less represented, although several indicators proposed by NSA tools could indirectly contribute to assessing progress on those goals. Besides providing a framework for assessing the correspondence and compliance of NSA tools to the SDGs, the proposed method of analysis also allows to verify the consistencies and the discrepancies between different NSA tools, pointing at their potentials and limitations. Hence, this study can provide insights and can suggest guidance and recommendations for overcoming some of the current limitations of the NSA tools, and more in general for the design of neighbourhood evaluation systems more directly and cogently targeting the SDGs. In this sense, the findings of this study can support local administrations and planners in the design and implementation of SDG-targeting policies, plans and projects aiming at systemic sustainability.

Keywords: 2030 Agenda, Sustainable Development Goals (SDGs), Urban Sustainability, Urban Targets, Criteria and Indicators, Neighbourhood Assessment Tools.

1. Introduction

The impact of urban areas and cities on environmental degradation, climate change and socio-economic crises has dominated the debate on sustainability in the last few decades (de Jong et al., 2015). Urban settlements, inhabited by 55% of the world's population, consume large amounts of energy, materials and natural resources. Despite cities covering just 3% of the

world's surface, they consume 78% of the world's energy and emit more than 60% of greenhouse gas emissions (GHG) (UN-Habitat, 2020a). Urbanisation represents a major contributor to climate change and biodiversity loss, two interrelated processes that profoundly affect the functioning and stability of ecosystem and, consequently, the overall quality of life for more than half of the world population (United Nations, 2020). Therefore, the perspective of sustainable urbanisation offers major opportunities to «fight against poverty, inequality, unemployment, climate change and other pressing global challenges» (UN-Habitat, 2020a) on various spatial levels, from global to local (Alberti, 1996; Komeily and Srinivasan, 2015).

To address these interconnected challenges, many urban sustainability indicators and assessment tools have been developed since the early 1990s when the local Agenda 21 (LA21) was adopted in Rio de Janeiro. Agenda 21 set out international guidelines to support local authorities in introducing principles of sustainable development into the domains of everyday urban planning and management practices through measurable targets to be achieved by 2021 (Merino-Saum et al., 2020). More recently, the United Nations 2030 Agenda and the Sustainable Development Goals (SDGs) have provided an integrated global action plan to guide the member states to design and implement sustainable urbanisation policies, programmes and initiatives. According to the SDGs framework, such actions should aim at 17 general goals, each further specified in terms of targets and indicators (Khussamov et al., 2020; United Nations, 2015). Countries and local governments are called to report on their own positioning with respect to SDGs through "Voluntary Local Reviews" (VLR), as requires by the Article 47 of the 2030 Agenda (UNDESA, 2019).

Within 2030 Agenda framework, each local administration is called to implement actions at the local level by addressing their context-specific challenges and priorities through a process of SDGs adaptation and localisation, also defined as "SDGs operationalisation" (European Commission, 2018; Fisher and Fukuda-Parr, 2019; Salvia et al., 2019; Valencia et al., 2019). Such operationalisation is crucial to guide policy-makers and practitioners in on-the-ground planning and policy design, since an estimated 65% of the 169 targets behind the 17 SDGs will not be reached without engagement of local and regional governments (OECD, 2018).

However, the SDGs operationalisation is itself a challenging undertaking, since it is not a trivial task for local governments to adapt their established policy-making and evaluation practices into plans and actions *specifically targeting* SDGs at the local scale (Fenton and Gustafsson, 2017; Grainger-Brown and Malekpour, 2019; Krantz and Gustafsson, 2021; Valencia et al., 2019). Indeed, there is a lack of well-established, generally accepted, and comprehensive frameworks for the evaluation of urban projects and interventions *specifically* devised to assess their contribution to the achievement of the SDGs, especially at the neighbourhood level, as argued more in detail below in Section 3. Most of the indicators suggested by the UN , in fact, are based on macro-scale data (national or regional) that are not specific enough to inform decision making and evaluation of individual development projects and urban transformations at the neighbourhood scale (Gómez-Álvarez et al., 2018; Kanuri et al., 2016a; Krellenberg and Koch, 2021; Simon et al., 2016).

Neighbourhood, as a fundamental urban unit, is often recognised as the most appropriate spatial scale for improving sustainable built environments (Berardi, 2013; Sala Benites et al., 2020; Sparshott et al., 2018). This is also demonstrated by the increasing interest in Neighbourhood Sustainability Assessment (NSA) tools – also referred to as neighbourhood sustainability rating tools, certification systems or indicator frameworks – designed for measuring the effectiveness of urban interventions at this spatial scale (Feleki et al., 2018; Kaur and Garg, 2019; Sharifi et al., 2021a; Sharifi and Murayama, 2013, 2014). Different NSA tools such as LEED (Leadership in Energy and Environmental Design), BREEAM (Building Research Establishment Environmental Assessment Method) and ITACA (Italian Institute for Innovation and

Transparency in Procurement and Environmental Compatibility), propose different sets of criteria and indicators to measure, monitor, and evaluate the sustainability of existing neighbourhoods and planned interventions, along different dimensions: environmental (e.g., public green space relevance, water and energy consumption, sustainable mobility and to accessibility), social (e.g., housing affordability, services and public spaces and services provision, community participation and involvement) and economic (e.g. economic activities and job creation) (Alberti and Susskind, 1996; Berardi, 2013; Curwell et al., 2005; Merino-Saum et al., 2020; Sharifi et al., 2021a).

In recent years, there have been attempts by some developers of NSA tools to adapt them to, and to show their consistency with, the SDGs framework. However, as it will be more extensively argued below, these are still limited attempts, which do not offer in-depth analyses necessary to assess the specific contributions of urban planning and design practice for achieving all the 17 SDGs.

To summarise, given these premises, the starting points of this study are:

(1) On one hand, there is no clear guidance, and a lack of established evaluation methods purposefully designed for assessing the contribution of urban projects and interventions to the achievement of 17 SDGs at the neighbourhood level.

(2) On the other hand, there are several established, reasonably well-crafted, ready-for-use, and tested tools for the evaluation of neighbourhood sustainability which, however, do not explicitly nor systematically correlate their evaluation systems and indicators to the SDGs.

Hence, this study aims to explore the potential, and the limitations, of the NSA tools to offer a practical set of criteria and indicators useful for assessing projects and interventions against the SDGs at the neighbourhood scale. For this, two related questions are explored:

1. How much are NSA tools compliant to SDGs?, and what correspondences and discrepancies exist between the NSA tools and SDGs?
2. How effectively and exhaustively do current NSA tools translate the SDGs targets into criteria and indicators useful for planning and design at the neighbourhood level?

For this purpose, this study carried out a comparative analysis of three internationally known and widely used NSA tools – the American LEED , the English BREEAM for Communities and the Italian ITACA protocol for Urban areas.

Besides providing an overview of how the three NSA tools consider or target different SDGs, this study also suggests possible developments, integrations and improvements to make these tools more clearly and explicitly SDG-oriented.

The remainder of this paper is divided into five subsections. Section 2 provides the background and report on relevant previous research related to the SDGs operationalisation at the neighbourhood level to which this study seeks to contribute; Section 3 briefly presents the NSA tools, highlighting their potential to support urban sustainability planning and design practice; Section 4 describes the method used in this study to assess the correspondence and compliance between the NSA tools and the SDGs, while the Section 5 presents the main findings of this analysis. Section 6 discusses these results in terms of possible indications on how local administrations and planners could operationalise the SDGs in their activities and policy frameworks in order to orient the on-the-ground planning and decision-making processes. Finally, the conclusions in Section 7 highlight some limits and potentials of the proposed comparative analysis, suggesting directions for future developments.

2. Urban Sustainability: the problem of SDGs operationalisation

In order to address multiple problems and challenges, the 2030 Agenda integrates and balances three dimensions of sustainable development – economic, social and environmental (UNESCO 2018b: 3) – within 17 SDGs, further subdivided into 169 targets and 231 unique indicators conceived for guiding UN member states in achieving sustainable development (Assembly U. G., 2017).

To ensure their pertinence at local levels, the SDGs framework was devised to be applicable to different national contexts, with inevitably different priorities and implementation capabilities. Within a global vision, each government is allowed, and expected, to set its own national targets, and to devise ways of integrating these targets into national policies. In this sense, the process of "SDGs operationalisation" requires localising, adapting, implementing, and monitoring of the SDGs also at the local urban scale. Such operationalisation is a crucial precondition for local authorities and stakeholders to be able to define, plan, and implement strategies targeting locally-adapted goals (Fisher and Fukuda-Parr, 2019; Global Taskforce of Local and Regional Governments, 2015; Kanuri et al., 2016a; United Cities and Local Governments, 2016; United Nations Development Group, 2014).

Many socio-economic and environmental challenges are concentrated within urban areas, and public authorities can have a significant influence over urban (un)sustainability through a wide range of statutory and non-statutory functions and responsibilities (Carmona, 1996). Indeed, many urban sustainability experiments in different countries are promoted by local authorities (Bai et al., 2010; Frantzeskaki et al., 2014). Urban and territorial planning can allow to address a wide range of SDGs through spatial visions, strategies and plans, policy principles, tools, institutional and participatory mechanisms, and regulatory procedures (UN-Habitat, 2018), which can be drivers of change in urban forms, functions, and in citizens' lifestyles and opportunities, aimed at integrated approaches to sustainability along environmental, economic and social dimensions. Furthermore, local public administrations such as municipalities can be recognised as leaders in collaboration with other public authorities and stakeholders (Mapar et al., 2020). However, the intrinsic diversity of cities – in terms of their geographical, social, economic and infrastructural conditions, and in their governance and management structures – does not allow for a "one-size-fits-all" approach, but requires ensuring that different urban contexts have flexible and tailor-made strategies and policies to map their local priorities onto their progress on SDGs. This requires (1) a process of operationalisation that includes a localisation (or adaptation) of global goals to specific environmental, economic, political and sociocultural contexts; and (2) a setting of local targets and indicators.

Hence, the fundamental question arising is how to build the relationship between the SDGs and the daily work of local governments and, consequently, how to implement localisation, measurement, and monitoring of relevant data for assessing the progress at the local level (Simon and Arfvidsson, 2015).

The UN 2030 Agenda defines a specific goal for urban issues, the SDG 11 "Making cities and human settlements inclusive, safe, resilient and sustainable" (UN-Habitat, 2020b). This represents an important milestone: the precursors of the SDGs, the Millennium Development Goals (MDGs) – set up by the United Nations (UN) for the period 2000-2015 – did not, in fact, consider explicitly the critical role of urban areas in advancing sustainable development (Valencia et al., 2019). Only the MDG 7 target 7.D "Ensure environmental sustainability" directly referred to the human settlements, in order to «achieve by 2020 a significant improvement in the lives of at least 100 million slum dwellers». Within a more comprehensive vision that includes different urban areas in both developed and developing nations, the SDG 11 is conceived to be universally applicable, and not just in poorer countries.

In general, the SDGs expand the focus on development outlined by the MDGs with a wider range of integrated, global, and universally applicable goals, in an effort to interrelate many

global challenges – such as climate change, environmental degradation and socio-economic inequalities –explicitly underlining their strong interdependencies (Bennich et al., 2020; Nilsson et al., 2018, 2016; Pradhan et al., 2017; Scharlemann et al., 2020).

Following such logic of interdependencies, the SDG11 is not the only "urban" goal. Indeed, most of the other SDGs include targets with "urban dimensions" and are intrinsically linked to the SDG11, such as the improvement of citizens' health (Goal 3), the decrease in fossil energy consumption (Goal 7), the innovation of transport infrastructure (Goal 9), the reduction of inequalities (Goal 10), the responsible consumption (Goal 12), or the reduction of air pollution (Goal 13). The UN-Habitat's 2016 Report "Sustainable Urbanisation in the Paris Agreement" highlights that 113 out of 164 of the submitted Nationally Determined Contributions (NDCs) have strong or moderate "urban content", demonstrating the link between sustainable urbanisation and climate action (UN-Habitat, 2017). The bulk of SDGs actions tend to be located in urban areas because cities and urban settlements are places where «poverty and inequalities are tackled, health and education services are provided, ecosystems are protected, and human rights must be guaranteed» (Kanuri et al., 2016b). For this reason, «sustainable urbanisation can play a key role in the Decade of Action to accelerate growth and shared prosperity to advance the achievement of the SDGs by 2030» (UN-Habitat, 2020a).

This accent on urban dimension of sustainability goals is the source of demand for effective evaluation tools. According to the Eval4Action campaign launched by the United Nations Population Fund (UNFPA, 2020), the evaluation of plans and projects at urban scale has the highest multiplier effect on sustainable development because it can help city governments and decision makers in understanding the effectiveness of their actions, and in promoting evidence-based policies. However, as suggested above, many SDGs targets lack clear operational metrics, indicators and baselines that could be directly employed to track the progress on the SDG 11 and on the "urban dimension" of other SDGs. This is demonstrated by the analysis of 484 indicators of urban and regional environmental sustainability sourced from 40 indexes and online data repositories conducted by Thomas et al. (2020), arguing that only roughly half of these indicators can be used in practice.

Therefore, to summarise, three main factors can be highlighted that make the SDGs operationalisation difficult at the neighbourhood and suburban level:

(1) In their current formulation, the SDGs indicators and targets are tracked at the macro-territorial scale, which may not be relevant nor sensitive to area-based projects and transformations (e.g., at the neighbourhood level). This is due to the lack of adequately localised data that are difficult to collect and monitor at this spatial scale. Generally, in fact, the SDGs indicators are calculated using data collected at most on the aggregate city-wide scale, instead on a more granular basis.

(2) Many SDGs focus on processes on macro-geographic scales, at the level of urban regions or metropolitan area, ignoring those on lower scales which could jointly contribute significantly to the achievement of different SDGs. For example, the target 11.2. «Access to safe, affordable, accessible and sustainable transport systems…for all» mainly considers public transportation but does not consider other mobility modes such as for example cyclability and walkability. Furthermore, the proposed indicator for this target only considers the «convenient distance of public transport» without an evaluation of the level of service quality and their effective accessibility. In the same way, the target 11.5 «reduce the number of … people affected and … the economic losses … caused by disasters» does not give due weight to the smaller but more frequent hydrological and geophysical hazards whose cumulative impacts could be significant over time (Valencia et al., 2019).

(3) Furthermore, the current evaluation practices are often strongly centred on achieving individual goals, or a small subset of SDGs. This also depends on the fragmentation in city governance and and siloed departments. Similarly, many researches develop theoretical knowledge and empirical investigations that do not take into account positive or negative effects in other complementary fields (Scharlemann et al., 2020). This condition – mostly related to the non-sustainability of "traditional" development paradigm [Sen, 1983 in (Pradhan et al., 2017)] – represents a limit to actions' effectiveness and efficiency that, on the contrary, require a deep evaluation of SDGs interactions in terms of synergies and trade-offs.

Given such difficulties of SDGs operationalisation, cities would need to develop new evaluation systems with operational indicators based on high quality, accessible and reliable disaggregated data, to assess urban projects and policies, and to measure progress towards SDGs at the neighbourhood level (Simon et al., 2016). This would likely complement and strengthen other local measures of change, and would contribute to the most practical progress (Klopp and Petretta, 2017; Morano et al., 2021; Ordonez-Ponce et al., 2021) in providing evidence on which to base future policy and investment decisions (GPSC World Bank, 2018).

3. Neighbourhood Sustainability Assessment Tools: A framework for operationalising the SDGs at the suburban scale?

The above discussion suggests that robust assessment tools for evaluating and monitoring progress on SDGs at the suburban scales are of crucial importance. There is a broad consensus on the usefulness of urban sustainability assessment at the district or neighbourhood level (UN-Habitat, 2021). Actions taken at this micro-geographic scale, in fact, can lead to positive improvement of the quality of urban life, in efficiency and environmental impact of cities (Banchiero et al., 2020; Ramiller, 2019; Saiu, 2020, 2017).

This potential is also demonstrated by the diffusion of the Neighbourhood Sustainability Assessment (NSA) tools, developed by various organisations including government entities since the end of the last century, devised to guide and promote sustainable planning and design, as described and analysed by many studies (e.g. (Ameen et al., 2015; Berardi, 2013; Grazieschi et al., 2020; Kamble and Bahadure, 2020, 2020; Kaur and Garg, 2019; Lin and Shih, 2018; Momoh and Medjdoub, 2018; Ramiller, 2019)).

Following the objectives of the Agenda 21 which emphasised the role of local action in achieving global goals (Merino-Saum et al., 2020), many NSA tools have been developed and implemented for monitoring the local sustainability performance of the small-scale urban units, progressively shifting the attention from building to the neighbourhood. This is considered the smallest unit of city administration and social organisation, characterised by different «spatially based attributes and processes relating to the built environment, the economic, social, and cultural characteristics of the population residing within them, the interactions between residents and the forms of employment, services, and facilities located within neighbourhoods, and how these are utilized» (Flint, 2009). Therefore, the spatial unit of neighbourhood is suitable for the experimentation and implementation of innovative sustainable planning and design initiatives and for dealing with complex interactions between different urban components (Sharifi et al., 2021c).

The NSA tools evaluate neighbourhoods' degree of achieving many urban sustainability goals through specific criteria and indicators (Borges et al., 2020; Dawodu et al., 2017; Grazieschi et al., 2020; Komeily and Srinivasan, 2015; Sharifi and Murayama, 2013; Subramanian et al., 2021). In this, they can be useful to assist local governments and administrations, private and public enterprises, and urban designers in the assessment of current performances of an

urban area, in their policy and design choices, and in the monitoring of the progress on dimensions of sustainability, both in urban regeneration projects and in new developments. Furthermore, NSA tools can help to raise the awareness of the inhabitants and other stakeholders thanks to typically clear and accessible interpretation of sustainability they provide. As Ramiller (2019) note, these frameworks «create a common point of reference for neighbourhood actors from diverse socio-spatial contexts» which allows to define, even within the diversity of each local context, a common operational framework for the assessment of the sustainability performance of urban areas.

However, one of often observed limitations of NSA tools is the lack of real integration between the different dimensions of sustainability. As Oliver and Pearl (2018) argued, these tools «rely on an array of technical and performance criteria that fit within a traditional framing of 'sustainability' that is based on efficiency and which favours environmental criteria over social, economic or institutional criteria».

Nevertheless, more recent versions of some of the best-known NSA tools have made efforts to expand their sets of criteria and indicators to fill some of the mentioned gaps, especially to more adequately account for the objectives of social sustainability and equity, and to consider all sustainability dimensions, according to the SDGs. Among these, the BRE (Building Research Establishment) Global Group has recently analysed the alignment between their assessment schemes and the 17 SDGs, highlighting a high level of correspondence leading to the conclusion that the SDGs are not « a new framework that requires a shift within the schemes in order to report on them or to assist in their facilitation» (BRE Global Limited, 2020). Although this self-assessment has shown a relatively weak relation with many of the SDGs targets, it has also suggested that many SDGs are indirectly represented by BREEAM's criteria, concluding that BREEAM Communities «can add value in a way that may not meet the specific requirements of the indicators, but facilitate the success of the goal on a higher level or through associated processes» (BRE Global Limited, 2018). A similar operation was conducted by the German Sustainable Building Council (DGNB) that also provides an additional incentive – the "Agenda 2030 bonuses" – for selected criteria related to the implementation of SDGs (DGNB, 2021, 2020).

Other efforts to link evaluation methods at neighbourhood scale and the SDGs were conducted by many researchers focusing primarily on a single SDG, or on a small subset of SDGs, especially on the Goal 11 which is directly related to urban issues (Abastante et al., 2021; Arslan et al., 2016; Klopp and Petretta, 2017). Few studies have recently analysed the role of NSA tools in the achievement of *all* the 17 SDGs. Among these, Diaz-Sarachaga et al. (2018) analysed the correspondence between LEED-ND and Envision rating systems credits and prerequisites on one hand, and the SDGs and New Agenda items on the other hand. This analysis revealed that LEED-ND and Envision tools do not address most of the SDGs, but at the same time it highlighted their potential for the development of a new and ad hoc frameworks. Kawakubo et al. (2018) examined CASBEE-City, the new version of Comprehensive Assessment System for Built Environment Efficiency (CASBEE), for measuring progress toward SDGs and GHG mitigation goals in 76 world cities in 39 countries. Miyazaki et al. (2019) also demonstrated the strong relationship between CASBEE assessment items and the 17 SDGs, suggesting the need of updating the tool in view of the SDGs. Furthermore, the authors suggested the need for further analyses to assess the relationship between other tools and SDGs, also in order to highlight the differences and key features among different available tools.

The present study seeks to contribute to this field of research by evaluating the degree of correspondence and compliance between the criteria used in three prominent NSA tools and all SDGs *individual targets* connected with urban planning and design practice. Hence, one important and distinctive feature of the present study is not to consider each SDG as a "mono-

lithic" goal, but to conduct a more fine-grained analysis of the degree of correspondence between the NSA tools criteria and the individual targets comprised in each SDG. Furthermore, starting from this analysis of correspondence, this study provides an attempt to assess not only the number of criteria attributable to each goal, but also the "weight" given to each SDGs by different NSA tools (Sub-section 4.3). These two distinctive results of our analysis can shed additional light concerning the current potential and limitations of the NSA tools for targeting SDGs.

4. Methodology: SDGs-NSA cross-analysis

This study proposes a detailed analysis and assessment of the degree of correspondence and compliance between three NSA tools and all 17 SDGs. To this end, the comparison methodology encompasses three steps:

1. identification of SDGs "urban targets", defined as the targets which are related to processes "localisable" at urban and suburban scale, and on which policies, planning and design choices can have an impact, as better explained below (Step 1);
2. analysis of NSA tools criteria through a specific analysis sheet that allows to briefly summarise and easily compare the structure and contents of different tools (e.g., key performance areas, criteria and associated scorecard) (Step 2)
3. evaluation of the degree of correspondence and compliance between NSA tools criteria and different SDGs urban targets; these results are summarised both in terms of (a) the *number of criteria* related to each SDGs urban target, and in terms of (b) the *overall score/weight* each NSA tools assign to those criteria.

The logical structure of this three-step procedure is summarised in Figure 1.

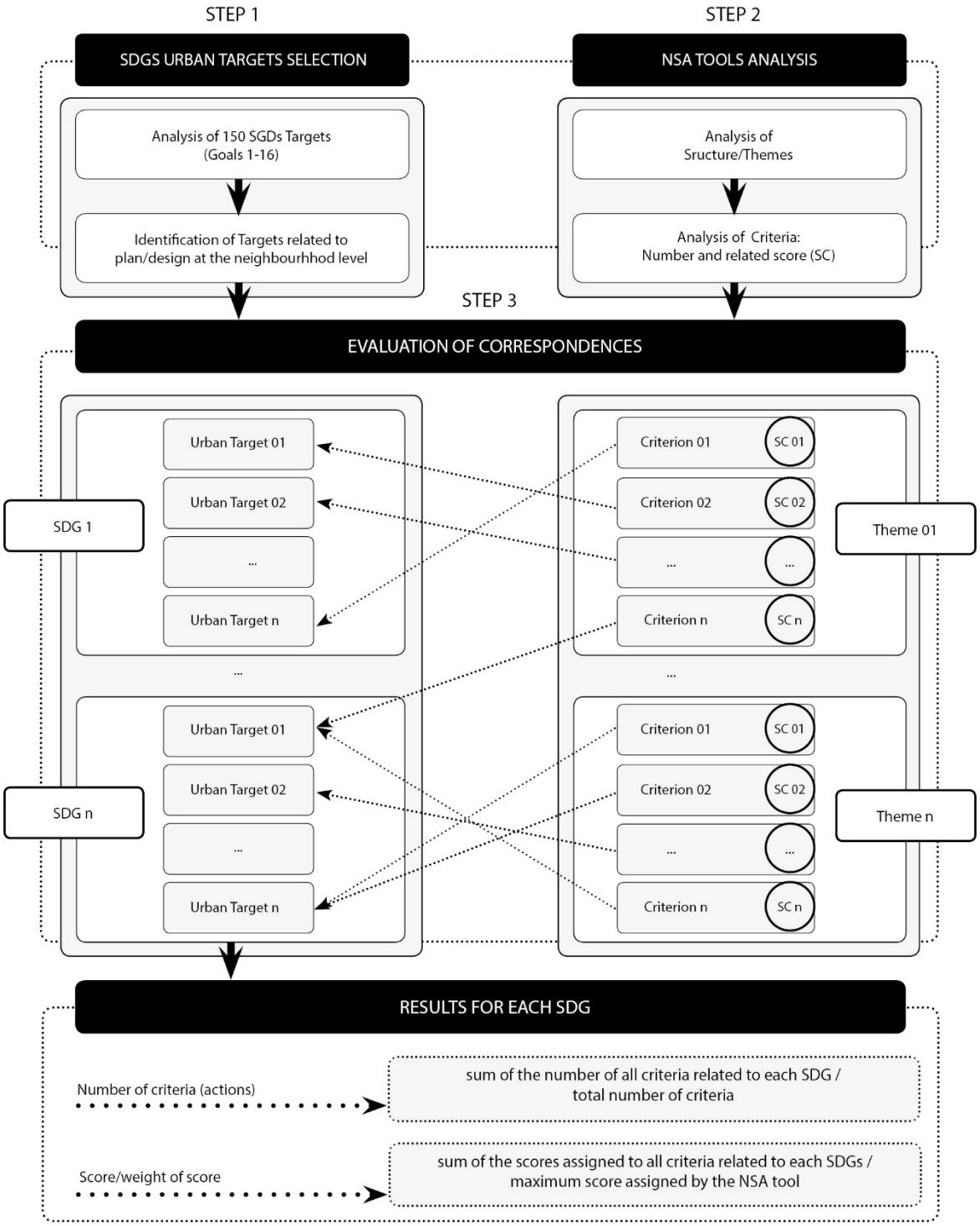

Figure 1. The scheme synthetises the proposed evaluation methodology used to correlate NSA tools criteria and SDGs urban targets.

Step 1. Identification of SDGs "urban targets"

To identify urban targets, all the SDGs targets were analysed to verify potential relationship with urban planning, policy and projects. Each SDG, in fact, is subdivided into several targets that correspond to a wide range of strategic actions that can allow to better evaluate different aspects of urban sustainability. The analysis excludes the 19 targets related to the SDG 17 "Partnership for the Goals" targets, since this Goal aims to «strengthen the means and implementation and revitalise the global partnership for sustainable development», encompassing

many transversal targets not directly related to urban contexts. Thus, excluding the 19 targets belonging to the SDG 17, we were left with 150 targets examine.

Among these, targets identified as "urban" are those containing in their description a number of keywords related to possible urban policies and issues, such as "basic services" (target 1.4), "small-scale food production" (target 2.3), "road traffic accidents" (target 3.6), "sustainable lifestyles" (target 4.7), "participation of local communities" (target 6.b), "local culture and products" (target 8.9) and "local planning" (targets 15.9) (UN-Habitat, 2020c; UN-Habitat and UCGL, 2020). Notably, in identifying such urban targets for the subsequent analysis, both the targets directly and indirectly influenced by transformations and policies at urban and neighbourhood level are considered. To exemplify this distinction, consider the target 11.2 "provide access to safe, affordable, accessible, and sustainable transport systems". In our taxonomy, this is a *direct* urban target since it can be directly targeted by urban and neighbourhood-level policies and interventions. However, pursuing that target presumably contribute to other targets, for example to "the reduction of fossil fuel consumption related to private motorized transport" (target 7.2), to "the reduction of air pollution" (target 3.9), and to "the promotion of mental health and wellbeing" (target 3.4) (by encouraging active mobility, among others). These latter three targets would thus in our terms be considered *indirect* urban targets.

In total, 61 SDGs urban targets that should be assumed to be directly or indirectly impacted by urban planning and design at the neighbourhood scale are identified (Table 1). Besides the ten targets of the SDG 11 which directly deal with urban questions, SDG 12 and SDG 15 have the highest number of urban targets, followed by SDG 6 and SDG 3. Conversely, the "social goals" –those with a stronger focus on social and human well-being (Folke et al., 2016) – such as SDG 1, SDG 5, and SDG 10, are less directly represented.

Table 1. "Urban targets": SDGs targets directly or indirectly related to urban planning, policy and projects.

SDGs	Goal	SDGs "Urban Targets"
SDG 1	***No poverty***	1.4. Ensure equal access to basic services. 1.5. Improve the resilience to natural disaster and extreme weather of the poor and those in vulnerable situations.
SDG 2	***Zero Hunger***	2.3. Promote the small-scale food production and ensure secure and equal access to land. 2.4. Implement resilient agricultural practices that help maintain ecosystems.
SDG 3	***Good Health and Well-being***	3.4. Promote mental health and well-being. 3.6. Reduce Road traffic accidents. 3.9. Reduce air, water and soil pollution and contamination. 3.d. Strengthen the capacity for early warning, risk reduction and management of health risks.
SDG 4	***Quality Education***	4.4. Increase technical and vocational skills, for employment, decent jobs, and entrepreneurship. 4.7. Promote education for sustainable development and sustainable lifestyles. 4.a. Build and upgrade education facilities.
SDG 5	***Gender Equality***	5.a. Given access to ownership and control over land and other forms of property.
SDG 6	***Clean Water and Sanitation***	6.3. Improve water quality by reducing pollution. 6.4. Improve water-use efficiency. 6.5. Implement integrated water resources management at all levels. 6.6. Protect and restore water-related ecosystems. 6.b. Support and strengthen the participation of local communities in improving water and sanitation management.
SDG 7	***Affordable and Clean Energy***	7.1. Implement the efficient energy systems. 7.2 – 7.3. Increase the use of renewable energy.
SDG 8	***Decent Work and Economic Growth***	8.3. Create new job opportunities related to building efficiency and urban sustainability. 8.4. Reduce the built environment's footprint and decouple economic growth from environmental degradation. 8.9. Promote sustainable tourism that creates jobs and promotes local culture and products.
SDG 9	***Industry Innovation and Infrastructure***	9.1. Develop quality, reliable, sustainable, and resilient infrastructures. 9.4. Increase resource-use efficiency and adopt clean technologies. 9.5. Encourage Innovation.
SDG 10	***Reduce Inequalities***	10.2 Empower and promote the social inclusion of all. 10.3 Ensure equal opportunities.
SDG 11	***Sustainable Cities and Communities***	*All targets (11.1-11.7, 11.a, 11.b, 11.c)*
SDG 12	***Responsible Consumption and Production***	12.1. Implement the 10-year framework of programmes on sustainable consumption and production. 12.2. Promote efficient consumption of natural resources and production patterns. 12.4. Achieve the environmentally sound management of chemicals and all wastes throughout their life cycle. 12.5. Reduce waste generation through prevention, reduction, recycling, and reuse. 12.8. Information and awareness for sustainable development and lifestyles 12.b. Develop and implement tools to monitor impact of sustainable tourism that creates jobs and promotes local culture and products.
SDG 13	***Climate Action***	13.1. Improve resilience to natural disasters and extreme weather. 13.2. Integrate climate change measures into planning. 13.3. Improve awareness-raising and planning capacity on climate change mitigation and adaptation.
SDG 14	***Life below Water***	14.1. Prevent and reduce marine pollution from land-based activities. 14.2. Manage and protect marine and coastal ecosystems. 14.5. Conserve coastal and marine areas.
SDG 15	***Life on Land***	15.1. Ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services. 15.2. Promote sustainable management of forests, halt deforestation, restore degraded forests and increase reforestation. 15.4. Maintain terrestrial, inland freshwater and mountain ecosystems, and forests.

		15.3. Combat desertification, restore degraded land and soil, including land affected by desertification, drought, and floods. 15.5. Reduce the degradation of natural habitats, halt the loss of biodiversity, protect, and prevent the extinction of threatened species. 15.9. Integrate ecosystem and biodiversity values into local planning.
SDG 16	***Peace, Justice and Strong Institutions***	16.4. Recover and reassign of stolen assets, (e.g., confiscated lands and properties for social use). 16.6. Develop effective, accountable, and transparent institutions, at the municipal level, regarding urban planning offices. 16.7. Ensure responsive, inclusive, participatory, and representative decision-making at all levels.
SDG 17	***Partnership for the Goals***	17.8. Increase the availability of high-quality, timely and reliable disaggregated data. 17.9. Develop measurements of progress on sustainable development.

Step 2. Analysis of NSA tools criteria

The second step in the analysis focuses on three NSA tools – (1) LEED Cities and Communities (LEED v.4.1, 2019), (2) BREEAM Communities (2017) and ITACA Protocol (2020). The choice to examine these three tools was guided by their international recognition, and for them being among the most renown, studied, and widely applied assessment protocols (e.g. see (Awadh, 2017; Congedo, 2021; Diaz-Sarachaga et al., 2018; Liu et al., 2020; Orova and Reith, 2019; Principi et al., 2015; Sharifi et al., 2020)). Furthermore, these three tools are actively maintained by their respective developers and have recently been updated to better integrate and balance different dimensions of urban sustainability (Table 2).

Table 2. The selected international Neighbourhood Sustainability Assessment Tools and their characteristics.

NSA Tool	Full Terminology	Version	Country	Developer(s)	N. of indicators	Key Performance Areas (KPA)
LEED Cities and Communities	Leadership in Energy and Environmental Design	2019 (v.4.1)	USA	US Green Building Council (USGBC)	38	(1) Integrative Process; (2) Natural System & Ecology; (3) Transportation and Land Use; (4) Water Efficiency; (5) Energy and Greenhouse Gas Emissions; (6) Material and Resources; (7) Quality of Life; (8) Innovation; (9) Regional Priority.
BREEAM Communities	Building Research Establishment Environmental Assessment Method	2012 (v.1.2)	UK	Building Research Establishment (BRE Global Ltd)	40	(1) Governance; Social and economic wellbeing - Local economy; (2) Social and economic wellbeing - Environmental conditions; (3) Social and economic wellbeing - Social Wellbeing; (4) Resources and Energy; (5) Land use and Ecology; (6) Transport and Movement; (7) Innovation.
ITACA Protocol, Urban scale	Istituto per la Trasparenza degli Appalti e la Compatibilità Ambientale - ITACA	2020	EU	Institute for Procurement Transparency and Environmental Compatibility (ITACA) -no profit organisation, Italy	69	(1) Governance; Urban Planning Aspects; (2) Urban Landscape Quality; (3) Architectural aspects; (4) Public Spaces; (5) Urban Metabolism; (6) Biodiversity; (7) Adaptation; (8) Mobility & Accessibility; (9) Society & Culture; (10) Economy.

1. LEED for Cities and Communities (*LEED v.4.1*) is the updated version (2019) of *LEED for Neighbourhoods (LEED ND v.4*), a voluntary tool for sustainable neighbourhoods developed by the United States Green Building Council (USGBC, 2019). Despite the number of criteria has decreased from 59 to 40, this version considers more Key Performance Areas (KPAs). Among these, the KPA7 "Quality of Life" which includes 8 criteria of the 40 totals (including the pre-requisites), which are assigned a maximum of 20 points out of the 110 totals.

2. BREEAM Communities was first released in United Kingdom in 2008 by BRE Global Group and was updated in 2012. The new version divides the assessment criteria into eight KPAs, three of which assess "Social and Economic Wellbeing" issues, divided into three subthemes "Local Economy", "Environmental Conditions" and "Social Wellbeing" which jointly include 17 criteria out of total 41, contributing to over 40% of the overall score (BRE Global Limited, 2017). Other criteria and indicators of different KPAs, while not directly relating to social issues, have significant impacts on social issues such as the mitigation of pollution and environmental risks (SE03, SE04, SE08, SE10, SE13, SE18); employment policies (SE01, SE17); services and infrastructures accessibility (SE06, SE09, SE11).

3. ITACA Protocol was developed in 2016 by the Italian Institute for Procurement Transparency and Environmental Compatibility (ITACA) to evaluate the sustainability of urban environments (ITACA, 2016). The 2020 version includes 71 criteria which are divided into 10 KPAs covering different aspects of urban sustainability (ITACA, 2020). In addition to the more traditional criteria related to environmental and energy issues, ITACA focuses on socio-economic aspects important for assessing urban quality. Only two among these are directly related to social sustainability, KPA9 "Society and Culture" and KPA10 "Economy" which include 9 criteria of the 71 total, corresponding to a maximum score of 44 points out of the 351 total, about 12.5%. ITACA considers as a proxy for a social-oriented urban sustainability the proximity to the main services and leisure facilities, access to employment, diversity of uses and variety of the housing supply for different social groups and users, to promote social diversity within the urban area.

For each of these three tools an *analysis sheet* has been compiled to briefly summarise and easily compare: (a) the Key Performance Areas (KPAs) which correspond to the main themes of analysis; (b) the Key Issues (KIs) and related criteria adopted in the assessment of each KPA; (c) the score assigned for different KIs. An excerpt of an analysis sheet is presented in Figure 2 while the full sheets for all three NSA tools are reported in the Appendix A.

Appendix A. LEED for Cities and Communities v4.1

10 Performance Areas	*Max Score* Cities	Commun.	*Criteria*		*40 Key Issues*
1 Integrative Process	**5**	**5**	**2**	**Code**	**Purpose & Intent**
Integrative Planning and Leadership	1	1	Criteria 1	IP 01	To support high-performance, cost-effective outcomes through an early analysis of the interrelationships among city or community systems
Green Building Policy and Incentives	4	4	Criteria 2	IP 02	To encourage the design, construction, and retrofit of buildings using green building practices.
2 Natural System and Ecology	**9**	**9**	**5**	**Code**	**Purpose & Intent**
Ecosystem Assessment	required	required	Prereq. 1	NS 01	To assess the existing ecosystem conditions and services provided by ecosystems, built landscapes, and other open spaces to inform the city development along with conservation and restoration efforts.
Green Spaces	2	2	Criteria 1	NS 02	To provide accessible green spaces that positively impact physical, mental and psychological health and well-being of the community while also enhancing the environmental quality of the city or community.
Natural Resources Conservation and Restoration	2	2	Criteria 2	NS 03	To conserve and restore the natural resources within the city or community.
Light Pollution Reduction	1	1	Criteria 3	NS 04	To minimize and manage ambient light levels to protect public health and the integrity of ecological systems and increase the night sky access, improve nighttime visibility, and reduce the consequences of development for wildlife and people.
Resilience Planning	4	4	Criteria 4	NS 05	To strengthen the resilience of communities to climate change risks, natural and man-made hazards and extreme events.
3 Transportation and Land Use	**15**	**15**	**6**	**Code**	**Purpose & Intent**
Transportation Performance	6	6	Prereq. 1	TR 01	To promote non-motorized transportation, encourage use of public transit and reduce pollution from transportation sector.
Compact, Mixed Use and Transit Oriented Development	2	2	Criteria 1	TR 02	To encourage compact and mixed use development, high levels of connectivity and daily walking, biking, and transit use.
Access to Quality Transit	1	1	Criteria 2	TR 03	To encourage use of diverse transportation modes in order to reduce the reliance on personal vehicles.
Alternative Fuel Vehicles	2	2	Criteria 3	TR 04	To reduce pollution by promoting alternatives to fossil fuel vehicles.
Smart Mobility and Transportation Policy	2	2	Criteria 4	TR 05	To promote efficient operation of transport systems, user facilitation, behavior change and reduced environmental impact through smart technologies and transportation policies.
High-Priority Site	2	2	Criteria 5	TR 06	To preserve historic structures and sites and focus growth and redevelopment on infill sites and other priority locations.
...					
Total	**110**	**110**	**40**		

Figure 2. The structure of the NSA Tool analysis sheets: an excerpt from LEED v4.1 sheet (see the Appendix A).

Step 3. Evaluating the degree of correspondence between NSA tools criteria and SDGs urban targets

Finally, the 152 criteria reported by LEED (40 criteria), BREEAM (41 criteria) and ITACA (71 criteria) were cross-tabulated with 61 SDGs urban targets identified in the Step 1. On each individual couple (NSA criterion, DGSs urban target), the degree of direct or indirect correspondence between the NSA tools criteria and the SDGs urban targets was assessed.

Besides identifying the number of direct or indirect criteria related to each urban target, the overall score/weight each NSA tool assigns to each set of criteria corresponding to each SDG was calculated. Such score/weight allows to represent which Goals are most covered by the criteria currently in use in different NSA tools.

An example excerpt of the cross-tabulation sheets elaborated for each NSA tool is presented in Figure 3, while the full sheets are reported in the Appendix B. In the example, in the rows

are indicate the criteria from LEED, while the SDGs are indicated in columns. In the summary row (bottom of the sheet) are reported the total number of criteria corresponding to SDGs and the total score/weight assigned.

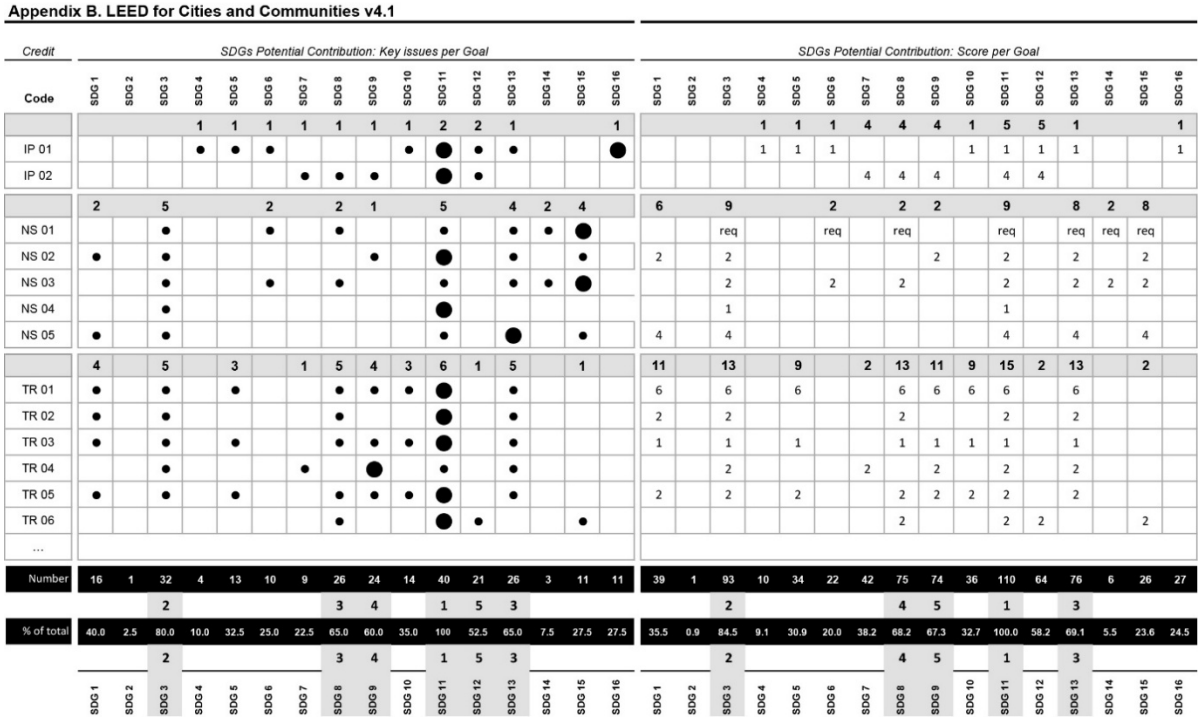

Figure 3. The structure of the assessment sheets: an excerpt on LEED v4.1 (see the Appendix B).

5. Results

The synthesis of our analysis described above are presented in Table 3 and Table 4. The tables summarise the findings on the degree of correspondence and compliance of the three selected NSA tools and the SDGs. In particular, Table 3 lists the criteria of different NSA tools directly related to each urban target, while Table 4 highlights the number of direct and indirect criteria (graphically represented respectively by large and small dots) of the three selected tools, and the related score assigned, expressed as a number of criteria and as a percentage of total score.

Table 3. SDGs "urban targets" and NSA tools criteria: the alignment for each SDG urban target.

SDGs		**Neighbourhood Sustainability Assessment Tools – Criteria**			**Criteria with direct relations**
Goal	Urban Targets	LEED	BREEAM	ITACA	Total Number
SDG 1	**1.4, 1.5**	EN 01, WE 01, QL 01-04, QL 06	SE 02, SE 05	10.01-03	**12**
SDG 2	**2.3, 2.4**	*- only indirect -*	*- only indirect -*	9.05	**1**
SDG 3	**3.4, 3.6, 3.9, 3.d**	QL 05	*- only indirect -*	5.06, 5.08-09	**4**
SDG 4	**4.4, 4.7, 4.a**	*- only indirect -*	SE 17	*- only indirect -*	**1**
SDG 5	**5.a**	*- only indirect -*	*- only indirect -*	*- only indirect -*	-
SDG 6	**6.3, 6.4, 6.5, 6.6, 6.b**	WE 02-03	RE 03, LE 03, LE 06	5.02, 7.01.2-3, 7.03.3	**9**
SDG 7	**7.1, 7.2**	EN 02-03, EN 05	RE 01	5.10-5.12	**7**
SDG 8	**8.3, 8.4, 8.9**	*- only indirect -*	SE 01	7.03.2, 10.04	**3**

SDG 9	**9.1, 9.4, 9.5**	TR 04, IN 01	INN 01	8.09	**4**
SDG 10	**10.2, 10.3**	QL 08	SE 15	*- only indirect -*	**2**
SDG 11	**11.1 – 11.7** **11.a, 11.b, 11.c**	IP 01-02, NS 02, NS 04, TR 01-03, TR 05-06, QL 07	GO 01-04, SE 04, SE 08, SE 16, SE 06-07, SE 09, SE 11, RE 02, RE 04, LE 05, TM 01-06	1.01-02, 2.01-04, 2.bis.01-02, 2.bis.05, 3.01-3.05, 4.01-04, 5.05, 6.02-03, 7.02.1 3, 8.01-08, 8.10, 8.11.1-2, 9.01-04	**80**
SDG 12	**12.1, 12.2, 12.4, 12.5, 12.8, 12b**	MR 01-06	RE 05-06	2.bis.03-04, 5.03-04	**12**
SDG 13	**13.1, 13.2, 13.3**	NS 05, WE 04, EN 04	SE 03, SE 10, SE 13, RE 07	5.01, 5.07, 5.13-14, 7.01.1, 7.03.1, 7.03. 6, 7.03.4	**16**
SDG 14	**14.1, 14.2, 14.5**	*- only indirect -*	*- only indirect -*	*- only indirect -*	-
SDG 15	**15.1, 15.2, 15.3, 15.4, 15.5, 15.9**	NS 01, NS 03	LE 01, LE 02, LE 04	6.01	**6**
SDG 16	**16.4, 16.6**	IP 01, QL 07, EN 06	GO 01-04	1.01, 1.02	**9**

Table 4. NSA tools criteria with direct and indirect relations with each SDG and the related score expressed both in number and percentage of the total.

SDG	NSA Tool	Direct Criteria	Total Criteria	%	Total Score	%	SDG	NSA Tool	Direct Criteria	Total Criteria	%	Total Score	%
SDG 1	*LEED*	7	16	40.0	39	35.5	**SDG 9**	*LEED*	2	24	60	74	67.3
	BREEAM	2	15	36.6	43	34.1		*BREEAM*	1	17	41.5	61	48.4
	ITACA	3	24	33.8	118	33.6		*ITACA*	1	27	38	134	38.2
SDG 2	*LEED*	0	1	2.5	1	0.9	**SDG 10**	*LEED*	1	14	35	36	32.7
	BREEAM	0	0	0	0	0		*BREEAM*	1	18	43.9	52	41.3
	ITACA	1	2	2.8	10	2.8		*ITACA*	0	19	26.8	97	27.6
SDG 3	*LEED*	1	32	80	92	83.6	**SDG 11**	*LEED*	10	40	100	110	100
	BREEAM	0	29	70.7	95	75.4		*BREEAM*	20	41	100	126	100
	ITACA	3	50	70.4	247	70.4		*ITACA*	25	71	100	351	100
SDG 4	*LEED*	0	4	10	10	9.1	**SDG 12**	*LEED*	6	21	52.5	64	58.2
	BREEAM	1	7	17.1	21	16.7		*BREEAM*	2	13	31.7	49	38.9
	ITACA	0	4	5.6	20	5.7		*ITACA*	4	23	32.4	114	32.5
SDG 5	*LEED*	0	13	32.5	34	30.9	**SDG 13**	*LEED*	3	26	65	76	69.1
	BREEAM	0	10	24.4	27	21.4		*BREEAM*	3	25	61	82	65.1
	ITACA	0	12	16.9	59	16.8		*ITACA*	9	43	60.6	214	61.0
SDG 6	*LEED*	2	10	25	22	20	**SDG 14**	*LEED*	0	3	7.5	6	5.5
	BREEAM	3	13	31.7	40	31.7		*BREEAM*	0	7	17.7	18	14.3
	ITACA	4	10	14.1	50	14.2		*ITACA*	0	2	2.8	10	2.8
SDG 7	*LEED*	3	9	22.5	42	38.2	**SDG 15**	*LEED*	2	11	27.5	26	23.6
	BREEAM	1	4	9.8	26	20.6		*BREEAM*	3	11	26.8	32	25.4
	ITACA	3	6	8.5	30	8.5		*ITACA*	1	27	38	139	39.6
SDG 8	*LEED*	0	26	65	75	68.2	**SDG 16**	*LEED*	3	11	27.5	27	24.5
	BREEAM	1	21	51.2	73	57.9		*BREEAM*	4	8	19.5	21	16.7
	ITACA	2	38	53.5	159	45.3		*ITACA*	2	7	9.9	19	5.4

Figures 4 and 5 graphically show the total number of criteria and the percentage of score assigned to each SDG by the three selected NSA tools, as reported in Table 4.

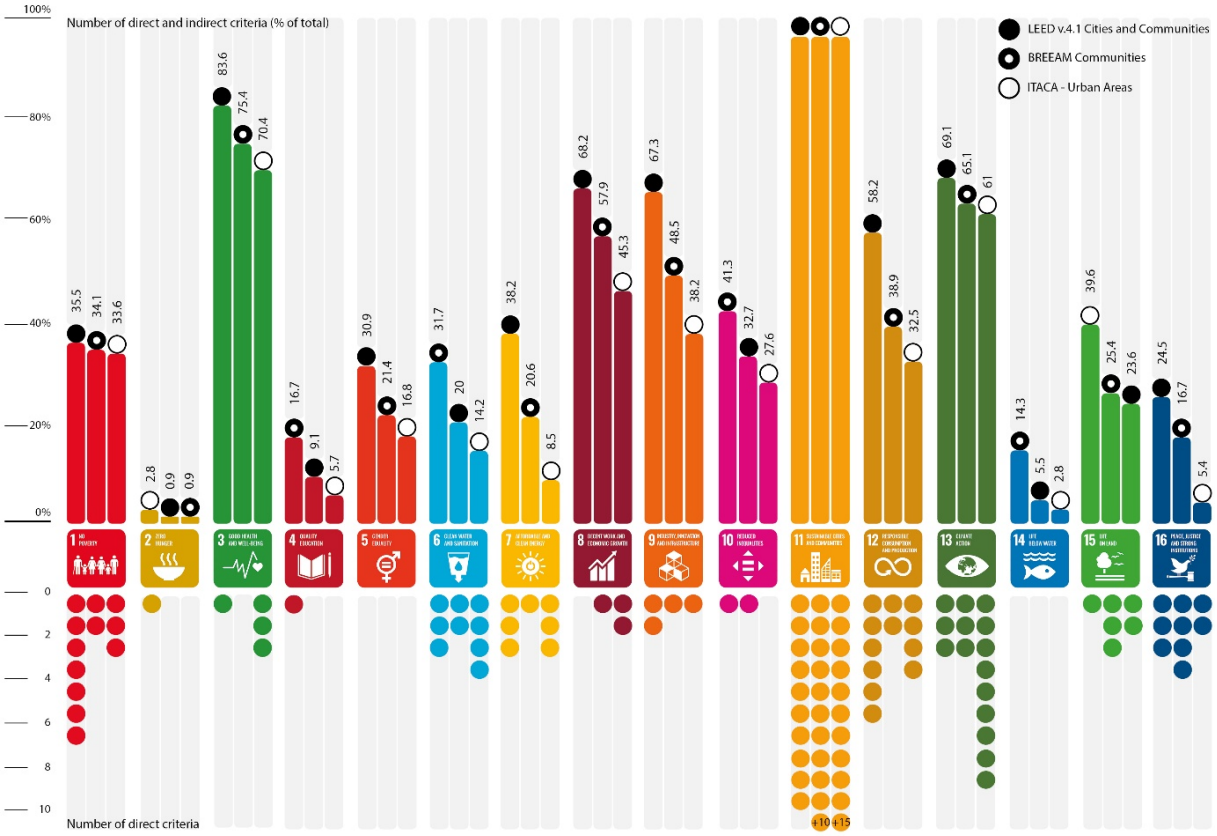

Figure 4. The number of direct criteria (below half) and the percentage of the number of criteria (above half) indirectly and directly related to each SDG in the three selected NSA tools.

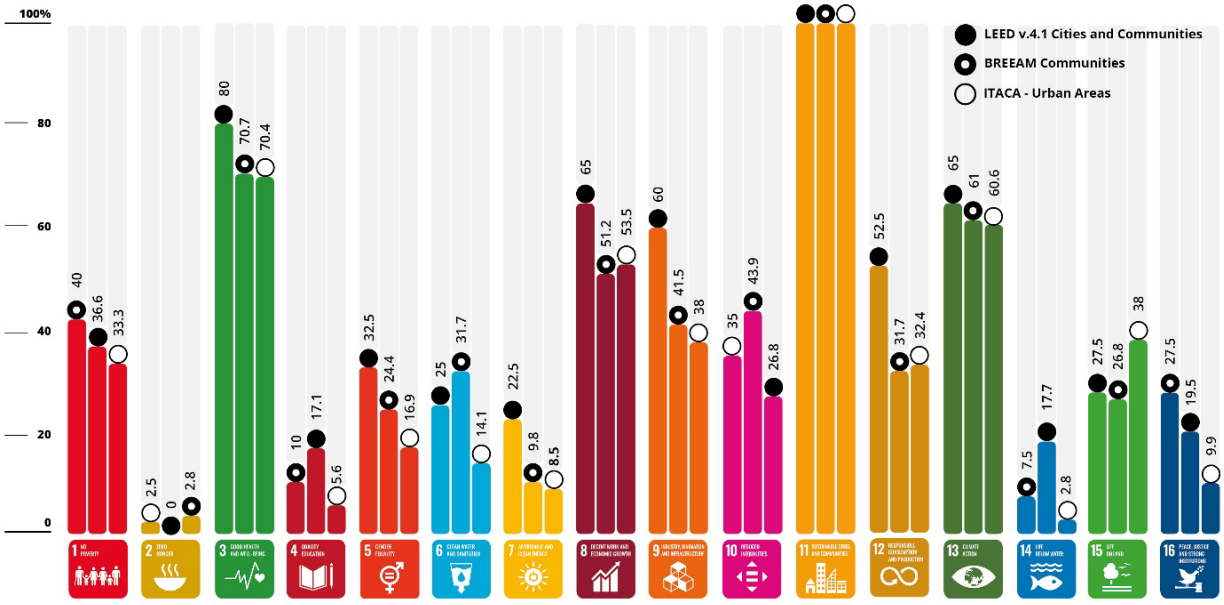

Figure 5. Percentage of score assigned to each SDG by the three selected NSA tools.

6. Discussion

The results of the analysis show the different importance each NSA tools assigns to different SDGs, and allow a general assessment of how effectively and comprehensively individual SDGs have been operationalised in the three examined tools.

Overall, except for the Goal 11 on which all NSA tools provide an extensive coverage, the prevailing sustainability dimensions assessed by the examined NSA tools are related to the goals of good health and wellbeing (SDG 3) and climate action (SDG 13). Despite there being few direct criteria related to the SDG 3, many other criteria are indirectly related to this goal, according the findings of this study.

Good health and wellbeing in neighbourhood (SDG 3) are influenced by the quality of places, such as streets and public spaces safety, air, water and soil pollution, the provision of green spaces and also the health risks from environmental hazards that can have a great impact on the health of neighbourhood inhabitants. The greatest relevance of SDG 3 is given by LEED, following by ITACA respectively with 32 and 50 related criteria. Among these, three criteria in ITACA are directly related to the Goal 3 which consider air quality monitoring, acidifying and photo-oxidant emissions (criteria 5.06, 5.8 and 5.9), while LEED directly consider environmental pollutants in the criterion QL 05 (see Appendix A).

Climate action (SDG 13) assesses the direct and indirect impacts of climate-related natural disasters such as storms, floods, and heatwaves on neighbourhoods. ITACA promotes mitigation and adaptation strategies to address climate change and reduce population risks (7.03.5-6) especially through increasing of the soil permeability (5.01), regreening (7.03.1), waterpipes extraordinary maintenance (7.01.1) and re-naturalisation of waterways (7.03.4). LEED includes specific criteria for resilience planning (NS 05), and stormwater management (WE 04) and BREEAM considers specific criteria for flood risks assessment and management (SE 03, SE 13), and the adaptation to the climate change at the neighbourhood level (SE 10). The greenhouse emissions reduction is considered by all the three analysed tools (ITACA: 5.07, 5.13-14; LEED: EN 04; BREEAM: RE 07)

In addition to these SDGs, the goals related to decent work and economic growth (SDG 8); industry, innovation, and infrastructure (SDG 9); and responsible production and consumption (SDG 12), have a high importance for neighbourhood interventions. As for the SDG 8 and SDG 9, there are few criteria directly associated to their targets, but many indirectly representing their impacts.

The sustainable economic growth and the prosperity for all in neighbourhoods (SDG 8) is related to the capacity to generate new job opportunities, according to SDG targets 8.3 and 8.9. Despite the importance of this goal, the economic dimension of sustainability is not well addressed by the examined NSA tools. Direct correspondences are not available in LEED, while BREEAM evaluates the "Economic impact" (SE 01) based on the capacity of a neighbourhood project to attract investment, create new jobs, complement and enhance existing economic activities in the local area and surrounding economy. Similarly, ITACA evaluates the "Employment potential" (10.4) also in order to reduce commuting and to increase mixed use of the area. The SDG 8, in fact, also considers the reduction of the built environment's footprint, calling for decoupling of the economic growth from environmental degradation (target 8.4). The high relevance of SDG 8 in NSA tools in related to this latter aspect.

Innovation in neighbourhoods (SDG 9) is related to the use of smart technologies in housing and transport to promote innovative solutions for modern public and non-motorised transport systems, public spaces, and homes, and to incentive a change in habits and lifestyles. Innovation is evaluated with a specific criterion in LEED (IN 01) and BREEAM (INN 01). LEED also assigns a specific score for "alternative fuel vehicles" (TR 04), while ITACA addresses the "accessibility of ICT technologies" (8.09).

Sustainable patterns of production and consumption in neighbourhoods (SDG 12) are assessed through the efficient management of natural resources, the reduction of energy consumption and material footprint, the reduction and the safe handling of waste and pollutants, but also the promotion of sustainable consumption choices and lifestyles. LEED contains a specific thematic area "Materials and resources" that considers six direct indicators related to the reduction and efficient management of waste and material recovery and reuse (MR 01-06); BREEAM promotes the use of low-impact materials and the resource efficiency throughout the life cycle (RE 05-06) and ITACA assigns scores to the reuse of building heritage (2.bis.03), and the land consumption reduction by the integration of the project with surroundings (2.bis.04), while waste management is evaluated through two direct indicators (5.03, 5.04).

An intermediate degree of relevance in the three examined NSA tools are given to other "social goals", as define in the previous section, such as "no poverty" (SDG 1) and reduced inequalities (SDG 10). In particular, the poverty issues of neighbourhood inhabitants are related to the access to basic services and adequate housing and to the resilience to natural disaster of poor and vulnerable people. All three NSA tools address some of these aspects, with LEED having six directly related and nine indirectly related criteria that refer to the equal accessibility to drinking water and sanitation services (WE 01) and to the preliminary assessment of needs and priorities of the population and housing characteristics of the area (QL 01). The topic of housing is highly relevant in ITACA which contains three dedicated criteria (10.01, 10.02 and 10.03) while BREEAM dedicate a specific criterion for dealing housing provisions (SE 05) and for assess demographic needs and priorities (SE 02).

According to the definition of the SDG 10, strategies, investments and incentives to reduce inequalities in neighbourhoods refers to the social, economic and political inclusion of all inhabitants (10.2). Thus, this goal is also related to the equitable access to housing, transport and services, better employment opportunities, and spaces for inclusion and participation. Despite their importance, this Goal is overall poorly considered by the NSA tools. ITACA does not include a specific criterion; LEED provides for the evaluation of "Civil and human rights" implementation (QL 08) through the interventions that promote a discrimination-free quality of life for all relating to employment, housing, and public accommodations; BREEAM evaluates "inclusive design" strategies (SE 15) that enhance accessibility an inclusion for neighbourhood current and future residents. However, many criteria included in other thematic areas can influence this goal indirectly, such as housing affordability and transport accessibility.

Furthermore, although the number of direct criteria is high, the total number of criteria (direct and indirect) and the general score related to the SDG 1 are lower because many criteria are defined as prerequisites without scoring. On the contrary, only two criteria are directly related to the SDG 10 but there are many indirect criteria which allow this goal to obtain a high score.

Among the "social goals", SDG 4 and SDG 5 are less considered by the three NSA tools. These two goals concern very specific topics which often are not included in the assessment of a project at the neighbourhood scale. However, some criteria try to evaluate some aspects of the two goals. Regarding the inclusive and equitable education and lifelong learning opportunities for all (SDG 4), BREEAM is the only tool that includes one direct criterion "Training and Skills" (SE 17) to ensure that the project enhance skills and training opportunities. In particular, this criterion assesses the partnership between the developer and a training provider to promote and contribute to local training and skills initiatives for residents and businesses in the neighbourhood and wider area. Regarding the inclusion and the empowerment of women and girls (SDG 5), none of the three NSA tools explicitly addresses this goal. However, this topic is indirectly pursued through several other criteria related to the accessibility and security of

public spaces, streets and transportation systems, and the participation in local governance and decision-making during the planning and/or construction phase.

Similarly to SDG 4 and SDG 5, two traditional "environmental goals" SDG 6 and SDG 7 related to water and energy efficiency appear less included in the three NSA tools. The sustainable management of water (SDG 6) is included in ITACA, BREEAM and LEED with respectively four, three and two direct criteria related to the efficiency in water treatment and reuse, the reduction of water pollution, demand and dissipation in sewer systems, and the promotion of rainwater harvesting. Furthermore, an indirect impact on this goal is covered in ITACA with a criterion (7.01.3) on the use of xerophytic plants to save water for irrigation of green areas . Due to the complexity of these topics, LEED highlights the need for integrated water management systems (WE 03). The improvement of equitable accessibility to affordable, clean and efficient energy systems (SDG 7) concerns many sectors, such as power, transportation, industrial and commercial activities, and housing. This Goal is included in LEED, ITACA and BREEAM, respectively with five, three and one directly related criteria that allow evaluating the progress towards a low carbon economy by reducing fossil fuel consumption, supporting renewable energy technologies, and improving energy efficiency. ITACA promotes the institution of energy communities (5.12) that can foster the development of decentralised production technologies, the creation of innovative sharing rules and potentially reduced energy costs for residents.

Surprisingly, SDG 6 and SDG 7 have a high number of direct criteria, but a low overall score associated to them. This is also the case of the SDG 16 related to the institutional dimension of sustainability. At the neighbourhood level, this goal includes the governance and management aspects of transformations such as the promotion of multi-stakeholder processes to ensure participatory planning and decision-making. BREEAM contains a specific thematic area "Governance" that contains four criteria directly related to the consultation and engagement of the community and other key stakeholders in design, planning and construction process (GO 01-02), in masterplan's design (GO 03), and the active involvement in developing, management and owning selected facilities (QO 04). ITACA also provide a specific thematic area for governance that includes criteria for participation (1.01), and for the social management of the construction site to minimise the negative effects on the quality of life of the citizens affected by the implementation of the interventions (1.02). LEED contains two direct criteria to evaluate "Integrative planning and leadership" (IP 01) and "Civic and community engagement" (QL 07).

The SDG 15 has an intermediate position in relation to the three proposed. This goal calls for the conservation and restoration of the terrestrial ecosystems (e.g., forests, wetlands, drylands, and mountains) that provide conditions for human life such as the access to basic services and food supply. At the neighbourhood level, this goal can be achieved through planning and design strategies focused on urban biodiversity and ecosystem safeguard and improvement, such as the protection of natural heritage, the development of green infrastructures and the restoration of degraded soils. BREEAM evaluates this goal through three direct criteria that promote strategies to enhance environmental values on the neighbourhood and in the surroundings (LE 01-LE 04), and to encourage the use of previously developed or contaminated land (LE 02). LEED requires a preliminary assessment of the existing conditions and ecosystems services, built landscapes, and other open spaces (NS 01), and includes a direct criterion for the evaluation of natural resources conservation and restoration strategies (NS 03). ITACA directly evaluates this aspect through the increase of the naturalistic green spaces (6.01).

In the last positions are SDG 2 and SDG 14, respectively related to food production and marine ecosystems, which are less or not at all covered in the three examined NSA tools. The potential impacts of agriculture and food production at the urban small-scale of the neighbourhood are accounted only by ITACA through the criterion "Urban Gardens" (9.05). which considers the role of local food production in the supply of food in cities. Another indirectly criterion "Relation between the peri-urban agricultural areas" (2.bis.02) promotes the design solutions for the regeneration of infill spaces and peri-urban agricultural areas. Finally, the SDG 14 is a very specific goal related to the conservation and the sustainable use of the oceans, seas, and marine resources. Although there is no direct criterion, this is a cross-cutting goal that may be indirectly related to the proper management of waste, the reduction of pollution that can flow into marine areas. This issue is particularly related to the neighbourhoods of coastal cities and developments.

Following this summary of the main findings, it is useful to highlight another operational potential of the proposed study for orienting planning and design process toward specific SDGs targets.As a way of example, assume the purpose is to identify the NSA criteria, and the corresponding recommended actions, related to SDGs targets aiming at improving urban resilience and risk mitigation. First, such analysis would require to identify SDGs targets related to resilience and risk mitigation (targets 1.5, 11.5, 11.6, 11.b, 13.1, 13.2, 13.3). Then, the corresponding NSA criteria would be identified through lookup in the NSA-SDGs cross-table. From these NSA criteria, a set of recommenced project actions at neighbourhood level would be recommended. Table 5 summarises the output of such a procedure. Similar procedures could be easily performed for other thematic sets of urban targets in order to expand the analysis of planning and design actions correlated to SDGs associated with other dimensions of sustainability.

Table 5. Resilience and risk mitigation. SDGs Urban targets 1.5, 11.5, 11.6, 11.b, 13.1, 13.2, 13.3

NSA Tool	Criteria Code/Aim		Project Actions at the Neighbourhood level
LEED v.4.1	WE 04	Stormwater Management: To reduce runoff volume, prevent erosion, flooding and recharge groundwater.	• Water storage within green infrastructures. • Strategies to minimize disturbed areas, preserving pre-development runoff conditions, limiting the amount of impervious cover. • Design techniques for evaporation, infiltration and detention storage of paved surfaces.
BREEAM	SE 10	Adapting to climate change: To ensure the development is resilient to the known and predicted impacts of climate change.	• Water storage within green spaces. • Hard flood defences and barriers. • Attenuation of run-off with green open space and green roofs. • Use of sustainable drainage systems.
LEED v.4.1	NS 05	Resilience Planning: To strengthen the resilience of communities to climate change risks, natural and man-made hazards and extreme events.	• Vulnerability and capacity assessment: identify the local environmental context and site-specific risks (natural and man-made) and develop a Resilience Plan for the community.
BREEAM	SE 03	Flood risk assessment: To ensure that the development takes account of flood risk and, where it is present, takes appropriate measures to reduce the risk of flooding to the development and the surrounding areas.	• Design of the development to minimise flood risk on site and off site. • Building design incorporate resilient measures. • The planned ground level of the buildings and access to the buildings and the site are designed (or zoned) so they are above the design flood level of the flood zone in which the assessed development is located. • An emergency plan is established in the event of flooding.
BREEAM	SE 13	Flood risk management: To avoid, reduce and delay the discharge of rainfall to public sewers and watercourses, thereby minimising the risk of localised flooding on and off site, watercourse pollution and other environmental damage.	• Masterplan with recommendations based on the site-specific flood risk assessment. • Calculation and design details for all elements regarding the surface water run-off drainage strategy.
BREEAM	LE 01	Ecology strategy: To ensure that the development protects existing natural habitats, minimises and mitigates its impact and promotes measures to enhance biodiversity on site and in the locality.	• Ecological Impact Assessment of development to identify ecological features of value (including those off-site that may be affected by the development). • Ecology strategy, covering the construction and operation phases, drawn up by a suitably qualified ecologist to avoid damage to any valued ecological features on or near site. • Mitigation/Compensation plan to ensure there is no net loss of any of the valued ecological features.
BREEAM	LE 06	Rainwater harvesting: To ensure that surface water run-off space is used effectively to minimise water demand.	• Percentage of the total hard surface for the site (roof plus hard-standing) that is designed to allow the harvesting of rainwater for re-use. • Rainwater collection systems are designed to ensure both the demand and yield for the building will be considered when sizing the tank.
ITACA	5.01	Soil Permeability: To minimize the interruption and contamination of natural water flows.	• Masterplan with the detail of different types of settlement surfaces. • Calculation of the permeability index.

ITACA	5.02	Intensity of water treatment: To maximize the collection and storage systems of rainfall peaks.	• Calculation of the water entering the waterproof surfaces of the area (streets, squares, squares, parking lots, etc.), collected and treated to be reused in the area for both irrigation and for other uses.
ITACA	7.01.1	Water pipes extraordinary maintenance: To reduce the hidden of pipelines losses.	• Ratification of maintenance agreements for water pipes
ITACA	7.01.2 7.03.3	Reduction, collection and recovery of rainwater dissipated in sewer systems: To store and slowly return rainwater to the surface circulation or to the atmosphere through evapotranspiration.	• Calculation of hydraulic invariance of the development.
ITACA	7.03.6	Damage reduction in open public spaces: To promote the use of building materials resistant to flood water.	• Use of flood-damage resistant materials.

7. Conclusions

The articulated web of relationships between NSA tools criteria and SDGs targets presented in the Discussion section offers a *prima facie* level of understanding and preliminary answers to our research questions (1) on the compliance, correspondences and discrepancies between SDGs and current NSA tools and (2) on how the current NSA tools translate the SDGs targets into criteria and indicators useful for planning and design at the neighbourhood level.

The degree of correspondence between the SDGs targets and the NSA tools criteria highlighted by this study indicates the potential value of neighbourhood sustainability assessment in the operationalisation of SDGs in the planning and design practice. Neighbourhood is a relevant spatial unit to pursue the objectives of sustainability, for it is at this scale that important interactions between space and society occur, in many of their social, economic, environmental and governance dimensions. The complexity of the neighbourhood scale requires a systemic intervention on the urban fabric and environment and implies the understanding of the role of inhabitants as a key component for the effective implementation of urban sustainability.

However, the still limited representation of some SDGs in the examined NSA tools, as our analysis and discussion have shown, suggests considering complementary metrics to account for the underrepresented dimensions of sustainability. Hence, this study may be a starting point for future research aimed at selection and systematisation of the most appropriate and operationally relevant criteria for the definition of new integrated assessment models capable of covering all the SDGs "urban targets" at the neighbourhood scale. The usefulness of such integrated SDGs-centric models could also derive from the possibility of better integrating sustainability assessment at the neighbourhood scale within the ordinary planning practices and procedures carried out by public planning offices.

Despite the potentials of the NSA tools suggested in this paper, it should conclusively be observed that even today the evaluation of sustainability at the neighbourhood scale is limited to a few exceptional cases and does not represent ordinary planning activity. The NSA tools have a limited application and impact in the ordinary planning practice also due to their prevailing "private" nature. The lack of use of such evaluation models by city administrations is also due to their limited capacity to conduct analyses and gathering data at the neighbourhood level. Many national and local statistical offices, in fact, have limited budgets and information technology skills to collect and publish regularly statistics and data sets (MacFeely, 2018). Therefore, such fine-grained evaluation is currently an expensive process that not all cities and neighbourhoods can afford.

That is why it is necessary to institutionalise neighbourhood sustainability evaluation in the ordinary practice, using indices and indicators based on easily measurable and accessible data. Furthermore, metrics consistent with the SDGs should be used to enable the effective implementation of the 2030 Agenda. Ultimately, our effort aims at bringing the attention to urban transformation, projects and policies which operate at the neighbourhood scale, and hence require that their impacts also be evaluated and tracked at that spatial level. This would allow to

define a ‘Sustainable Development Roadmap’ with concrete goals and targets for mayors, local administrations, leaders (Kanuri et al., 2016a), and planning practitioners.

To conclude on a more general note, this study of course cannot, nor does it intent to claim that urban planning and policy alone are the *panacea*, the universal channel through which to address all the problems of sustainability. But they are important, a pillar of sustainability. Therefore, our call to more cogently link urban policies, planning and design with their systematic evaluation in terms of the SDG goals is programmatically oriented in two related directions. One, not to overlook the contributions of actions and policies that are currently being implemented at the local level, by underestimating their impact in pursuing Sustainable Development Goals. But also, and more importantly, to stimulate a more direct and coherent pursuit of such policies and actions. Since any effective and action-binding evaluation procedure is also a (political) process of value creation, of defining what is valuable and where the value resides, therein resides the important role for evaluation models to play in stimulating such policies and actions at the local and neighbourhood level.

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