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Assessing a Sustainable Urban Development: Typology of Indicators and Sources of Information

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Abstract

In the field of sustainability assessment of built environment, the focus has started shifting from buildings to neighbourhoods and cities. As a result, numerous assessment systems have emerged to support investors in the design and development of sustainable neighbourhoods. Such approaches, however, can hardly be applied to existing neighbourhoods. The paper explores how “flexible” indicator systems can support the process of sustainable development of existing neighbourhoods. It also deals with issues related to the selection of indicators, identification of data sources and data protection. It is recommended to use such indicators systems to support housing improvement districts (HID) among others.

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1. Introduction

When it comes to the implementation of the principles of sustainable development in the construction sector and their translation into practical actions, the focus has started shifting from single buildings (micro-scale) to entire neighbourhoods and cities (meso- and macro-scale). The recognition of the necessity to start “thinking bigger” comes as a response to the growing concerns over the increase of the total population and environmental impact that has recently reached critical levels in numerous cities and urban areas worldwide. Additionally, the idea of shifting scales stems from a realisation that the sustainability challenge has to do with more than just buildings, but includes numerous complex interrelationships between buildings, open spaces, and transport networks, among others.

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According to the latest progress report of the UN-HABITAT II [1] the urbanization model in place is unsustainable and new conditions need to be defined to achieve inclusive, people-centred and sustainable global development. While cities are crucial “engines” of social and economic growth, they have not succeeded in addressing emerging and existing challenges, such as urban sprawl, congestion, air pollution, poverty, greenhouse gas emissions, etc.

2. Neighbourhood as an object of assessment and scale for intervention

Achieving sustainable urban development is a hugely difficult task to accomplish due to its complex and continuously-evolving nature. Many cities struggle to achieve their commitments to sustainability. Subdividing the “city” system into smaller units and involving “local stakeholders” (i.e. homeowners, business owners, lobbies, associations and unions, local institutions) in the development process and improvement of these units would facilitate such transformations. In this case, local stakeholders are involved not only as people affected by the current urban processes and their socio-economic impacts, but also as co-creators and co-implementers of the final decisions.

The neighbourhood level has increasingly been proved as an appropriate level to implement sustainability principles in urban transformation processes [2]. The terms “district”, “neighbourhood” and “community” are used interchangeably throughout the paper. The neighbourhood or district represents a “meso” level of analysis and action between the city and single buildings. Within the boundaries of neighbourhoods, different types of community institutions and social networks are formed, functioning as intermediaries between local individuals, and offering in principle more opportunities for active participation in collective decisions and their implementation. Compared with the city scale, the level of involvement, engagement and motivation of different actors to participate in decisions influencing their living environment and conditions is higher in individual neighbourhoods, as residents are involved more directly and rather share the same living experiences. Hence, implementing interventions at a neighbourhood level often appears to be a more promising option for a transition to urban sustainability. While at the city and building level both conceptual and analytical considerations have been dealt with since many years, neighbourhoods are increasingly moving into the focus of research and policy [3, 4]. However, the spatial boundaries of a neighbourhood cannot always be clearly defined. It may be a territorially defined administrative unit of a city, an area of study/application whose demarcation is made from a contextual perspective or an area within which the residents identify themselves and they develop a higher sense of responsibility. A current topic of discussion is how to demarcate a spatial boundary that would be suitable for each specific topic, such as mobility, energy supply or quality of the local supply chains.

Sustainability assessment systems are instruments that allow urban planners, local authorities and other key stakeholders to support an analysis of new developments, as well as of existing districts, from an environmental, social and economic point of view. Particularly, in the case of existing urban districts, they can assist in the identification of problem areas, the development of strategies for improvement and the ongoing monitoring of the success and impact of the adopted sustainability interventions and measures. However, decision-makers are today faced with a great diversity of available indicators and indicator systems. “Fixed” indicator sets are usually found in the already existing neighbourhood sustainability and certification systems and can be effectively used for the comparison of new neighbourhood developments. However, “flexible” indicator sets allowing “context-specific” indicators and being more adjustable to local conditions are more appropriate for measuring the sustainable development of existing neighbourhoods. The last category is the main focus of this paper.

Additionally, it is essential to understand the various purposes, scopes, scales for which each indicator is used, as well as to identify the stakeholders, scope of influence and their possibilities of action that can result in a positive progress in the area to which each indicator is assigned. In this context, the authors explore key issues related to the development of an indicator system (top-down versus bottom-up), a systematic way of classifying and describing the selected indicators taking into account *multiple effects* that indicators may have upon one another and the *impact chains* and interactions that can take place. Finally, considering the different potential forms of co-creation to mobilise local stakeholders and the necessary funding at a district level, the authors discuss in what context and by whom indicator systems to support sustainable neighbourhood development could be used.

3. Sustainability assessment of urban development: background

Sustainability assessment of the built environment was initially focused on the building, the smallest urban unit of a human settlement. However, the sustainability of the urban environment poses much more complex issues than solely the performance of single buildings. The quality of urban design and environment (e.g. optimal transportation and energy supply, design of public spaces, etc.) as well as the interactions of people and how they use a place are parameters that influence urban sustainability. Thus, the need to expand the sustainability scope and metrics to larger scales of the built environment leads to a more targeted focus on neighbourhoods or districts as the appropriate geographic scale for intervention.

Several sustainability assessment systems and tools have been developed for urban districts and neighbourhoods over the last decades, mostly as a result of the further development, expansion and adaptation of already established building sustainability assessment and certification systems to accommodate the complexities of the urban scale [5, 6]. Usually, these are suited for newly designed and constructed districts, thus for decisions at the master planning level to influence the decisions of individual developers, whereas for the sustainable transformation and improvement of existing districts, they are still too inflexible [3, 7].

Most of the systems follow a performance-oriented approach (absolute assessment, performance at a specific point in time) failing to reflect the dynamic and constantly changing character of an existing neighbourhood. In such a case, it makes more sense to analyse the specific situation, to define targets for improvement and to measure and assess the progress over time towards a set of short-term or longer-term sustainable development targets, and therefore to apply a “distance to target approach”. Often, local authorities refuse the application of an absolute sustainability assessment out of fear of stigmatisation and substantial disadvantages in case of a poor performance. An absolute poor score could potentially discourage potential investors and developers from engaging in the improvement and transformation processes.

Another characteristic that makes most of today’s sustainability assessment systems inflexible is that they usually comprise a “fixed” set of indicators. However, the sustainable development of an existing district is a process driven by various actors with different ambitions and different possibilities to act, compared to the planning of new neighbourhoods, where the main decision-maker is the neighbourhood developer. Any realistic and reliable assessment should take account of the specificities of concrete locations and varying needs of different stakeholders [8]. Thus, an indicator set should be flexible and adaptive enough to reflect the varying and time-evolving public interests and needs within the district, as well as to respond to emerging issues. The solution may be the development of a system consisting of core indicators complemented with other specific indicators adapted to the specific conditions of each case. A way of how to create and use such an indicator system is explained in the next section.

4. How to create and use a flexible indicator system to support a sustainable development of urban districts

Indicator systems and -sets can be powerful decision-supporting tools that foster sustainable development by addressing different decision-making challenges, such as the interpretation, information-structuring, and influence [9]. Creating an indicator system through the selection, identification and definition of appropriate criteria and indicators to monitor and evaluate the successes or failures of transitions to sustainability is a rather complicated procedure and faces a number of challenges. A fixed set of indicators could not suit all situations. Many diverse indicator systems can be devised to meet the needs of districts that are located in different contexts. The way they are developed has fuelled much debate. A distinction can be made between two approaches to indicator development:

- the “top-down” (expert-led) approach that is based on expert knowledge and input. This includes, for example, the consideration of international or national standards and, if existent, the national or regional/local sustainability strategies.
- the “bottom-up” (citizen-led) approach that draws on local expertise and networks, and involves the public. This provides a basis for identifying local deficiencies and problems.

The tensions between top-down and bottom-up models of indicator development are well documented in the literature [10]. Combining the two approaches would represent an effective solution [11]. However, little is known

about how this works in practice and whether it can be successful in reflecting local values and understandings of sustainability. For this reason, there is wide agreement that local stakeholders need to participate in all stages of indicator development and implementation as indicators evolve (over time) with the emergence of new circumstances within the district, as well as new scientific knowledge and data availability [10].

A vast number of indicators have already been developed and suggested worldwide [12]. Therefore, one may initially obtain and adopt indicators and indicator sets from already existing international, national or regional/municipal approaches to the assessment of sustainability or sustainable development of cities and districts (top-down). One example is the new ISO 37120 [13] standard. Additional criteria and assigned indicators to these criteria can be developed and agreed on through a participatory process (bottom up) taking place in the district under study with selected stakeholder groups (residents/ homeowners, businessmen, companies, suppliers, interest groups, local authority, etc.) [11].

Special attention should be paid to the examination of data availability and the selection of information sources. Care should be taken that the selected indicators are easy to measure or calculate, understandable (in specific cases even by non-experts) and reliable in the way that one can trust the information they are providing. Additionally, they should rely on available, accessible, of known quality data that can be obtained in a cost effective way and are frequently updated.

Besides meeting these fundamental technical requirements, it is useful to distinguish the indicators in terms of their measurability (objective/quantitative or subjective/qualitative approach), or in terms of their position in an impact/causal chain (closer to causes or effects). To what degree the indicators can be affected by improvement measures implemented by local stakeholders is an additional matter to consider in the selection and use of indicators. A corresponding typology is presented below.

4.1. A typology of indicators

It is useful to define a typology of indicators in order to improve the selection process. As a first step, a strategy can be followed making a distinction between

- Indicators that can be “directly influenced” by interventions of local actors inside the individual district (e.g. energy consumption of residential buildings). These indicators can be considered as “action-oriented” and help decision-makers in formulating clear targets and strategies.
- Indicators that “cannot be influenced” (at least not directly) by interventions of local actors and serve only information purposes (e.g. percentage of unemployed people). No goals can be defined for these indicators on the district level. These can be considered as “background” or “profile” indicators and mainly help decision-makers in understanding the current situation inside the district. However, some of them may give “early warnings” for problems in future. In this case, local actors can develop strategies to fight the consequences of these developments observed with the help of background indicators.

A further differentiation is made between a simple/individual indicator and the one that exists in a hierarchical system of partial indicators that can be summarized/aggregated using weighting factors determined on the basis of political or other targets. In contrast, there is the case where several indicators (proxy or consequential indicators) exist that can be used to describe the same criterion/thematic area. For example, the energetic quality of residential buildings (criterion) can be described and assessed in several ways; e.g., in terms of the energy demand, energy consumption, specifications for envelope and building services). Therefore, it is possible to adapt the selection of the indicators to the available data and information and to reach to a conclusion at the criterion level (higher level).

Furthermore, it is also important to acknowledge potential antagonistic effects of the outcome of particular indicators, either positive or negative, when analysing results. For example, although the use of wood for heating contributes to the conservation of non-renewable resources, it can also lead to an increase in the emissions of particulate matter and thus the deterioration of local air quality. The need for a broad system of indicators, able to map side effects and identify trade-offs or target conflicts, is evident.

One important question is how to frame indicators along impact/causal chains. A framework that can be employed to further systemize the indicators – among other possibilities – is the DPSIR framework (Driving Forces-Pressure-State-Impact-Response) adopted by the European Environment Agency (EEA) [14]. This approach is often chosen for analyzing topics related to the environment. The identification of causes, the characterization of the

current state, and the measurement of changes become possible among others. This is a way of supporting the analysis and control of processes, which are typical in the district development.

It is clear that different “measuring points” emerge along an “impact chain” that can be used for the process of designing and interpreting the indicators – see figure 1. Such an analysis facilitates the selection of indicators that are best suited to the area of interest or to the means of action of the respective active local players. Based on at which position in the chain an indicator is, it can be characterized as “action-oriented”/source-related or “success-oriented”/endpoint-related. It is also possible to use action- and success-oriented indicators (for the same issue) in parallel, both for the identification and implementation of measures to eliminate the problem already at its source, and the monitoring of the relevant success at the level of “endpoints”. Figure 1 describes the relationship between indicators along an impact/causal chain. For example, the area of mobility (criterion) can be described through the number of private cars, the quality of public transport or the mobility patterns of the residents among others (M1). The mobility-related emissions and noise can be hardly measured; therefore, they are usually calculated. However, the overall air quality and noise level can be measured (M2), but without being able to quantify exactly the impact of mobility on these factors. Noise and emissions affect the health of residents, yet such data are subject to data protection laws (M3). Through surveys, the individual satisfaction or the level of quality of life can be captured, considering that the impact of mobility can influence the responses (M4 and M5). Depending on the potential influence and interests of specific actors the most appropriate “measurement points” for indicators can be defined.

When working with indicators that are located at several points in the impact chain, the risk of double counting exist. However, this is a problem only for the case of an absolute assessment. In a process-oriented system the investigation of several indicators along on impact chain is beneficial to map individual perspectives of different actors or to help them identify causes and/or effects.

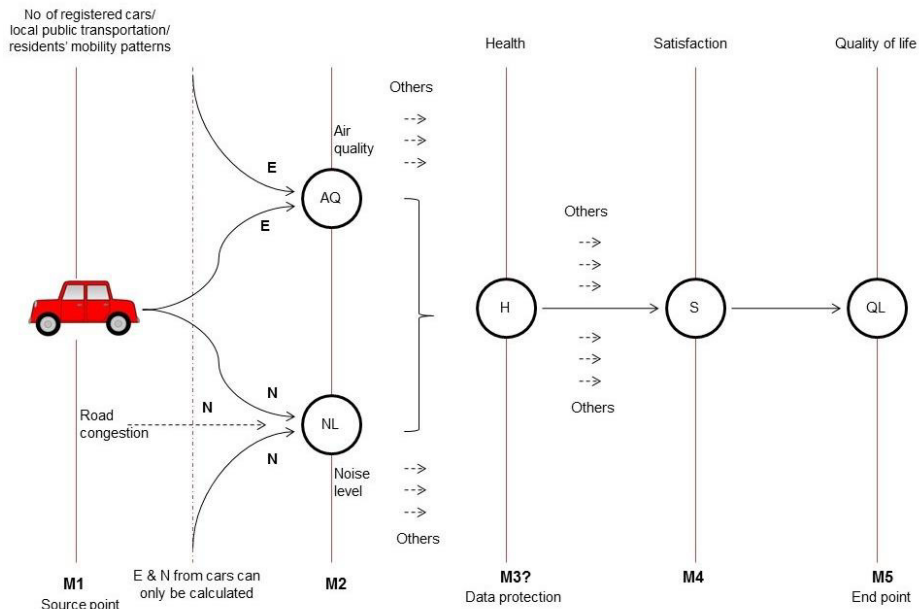


Fig. 1. Chain of impacts using “mobility” as an example. Different indicators are allocated to different “measurement points” (E = Emissions; N = Noise/ Sound; M = measurement point).

Finally, indicators can be differentiated as to whether they have an effect on one or more dimensions of sustainability. For example, climate change (environmental dimension) may lead to health- and comfort-related problems (social dimension) and to external costs for the society (economic dimension). The subject of multi-effects and multidimensionality was first taken up – amongst others – by the first author in ISO 21929-1: 2011 related to the

indicators for assessing the sustainability of buildings. This discussion can be transferable to the indicators for sustainable neighbourhood development.

4.2. An approach to the description of the indicators

Once the final list of indicators that best suits the district's characteristics is acknowledged and widely accepted, the indicators need to be clearly and precisely described and documented (data sources, target group, etc.). The development of a "factsheet" for each individual indicator that contains all necessary fields and presents available information in a unique template is necessary. Such an example is shown in table 1.

Table 1. Relevant aspects in the development, description and characterization of urban indicators.

Important information for the indicator		Examples of the different possibilities of expression
Aspects related to the description and classification of the indicator	Name	...
	Definition	...
	Object of assessment	Technical district elements (e.g. transport system), Building stock, Behavior of residents, quality of water, air, soil etc.
	Content/ Relationship with the general objectives of sustainable development	Economic, environmental, social, or technical themes, overlapping themes
	Relationship with the specific goals of sustainable district development	Importance of the indicator for the development of the neighborhood, what should be fostered?
	Type or character	E.g. what the indicator describes according to DPSIR framework (driving force, pressure, etc.)? What is the position in the impact chain, source, midpoint, endpoint?
	Measurability	Simple or complex, Qualitative or quantitative, etc.
	Time-related coverage	Refers to a certain point in time, Refers to a certain period of time, Temporal trend
	Quantification and assessment method	Is it based on calculation, measurement or survey results?
	Data requirements	Data needs
	Data availability and providers	List of potential data sources
	Precondition for use and interpretation	Easily understandable, Requires expert knowledge
	Degree of the "controllability" of the indicator	Can only be observed (no influence), Can be indirectly influenced, Can be directly influence
Alternative indicators that can be used in case good-quality data are not available	Consequential indicators...	
	...	
	Interrelationships with other indicators	...
Actor-related aspects	By which stakeholder groups it can be influenced?	Public / residents, Politicians & policy makers, etc.
	On which stakeholders groups may it have an impact?	Home owners, tenants, etc.
Action-related information	Measures for achieving positive progress	
	Communication at the indicator level	target value and target year available, only target value available, trend assessment, channel for communication

Structuring such a factsheet serves two purposes: to optimize the information management by identifying and listing all possible data sources (and their providers) and alternative calculation procedures, as well as to identify the acting stakeholders and their options/opportunities for action (specific measures to achieve progress). The development of a factsheet would also further ease the dissemination of the indicators' results to the public (through specification of appropriate "channels" of communication).

Indicators and indicator systems can be communicated in different ways according to the target audience. The amount of information provided about the process and result of the indicator-based assessment depends on the communication form chosen and the target group. It can be either a printed publication (e.g. a report or a brochure) or an online format (interactive or non interactive).

5. Data needs and data sources

Significant data requirements emerge when it comes to the monitoring and support of a sustainable neighbourhood development. Initially, it makes no difference whether data should be collected for indicators that can only be observed (background indicators) or can actually be influenced. It is recommended to initially investigate the available data sources and data before describing additional data requirements and building structures on how to fulfil these requirements. The description of the data requirements, depending on selected criteria, the identification of appropriate data sources and the establishment of structures for the collection and analysis of data is itself a part of the process. It is an advantage to develop several possible indicators for each criterion to be able to be adapted to the concrete situation based on the availability of information.

Data sets are available in both municipalities and individual neighbourhoods. Often these are systematically prepared for investors in the form of a location/site analysis (for example, number of unemployed people, inflows and outflows, crime statistics). A distinction is made between the analysis of the macro and the micro-location. Often, municipalities publish GIS-related data (for example, noise maps). Other data providers can be power utility organisations, chimney sweeps, or transport corporations. Such data sources must be systematically identified and analyzed. The use of already available data sources saves time and money.

As a problem, the issue of protecting personal data arises - for example, the energy consumption of individual homes. One way to solve the problem is the optional provision of such data by the citizens. When citizens (for example, homeowners, business owners, tenants) are more actively involved in the process of sustainable neighbourhood development, they are usually more willing to provide data [15]. Experiences from Karlsruhe in relation to the research project “Reallabor 131” [16] show that intensive cooperation with organizations - for example, the “tenants’ association” or the “association of homeowners and property owners” strengthens the confidence and increases the willingness to surrender specific details – like energy consumption of single buildings.

6. Sustainable development of districts as a process

The aim of following process-based approach to sustainable neighbourhood development is to improve the overall situation and not just to provide an assessment result. Financial expenditure is necessary for this purpose. One way is to mobilize private capital. A convincing argument for the owners of land and buildings can be that an improvement in the quality of the site/location can have a direct and positive effect on the real estate value of their properties. “Urban Improvement Districts”, in form of housing improvement districts (HID's) and others [17], offer a framework for pooling initiatives to support sustainable development.

“Urban Improvement Districts” [18] or “innovation areas” are areas that are legally specified on the basis of private initiative and with the participation of local stakeholders of the communities so that the landowners to improve the situation in the neighbourhood using their own financial resources and taking themselves all the necessary measures to achieve this. To this end, in many models a task manager is assigned, who cooperates both with the land owners and users in the quarter as well as with the municipal offices. “Urban Improvement Districts” are financed by a tax which is levied by the municipality and collected from all land owners in the area.

From the authors’ point of view, the tools for process-based sustainability assessments can be effectively combined with the HID's concept. The sustainability assessment can be used as a tool for the identification of goals, success factors and performance metrics, while a HID can provide the organizational and financial framework for the implementation of sustainability measures.

7. Conclusions and outlook

Indicators can be seen as a “useful” and effective way to capture, monitor and deal with different conditions and problems. There is no blueprint but multiple pathways to sustainable urban development, as districts, neighbourhoods and communities have different circumstances, priorities and ambitions, and therefore, devising a highly contextualized but nevertheless ‘fix’ set of indicators may not be the way to go for already existing urban districts. One solution here could be a context specific indicator set which is flexible enough to allow for “context-specific” indicators to be included as an addition. In the paper it was highlighted, among others, that it is useful to define a typology of indicators in order to improve the selection process, as well as to clearly and precisely describe and document the selected indicators.

The development and use of a context-specific set of indicators to support sustainable district development is currently being discussed and tested in Karlsruhe within the context of the project “Reallabor 131”. It is intended to publish the experiences gained in the selection process of the indicators, as well as in the development of their typology and the impact chains.

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