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Four types of measures for Smart and Sustainable Cities and when to use them

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HIGHLIGHTS

Improving cities is central to achieving many of the Sustainable Development Goals. Smart technologies are thought to contribute to these goals. So many cities are working towards being smart and sustainable.

However, measuring city progress is complex. There are many different measures available, but they have been created for different purposes. Some measures are also more appropriate for particular kinds of cities. Cities lack information and guidance as to what measures exist and how to evaluate and apply them.

UNU-EGOV reviewed 53 measures for smart, sustainable cities and identified four main types.

- Indicator standards
- Models
- Composite indicators
- Evaluations

Within these four main types we identified twelve sub-types that each have different uses for cities. In all, we found eight different uses for city measures.

Cities can use this information to identify what kind of measures will best match their current needs and goals.

1. The need for (good) city measures

Cities and other human settlements are central to human experience and many of the Sustainable Development Goals work towards improving cities. Technology is seen as a key resource in this process. A smart city is "an innovative city that uses information and communication technologies and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations" (ITU-T, 2014).

As cities strive to become smarter and more sustainable, they need to measure their progress. Measuring city progress is complex because a city is comprised of many different systems and the success of the city as a whole, depends not only on how well each part functions, but also on the interconnections between these systems. Good measures of cities have to take into account of both of these levels.

There are many ways to measure cities, including frameworks, models, indices and other tools, but it is difficult for cities to distinguish between them and to know which are really useful. In addition, cities face decisions as to whether to participate in various measures and need to understand the benefits and whether to use resources in this way. Cities lack information and guidance as to what measures exist and how to evaluate and apply them.

2. What we did

This study examined fifty-three different measures for smart cities. We included all tools, processes, methods and models for evaluating city states or progress. These measures were identified from the academic literature and from online searches. Many different terms are used to describe cities, so the survey included as many measures as possible, even when they did not explicitly use the terms smart or sustainable. So, some of the measures are for digital cities, liveability and urban quality, among others. However, we only considered measures of the city as a whole, rather than just one aspect.

3. What we found

There were four main types of measures. **Indicator standards** are sets of indicators designed to measure aspects of city performance. **Models** are maps of city components and how they are related, with some means of assessing the functioning of each component or the relationships between them. **Composite indices** assign a single measure to a city based on indicators that measure different city dimensions. **Evaluations** include tools for evaluating city interventions, as well as processes for conducting evaluations.

3.1. Indicator standards

Indicator standards are defined by standards bodies that operate at international, regional or national level. Our searches identified ten indicator standards for cities, eight of which were **defined by international bodies** such as the International Organization for Standardization (ISO) and the International Telecommunications Union (ITU-T).

The standards differ in terms of the **types of indicators** they include. Indicators can measure input, process, output, outcome and impact. Output, outcome and impact measures are preferred, and tend to use economic, social or environmental metrics. However, input and process measures are important when cities are in the early stages of improving, when other measures are not yet available or observable.

Indicator standards can be useful for cities because they have been compiled by experts who understand the challenges of selecting indicators, but they may not always reflect local goals and concerns. International bodies are interested in data that is comparable across cities, while cities might be more concerned with how they are addressing local issues. Cities may find that standards defined by regional bodies, where they exist, are more relevant.

3.2. Models

Nine of the city measures could best be described as models. Models provide an ideal state for cities to compare themselves with and, as such, can be a useful aid to planning as well as simply measuring cities. There were three different types of models.

The three **descriptive models**, which included the Boyd Cohen Smart City Wheel, were the simplest. They define a city in terms of a number of dimensions and then define measures for each of these dimensions. Such models ensure that a range of dimensions are considered, but the choice of dimensions might not be appropriate or comprehensive. These models differ from composite indices because they only report measures for each dimension, without trying to arrive at a single value.

Three of the city measures were **maturity models** that propose a set of levels through which the city develops. The maturity of the city is measured by comparing current characteristics with descriptions of performance at each level. Maturity models do not require specialist skills to use, but to be effective they need detailed performance descriptors with information about how to assess each level. The models reviewed were not well defined and better maturity models for cities are needed.

The last three models use **clustering techniques** to group cities and build knowledge of how city dimensions are related. They rely on advanced statistical techniques and are likely to be beyond the capabilities of the average city to implement without assistance.

SAMPLE MEASURES

- ITU-T, 2016. Y.4903/L.1603 Key Performance Indicators for smart sustainable cities to assess the achievement of sustainable development goals. https://www.itu.int/rec/T-REC-Y.4903-201610-I/en
- Cohen B, 2014. The smartest cities in the world. http://www.fastcoexist.com/3038818/the-smartest-cities-in-the-world-2015-methodology
- IESE Cities in Motion Index, 2019 https://media.iese.edu/research/pdfs/ST-0509-E.pdf
- World Council on City Data: https://www.dataforcities.org

3.3. Composite indices

Twenty-five of the city measures reviewed were composite indices. These are based on descriptive models but in addition to measuring each city dimension, they combine these values to get a single value for the state of a city. They originated from academic researchers, research groups and institutes, national governments, international bodies and private companies.

Seven of the indices aimed to simply **provide information** with no explicit purpose or use. Two of these were for regional use (Brazil and Europe), but the rest could be applied broadly. Most had only been implemented once or twice. An interesting exception was Numbeo's Quality of Life Index which, since 2009, supplements crowdsourced urban data with authoritative sources to provide an open information source about cities.

Another seven indices had the explicit goal of **transforming cities** by prioritizing investment, increasing economic competitiveness, promoting change and connecting cities with companies. Four of them were regional and three had global application. Of these indices only three (two UN-Habitat indices and the IESE Cities in Motion Index) have been applied repeatedly.

Five of the indices had **commercial purposes**. They collect data to advise companies on pay for international employees, to identify cities with the best conditions for innovation or to gain market intelligence. These indices originate from private companies and four of them are updated annually. Which cities participate is determined by the companies, although in some cases cities can apply to be included. Cities that score highly on these indices are likely to benefit from the exposure.

The final six indices originated from academic sources and aimed to **increased knowledge** by understanding relationships between city characteristics or actions and performance. Four were developed for specific regions (Europe, Spain, China's Shaanxi province) and the other two applied to a small selection of global cities, making them less useful for cities in general.

Composite indices claim to measure some city construct such as smartness, intelligence, economic power or liveability. However, they don't always take care to define these constructs, or to validate that this is indeed what is being measured. The indices from academic sources tend to do this, but those from national governments, international bodies and private companies rely on expert opinion, rather than statistical evidence. Cities should be aware that **not all indices are valid or meaningful**.

3.4. Evaluations

Four of the measures reviewed related to **competitions** such as the European Green Capital Award. These included lists of criteria on which cities were to be evaluated, but were not very useful as measures because they gave little detail. Such measures might be useful if the competition rewards and publicity are important for a city.

Three measures were **evaluation processes** used by commercial companies to evaluate cities. One of these, the World Council on City Data certifies cities as ISO37120 compliant and helps cities to develop data collection capabilities. Such processes could assist cities that want to develop their measurement capabilities.

The final two evaluation measures examined were complex technical tools that use advanced statistical techniques to **assess the systemic effects** of smart interventions. These could be useful in prioritising interventions, but are likely to be beyond the capabilities of the average city to implement without assistance.

4. What we concluded

For the four types of city measures, we identified twelve sub-types. These are listed in Table 1 together with the ways in which cities might use them. This table gives cities some idea of the kind of measures to consider, depending on current city goals and needs.

TYPE	SUB-TYPE	USES FOR CITIES
Indicator standards	Internationally defined	Aligning with international goals
	Regionally defined	Aligning with regional goals
Models	Descriptive models	Simple city monitoring
	Maturity models	City development
	Clustering models	Deeper analysis and understanding
Composite indices	Information goals	Simple city monitoring
	Transformation goals	City development
	Commercial goals	Benchmarking and positioning
	Knowledge goals	Deeper analysis and understanding
Evaluations	Competition criteria	Competitions
	Evaluation process	City development
	Intervention evaluation	Prioritising interventions

Table 1: City measures and their uses.

RECOMMENDATIONS

Cities should identify what they want to achieve in their own monitoring and be guided by that as to the types of measures they employ. While conforming to international standards is desirable, where these are not locally relevant, cities should adapt them to align to their own needs and priorities.

Descriptive models give cities a simple starting point for understanding the dimensions of city performance. Maturity models are simple to implement, but the current models available are not of a high standard.

Informative and transformative composite indices can be useful for cities because they provide a set of dimensions and measures. Cities should assess whether these are appropriate for their context. Cities may want to participate in commercial city measures where they perceive a competitive advantage.

Finally, competitions bring publicity to cities, but generally do not improve long-term monitoring of city progress. Evaluation processes, particularly those that are developmental, are more likely to embed good practices in cities over time.

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