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# ITU-T Y.4903/L.1603

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TELECOMMUNICATION
STANDARDIZATION SECTOR
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SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS AND NEXT-GENERATION NETWORKS, INTERNET OF THINGS AND SMART CITIES

Internet of things and smart cities and communities – Evaluation and assessment

SERIES L: ENVIRONMENT AND ICTS, CLIMATE CHANGE, E-WASTE, ENERGY EFFICIENCY; CONSTRUCTION, INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT

## Key performance indicators for smart sustainable cities to assess the achievement of sustainable development goals

Recommendation ITU-T Y.4903/L.1603

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# Recommendation ITU-T Y.4903/L.1603

## Key performance indicators for smart sustainable cities to assess the achievement of sustainable development goals


### Summary

Recommendation ITU-T Y.4903/L.1603 gives general guidance to cities and provides key performance indicators (KPIs) for smart sustainable cities (SSC) to help cities achieve sustainable development goals (SDGs). This Recommendation has been jointly developed with UNECE and other UN agencies.



### History

| Edition | Recommendation | Approval | Study Group | Unique ID* |
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### Keywords

Cities, information communication technologies, ICTs, key performance indicators, KPIs, SDGs smart sustainable cities, SSC, sustainable development goals, sustainable urban development.


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## FOREWORD

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In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

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## Key performance indicators for smart sustainable cities to assess the achievement of sustainable development goals

### 1 Scope

This Recommendation outlines the key performance indicators (KPIs) in the context of smart sustainable cities (SSC) used to assess the achievement of sustainable development goals (SDGs). Evaluating these indicators can help cities as well as their stakeholders understand to what extent they may be perceived as smart and sustainable.

The sustainability of a smart city is based on five main aspects:

– Economic: The ability to generate income and employment for the livelihood of the inhabitants.

– Social: The ability to ensure that the welfare (safety, health, education, etc.) of the citizens can be equally delivered despite differences in class, race or gender.

– Environmental: The ability to protect future quality and reproducibility of natural resources.

– Governance: The ability to maintain social conditions of stability, democracy, participation and justice.

– Cultural: The ability to promote cultural identity and adequacy, value and emotional well-being.

This Recommendation can be utilized by:

– Cities and municipal administrations, including the SSC-relevant policy-making organizations and government sectors, enabling them to develop strategies for making cities smarter and more sustainable.

– City residents and non-profit citizen organizations, enabling them to understand the development and progress of SSC.

– Development and operation organizations of SSC, including planning units, SSC-related producers and service providers and operation and maintenance organizations, helping them to fulfil the tasks of sharing information related to the use of information communication technologies (ICTs) and its impact on the sustainability of cities.

– Third party agencies and academia, supporting them in the selection of relevant KPIs for assessing the development of SSC.

The intention of identifying the KPIs is to establish the criteria to evaluate cities' performances and their progress towards becoming smarter and more sustainable and to provide the cities with the means for self-assessments. Cities are encouraged to periodically check their performances against the recommended indicators listed in this Recommendation in order to improve their performance.

This Recommendation lists the core indicators that have been selected as being applicable for all cities. The goals for moving towards increased smartness and sustainability differ between cities. Thus, based on their population growth, geographical locations, environmental conditions, demography, etc., cities may also select appropriate additional indicators among those listed in Appendix I.

This Recommendation focuses on general development of cities. Cities with particular interest in ICT development may refer to [ITU-T Y.4901] and [ITU-T Y.4902].

## 2 References

The following ITU-T Recommendations and other references contain provisions which, through references in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this ITU-T Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T Y.4900] Recommendation ITU-T Y.4900/L.1600 (2016), *Overview of key performance indicators in smart sustainable cities*.

[ITU-T Y.4901] Recommendation ITU-T Y.4901/L.1601 (2016), *Key performance indicators related to the use of information and communication technology in smart sustainable cities*.

[ITU-T Y.4902] Recommendation ITU-T Y.4902/L.1602/ (2016), *Key performance indicators related to the sustainability impacts of information and communication technology in smart sustainable cities.*

[ITU-T K-Sup.4] ITU-T K-series Recommendations – Supplement 4 (2015), *Electromagnetic field consideration in smart sustainable cities*.

[ITU-T Y-Sup.39] ITU-T Y-series Recommendations – Supplement 39 (2015), *Key performance indicators definitions for smart sustainable cities*.

[ISO 37120] ISO 37120:2014, *Sustainable development of communities – Indicators for city services and quality of life.*

## 3 Definitions

### 3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

**3.1.1 city** [ITU-T Y.4900]: An urban geographical area with one (or several) local government and planning authorities.

**3.1.2 ICT companies** [ITU-T Y.4901]: Companies which provide products and/or services with respect to information and communication technologies.

**3.1.3 knowledge economy** [b-OECD KE]: Economies which are directly based on the production, distribution and use of knowledge and information.

**3.1.4 smart sustainable city** [ITU-T Y.4900]: A smart sustainable city is an innovative city that uses information and communication technologies (ICTs) 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 with respect to economic, social, environmental, as well as cultural aspects.

NOTE – City competitiveness refers to policies, institutions, strategies and processes that determine the city's sustainable productivity.

### 3.2 Terms defined in this Recommendation

None.

## 4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

| | |
|---|---|
| AQI | Air Quality Index |
| BEV | Battery Electric Vehicle |
| BMI | Body Mass Index |
| BPL | Broadband-over-Power Line |
| $CO_2$ | Carbon dioxide |
| COP | Child Online Protection |
| EV | Electric Vehicle |
| FAO | Food and Agriculture Organisation |
| FCEV | Fuel Cell Electric Vehicle |
| GDP | Gross Domestic Product |
| GHG | Green House Gas |
| ICT | Information and Communication Technology |
| IP | Internet Protocol |
| ISO | International Organization for Standardization |
| KPI | Key Performance Indicator |
| LAN | Local Area Network |
| PHEV | Plug-in Hybrid Electric Vehicle |
| PM10 | Particulate Matter up to 10 micrometres in size |
| PM2.5 | Particulate Matter up to 2.5 micrometres in size |
| PPP | Purchasing Power Parity |
| QoL | Quality of Life |
| REEV | Range Extended Electric Vehicle |
| REX | Range Extender |
| SDG | Sustainable Development Goal |
| SMEs | Small and Medium-sized Enterprises |
| SSC | Smart Sustainable Cities |
| TCP | Transmission Control Protocol |

## 5 Conventions

None.

## 6 General principles for selecting key performance indicators (KPIs)

The selection of KPIs is based on the following principles:

– Independent: The KPIs should be independent or almost-orthogonal i.e., overlap of the KPIs should be avoided as much as possible.

– Simple: The concept of each indicator should be simple and easy to understand. There has to be one widely-accepted definition of the KPI to make sure the different users interpret it in the same way. Also the calculation of the associated data should be intuitive and simple.
– Measurable: The KPIs should be defined in a way that the value can be measured and comparable scientifically between different phases of urban development, which means the KPIs should be comparable over time and space. The historic and current data should be either available or easy to collect.
– Achievable: The goal of KPIs should be achievable and the set of indicators should cover all aspects of SSC. It should also be possible to extend and amend the set of KPIs according to the actual stage of development.
– Relevant: The KPIs should give more insight into the performance of the city in obtaining its strategy. The indicators for evaluation should be aligned to the measured subject. The index system should reflect the level of general development for a particular aspect.
– Timely: It is important to express the value of the KPI in time. Every KPI has a meaning only if the time dimension in which it is realized is known. Hence, its realization and standardization has to be time phased. KPIs are also able to deal with emerging issues in SSC construction.

# 7 Overview of key performance indicators

## 7.1 Definition of area, topic and type of KPIs

This Recommendation is based on the series of Recommendations and Supplements on SSC KPIs [ITU-T Y.4900], [ITU-T Y.4901], [ITU-T Y.4902] and [ITU-T Y-Sup.39] and the UNECE smart cities indicators [b-UNECE indicators]. This Recommendation also takes into consideration the definition of SSC, the UN sustainable development goals [b-UN Resolution 288], the city prosperity index of UN-Habitat [b-UN-Habitat report] and ISO indicators for city services and quality of life [ISO 37120].

The set of KPIs has been structured according to three major aspects, namely areas, topics and types of indicator.

The areas represent the more generic dimensions which provide a framework for the set of indicators. They correspond to the three pillars of sustainability: economy, environment and society and culture.

The topic indicates a group of specific indicators which describe an area of potential development. Nineteen major topics are identified and each indicator is assigned to one specific topic. Some topics include specific sub-topics which can be considered as keywords that more thoroughly define the nature of the indicators. The topics are:

– Economy, including the following topics:
  - ICT infrastructure
  - Innovation
  - Employment
  - Trade (sub-topics: e-Commerce and export/import)
  - Productivity
  - Physical infrastructure (sub-topics: water supply, electricity, health infrastructure, transport, road infrastructure, buildings and urban planning and public space)
  - Public sector

– Environment, including the following topics:
  - Air quality
  - Water and sanitation
  - Noise
  - Environmental quality
  - Biodiversity
  - Energy
– Society and culture, including the following topics:
  - Education
  - Health
  - Safety (sub-topics: disaster relief, emergency and ICT)
  - Housing
  - Culture
  - Social inclusion

The indicator type indicates the "applicability" of the indicator itself. In total, two indicator types are defined and explained below:

– The core indicators can be used by all cities globally.

– The additional indicators may be used by some cities according to their economic capacity, population growth, geographic situation, etc. Also, some additional indicators are very "smart" and can be addressed by "smarter" cities. These indicators are optional, especially for city self-benchmarking.

Using the area, the topic, and the type, the indicators are assigned a unit which indicates how they are measured; a definition which informs about what they describe. Figure 1 shows areas and topics of KPIs for SSC.

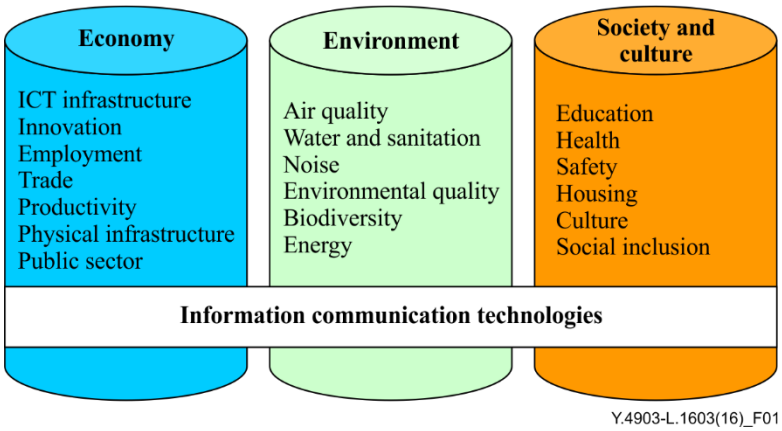


**Figure 1 – Areas and topics of KPIs for SSC**

## 7.2 Description of areas and topics of KPIs

### 7.2.1 Economy

The evaluation of the sustainability of the economy in SSC should be based on seven topics: ICT infrastructure (T1.1), innovation (T1.2), employment (T1.3), trade (T1.4), productivity (T1.5), physical infrastructure (T1.6) and public sector (T1.7). It is necessary to investigate whether or not SSC help to boost the local economy.

### T1.1 ICT infrastructure

ICT infrastructure is the basis for other ICT solutions which are the enablers of smart sustainable cities. ICT infrastructure includes terminals and access and network as well as services and information platforms. Typical indicators of ICT infrastructure should take into account the use and/or deployment of various terminals (computer, mobile phone, tablet, etc.), Internet, wireless/fixed broadband, backbone network, cloud computing platform, data centre, etc.

### T1.2 Innovation

The city's ability for innovation should be evaluated through multiple perspectives in order to indicate whether it is an innovative city. Innovative cities imply cities that can adjust to changes quickly and play a role as regional leaders. Innovation can be measured directly by research and development investment as well as research and development output which is well indicated in the form of patents produced.

### T1.3 Employment

Employment rate is a good indicator of the health of a city economy. Employment includes both formal and informal employment in a city.

### T1.4 Trade

Trade can be considered the heart of commercial prosperity. Trade can be measured in terms of exports and imports. E-commerce is also a good indicator of trade in SSC.

### T1.5 Productivity

In the context of SSC the evaluation of productivity should focus on the use of information and media, product and process innovation and business and service leadership.

### T1.6 Physical infrastructure

To make a city smarter and more sustainable, physical infrastructure should be improved in the following categories: water supply, electricity, health infrastructure, transport, road infrastructure, buildings and urban planning and public space, etc.

### T1.7 Public sector

The public sector is the part of the economy concerned with providing various governmental services. ICT use for improving the efficiency of these services should be a prime consideration for SSC.

## 7.2.2 Environment

The sustainability of the environment in SSC can be considered based on the following six categories: air quality (T2.1), water and sanitation (T2.2), noise (T2.3), environmental quality (T2.4), biodiversity (T2.5) and energy (T2.6).

### T2.1 Air quality

This category looks into the quality of air, which is an important area for consideration in many cities. One of the main concerns of city inhabitants is air pollution, which should be accurately monitored and its related data transparently made available to the public. Another aspect of air quality is the $CO_2$-e emissions of the city where "-e" is "equivalent" and every other greenhouse gas is converted into $CO_2$.

### T2.2 Water and sanitation

From the perspective of environmental protection, water should be considered in the following aspects: water resources, water distribution, water saving, waste water treatment, drainage, sanitation, etc.

### T2.3 Noise

This category considers noise exposure level in the city.

### T2.4 Environmental quality

The environmental quality can be evaluated through quantitative or qualitative methods in the following aspects: solid waste, electromagnetic fields, green areas and public spaces.

### T2.5 Biodiversity

Biodiversity is complicated to measure. At the city level it can be covered by several aspects such as native species and the natural environment for protecting these species.

### T2.6 Energy

This category considers the energy use of the city, including electricity consumption, renewable energy consumption as well as energy saving measures in households.

## 7.2.3 Society and culture

The sustainability of the area society and culture in SSC can be considered based on performance in the following six sectors: education (T3.1), health (T3.2), safety (T3.3), housing (T3.4), culture (T3.5) and social inclusion (T3.6).

### T3.1 Education

Education and training is critical to enhance human creativity and to improve the quality of human resources. The assessment of education improvement can be conducted through the following aspects: education investment, use of ICT as assistance, student capability improvement, adult literacy, etc.

### T3.2 Health

Generally health can be considered as health care and medical services. In a city health should be evaluated from the following perspectives: health administration (disease control, epidemic prevention and immunity, investment and distribution of medical resources, etc.), health service organization (hospital, pharmacy, health care centre, health insurance, etc.), and health status of city inhabitants (life expectancy, morbidity, mortality, etc.).

### T3.3 Safety

Security and safety have been the basic civil services guaranteed by administrators since early times. Security concerns nowadays mainly pertain to man-made threats, specifically crime and terrorism. Safety refers to actions taken in response to natural disasters and accidents. ICTs play a vital role in these two areas.

### T3.4 Housing

This category concerns the average living space and/or expenditure in SSC. At city level it is also very important to reduce slums as a sustainable development goal (SDG) of poverty eradication [UN Resolution 288].

### T3.5 Culture

SSC assessment concerning cultural aspects focuses on culture/knowledge infrastructure such as libraries, theatres, museums, galleries, etc.

### T3.6 Social inclusion

Equity and social inclusion in SSC should be sampled in the following sectors: equity of income/consumption, social and gender equity of access to services and infrastructure, openness and public participation and governance. Governance and public service have a great influence on

social development. It is obvious that modern governments should be open and highly efficient. Otherwise, frequent turbulence could jeopardize stability and development. In this category, ICT will also be evaluated as to whether or not it is helping improve social harmony and administrative efficiency.

## 8 Key performance indicators of SSC

As mentioned before, the indicator typology indicates the "applicability" of the indicator itself. Each indicator is labelled (Cx.y.z), where (i) x denotes the area, (ii) y the topic and (iii) z the indicator.

NOTE 1 – In this Recommendation the *e-service* concept (e.g., e-health and e-governance, etc.) is used in an inclusive way and refers to both wired and wireless services that benefit the cities and city inhabitants. The mobile wireless services could also be referred to as *m-services* (e.g., m-health and m-banking etc.). These ICT services and goods are also collectively known as s*mart services* (e.g., smart grid and smart lighting etc.) and s*mart goods* (e.g., smart meters). In some cases the smart service/goods concept is used instead of *e-service*, if this terminology is more widely adopted for the referred service or goods.

NOTE 2 – In this Recommendation, the term *city inhabitant* is used to refer to the people living in the city.

NOTE 3 – To align with the principles behind the SDGs it is encouraged that indicators are disaggregated where relevant, by income, sex, age, race, ethnicity, migratory status, disability and geographic location, or other characteristics.

NOTE 4 – It is good to combine the use of KPIs with other assessment methods (such as perceptions, surveys) to understand the satisfaction level of city stakeholders.

NOTE 5 – In this Recommendation the term GDP it is considered as "GDP with purchasing power parity (PPP) and constant prices".

NOTE 6 – This Recommendation identifies the KPIs related to ICT adoption and use in the context of SSC but does not provide any quantification method. Quantification methods will be provided separately.

## 8.1 Economy

This clause lists the core indicators defined for the economy area.

There are 13 indicators in this area covering Internet access, computer, research and development expenditure, patents, employment, labour productivity and water and electricity metering, reliability of electricity system, public transport network, road traffic and its information.

| Topic | Indicator name | Description | Unit of measure | Notes | Mapping to SDG goals and targets |
|---|---|---|---|---|---|
| T1.1 ICT infrastructure | C1.1.1 Internet access in households | Proportion of households with Internet access | % | NOTE 1 – This should align with ITU-T reporting requirements. [b-ITU-D IDI]<br>NOTE 2 – For any household member via a fixed or mobile network at any given time.<br>NOTE 3 – The data may be collected from local statistics department, or may need to be extrapolated from national data.<br>NOTE 4 – Annual surveys of households may be another method for data collection to obtain the proportion of households with Internet access. This proportion will then be applied to the in-scope population.<br>NOTE 5 – SDG indicator 17.8.1 is "Proportion of individuals using the Internet". [b-UN SDG] | 9.c<br>17.8 |
| T1.1 ICT infrastructure | C1.1.2 Household with a computer | Proportion of households with at least one computer | % | NOTE 1 – This should align with ITU-T reporting requirements. [b-ITU-D IDI]<br>NOTE 2 – Computer refers to a desktop computer, laptop (portable) computer, tablet, similar handheld computer, etc.<br>NOTE 3 – The data may be collected from local statistics department, or may need to be extrapolated from national data | 9.c |
| T1.2 Innovation | C1.2.1 Research and development expenditure | Research and development expenditure as a proportion of city GDP | % | NOTE 1 – Research and development is defined to include activities that systematically use research findings and expand the frontier of knowledge.<br>[b-UNECE R and D]<br>NOTE 2 – Data collection methodology for this indicator could be adapted from the Frascati manual (an internationally recognised methodology for collecting research and development stats).<br>[b-Frascati] | 9.5 |

| Topic | Indicator name | Description | Unit of measure | Notes | Mapping to SDG goals and targets |
|---|---|---|---|---|---|
| | | | | NOTE 3 – SDG indicator 9.5.1 is "Research and development expenditure as a percentage of GDP". [b-UN SDG] | |
| T1.2 Innovation | C1.2.2 Patents | Number of new patents granted per 100 000 inhabitants per year | Number/ 100 000 inhabitants/ year | NOTE 1 – Calculate as:<br>Numerator: the total number of new patents issued to residents and organizations of the city.<br>Denominator: One 100 000th of the city's population. | 9.b |
| T1.3 Employment | C1.3.1 Employment rate | Employment rate | % | NOTE 1 – Employment rate as reported by local/ national official body.<br>NOTE 2 – SDG 8.5.2 is "Unemployment rate by sex, age group and people with disabilities". [b-UN SDG] | 8.5 |
| T1.5 productivity | C1.5.1 Labour productivity | Annual growth rate of real GDP per employed person | % | NOTE 1 – Same as SDG 8.2.1. [b-UN SDG] | 8.2<br>2.3 |
| T1.6 Physical infrastructure – Water Supply | C1.6.1 Availability of smart water meters | Proportion of the water consumers (including households, companies, etc.) with smart water meters | % | NOTE 1 – Calculate as:<br>Numerator: Number of smart water meters.<br>Denominator: Total number of water meters. | 9.1 |
| T1.6 Physical infrastructure – Electricity | C1.6.2 Availability of smart electricity meters | Proportion of the electricity consumers (including households, companies, etc.) with smart electricity meters. | % | NOTE 1 – Calculate as:<br>Numerator: Number of smart electricity meters.<br>Denominator: Total number of electricity meters. | 9.1 |
| T 1. 6 Physical infrastructure – Electricity | C 1.6.3 Electricity system outage frequency | Average number of electrical interruptions per customer per year | Number | NOTE 1 – This is also known as SAIFI – System Average Interruption Frequency Index ( dimensionless number )<br>NOTE 2 – Calculate as:<br>Numerator: Total number of customer interruptions. | 7.b |

| Topic | Indicator name | Description | Unit of measure | Notes | Mapping to SDG goals and targets |
|---|---|---|---|---|---|
| | | | | Denominator: Total number of customers served. | |
| T1.6 Physical infrastructure – Electricity | C 1.6.4<br>Electricity system outrage time | Average length of electrical interruptions | Minutes | NOTE 1 – This is also known as CAIDI – Customer Average Interruption Duration Index (in minutes)<br>NOTE 2 – Calculate as :<br>Numerator: Sum of all customer interruption durations<br>Denominator: Total number of customers' interruptions. | 7.b |
| T1.6 Physical infrastructure – Transport | C1.6.5<br>Public transport network | Length of public transport systems per 100 000 inhabitants | km/ 100 000 inhabitants | NOTE 1 – Public transport should include both high capacity (e.g., heavy rail, metro, subway systems and commuter rail systems) and light capacity (e.g., light rail streetcars and trams, buses, trolleybuses).<br>NOTE 2 – Calculate as:<br>Numerator: km (one way length).<br>Denominator: One 100 000th of the city's population.<br>Express as km / 100 000 inhabitants.<br>NOTE 3 – One way length is defined as a transit line that is 10 km long (back and forth) is counted as 10km (one way length) vs 20 km (two way length). | 11.2 |
| T1.6 Physical infrastructure – Transport | C1.6.6<br>Road traffic efficiency | Travel time index | Ratio | NOTE 1 – Travel time index (TTI) is a measure of congestion that focuses on each trip and each distance of travel and relates to traffic efficiency.<br>NOTE 2 – Ratio of the travel time during the peak period to the time required to make the same trip at free-flow speeds.<br>NOTE 3 – Calculate as:<br>Numerator: Travel time in the peak period.<br>Denominator: Travel time in free-flow.<br>Expressed as a ratio. | 11.2 |

| Topic | Indicator name | Description | Unit of measure | Notes | Mapping to SDG goals and targets |
|---|---|---|---|---|---|
| T1.6 Physical infrastructure – Transport | C1.6.7<br>Real-time public transport information | Proportion of public transport stops and stations with real-time traffic information available | % | NOTE 1 – Calculate as:<br>Numerator: Number of stops and stations with real time information.<br>Denominator: Total number of stops and stations.<br>NOTE 2 – Via electronic bus bulletin boards, smartphone apps, etc. | 11.2 |

## 8.2 Environment

This clause lists the core indicators defined for the environment area.

There are 19 indicators in this area covering air quality, $CO_2$ emissions, water resource, waste water collection and treatment, sanitation, solid waste collection and treatment, city green areas, noise monitoring, native species monitoring, EMF and renewable energy, etc.

| Topic | Indicator name | Description | Unit of measure | Notes | Mapping to SDG goals and targets |
|---|---|---|---|---|---|
| T2.1 Air quality | C2.1.1<br>Air pollution | Air quality index (AQI) based on :<br>Particulate matter (PM10, and PM2.5),<br>$NO_2$ (nitrogen dioxide),<br>$SO_2$ (sulphur dioxide),<br>$O_3$ (ozone) and<br>CO (carbon monoxide) | Number | NOTE 1 – This indicator should be measured as annual mean levels of AQI.<br>NOTE 2 – Average concentrations can demonstrate long term exposure (chronic) while days exceeding demonstrates short term (acute) exposure each of which have different impacts on the population.<br>Concentration can be expressed as: PM 2.5 (µg/m3), PM 10 (µg/m3), $NO_2$ (nitrogen dioxide) (µg/m3), $SO_2$ (sulphur dioxide) (µg/m3), $O_3$ (ozone) (µg/m3), and CO (carbon monoxide) (µg/m3).<br>NOTE 3 – SDG indicator 11.6.2 is "Annual mean levels of fine particulate matter (e.g., PM2.5 and PM10) in cities (population weighted)" [b-UN SDG] | 11.6<br>12.4 |
| T2.1 Air quality | C2.1.2<br>GHG emissions | Greenhouse gas emissions per capita | Tonne CO2e / capita | NOTE 1 – Methodologies for determining GHG emissions include but are not limited to:<br>The global protocol for community-scale greenhouse gas emission inventories (GPC).<br>BSI Norm: PAS 2070 on Specification for the assessment of greenhouse gas emissions of a city. | 7.a<br>11.6 |

| Topic | Indicator name | Description | Unit of measure | Notes | Mapping to SDG goals and targets |
|---|---|---|---|---|---|
| | | | | Intergovernmental Panel on Climate Change (IPCC) Guidelines for national greenhouse gas inventories.<br>Global protocol for community-scale GHG emissions'<br>(GPC), (2012 Accounting and Reporting Standard).<br>NOTE 2 – This indicator can be either in total or partially subdivided into major city sectors (transportation, industry, commercial buildings, residential buildings, etc.)<br>NOTE 3 – In $CO_2e$, "e" means "equivalent" and every other greenhouse gas is converted into $CO_2$. | |
| T2.2 Water and sanitation | C2.2.1<br>Quality of drinking water | Index of compliance with standards relating to water quality parameters for drinking water | % | NOTE 1 – For this indicator to be implemented there will be a need to define what is considered to be an acceptable standard for water quality and a definition as to the minimum sampling required.<br>Preferable reference: World Health Organisation (WHO) Guidelines for drinking-water quality. [b-WHO water]<br>As an alternative a national reference can be used.<br>NOTE 2 – SDG indicator 6.3.2 is "Proportion of bodies of water with good ambient water quality".<br>NOTE 3 – SDG indicator 6.4.2* is "Level of water stress: freshwater withdrawal as a proportion of available freshwater resources [b-UN SDG ] | 6.3<br>6.4 |
| T2.2 Water and sanitation | C2.2.2<br>Access to improved water source | Proportion of city population with sustainable access to improved water sources | % | NOTE 1 – Calculate as:<br>Numerator: Number of city inhabitants with improved water sources.<br>Denominator: Total city population.<br>NOTE 2 – Improved water sources include: piped water, public tap, borehole or pump, protected well, protected spring or rainwater.<br>http://www.unwater.org/downloads/TFIMR_Annex_FinalReport.pdf<br>NOTE 3 – SDG indicator 6.1.1 is "Proportion of population using safely managed drinking water services". [b-UN SDG] | 6.1<br>1.4 |
| T2.2 Water and sanitation | C2.2.3<br>Water consumption | Water consumption per capita | l / day / capita | NOTE 1 – Calculate as:<br>Numerator: Total amount of water consumption (l /day)<br>Denominator: Total number of city inhabitants.<br>Express as: l / day / capita. | 6.1<br>1.4<br>6.4 |

| Topic | Indicator name | Description | Unit of measure | Notes | Mapping to SDG goals and targets |
|---|---|---|---|---|---|
| | | | | http://www.unwater.org/downloads/TFIMR_Annex_FinalReport.pdf<br>NOTE 2 – SDG indicator 6.1.1 is "Proportion of population using safely managed drinking water services". [b-UN SDG] | |
| T2.2 Water and sanitation | C2.2.4<br>Wastewater treated | Proportion of wastewater receiving treatment | % | NOTE 1 – Calculate as:<br>Numerator: Total amount of wastewater that has undergone (primary /secondary / tertiary) treatment.<br>Denominator: Total amount of wastewater produced in the city and collected.<br>NOTE 2 – Calculation of this indicator should be made on each level of treatment separately.<br>http://www.un.org/esa/sustdev/natlinfo/indicators/methodology_sheets/freshwater/waste_water_treatment.pdf<br>Primary: physical separation of suspended solids using primary clarifiers.<br>Secondary: After primary treatment to remove or reduce contaminants or growths with a focus on biological oxygen demand (BOD)<br>Tertiary: After secondary treatment for further reductions in BOD levels and other oxygen-demanding substances in the wastewater, remove nitrogen and phosphorus and including other separation techniques such as carbon adsorption, flocculation/precipitation, membranes for advanced filtration, ion exchange, chlorination, dechlorination , reverse osmosis, etc.<br>NOTE 4 – SDG indicator 12.4.2* is "Hazardous waste generated per capita and proportion of hazardous waste treated, by type of treatment". [b-UN SDG] | 6.3<br>12.4 |
| T2.2 Water and sanitation | C2.2.5<br>Wastewater collection | Proportion of households served by wastewater collection | % | NOTE 1 – Calculate as :<br>Numerator: Number of households served by wastewater collection.<br>Denominator: Total number of households. | 6.3<br>1.4 |
| T2.2 Water and sanitation | C2.2.6<br>Household sanitation | Proportion of the households with access to improved sanitation facilities | % | NOTE 1 – Calculate as :<br>Numerator: Total number of households using improved sanitation and facilities. | 6.2<br>1.4 |

| Topic | Indicator name | Description | Unit of measure | Notes | Mapping to SDG goals and targets |
|---|---|---|---|---|---|
| | | | | Denominator: Total number of households.<br>NOTE 2 – Improved facilities include:<br>• Flush or pour-flush to piped sewer system, septic tank or pit latrine,<br>• Ventilated improved pit latrine,<br>• Pit latrine with slab,<br>• Composting toilet.<br>http://www.unwater.org/downloads/TFIMR_Annex_FinalReport.pdf<br>NOTE 3 – SDG indicator 6.2.1 is "Proportion of population using safely managed sanitation services, including a hand-washing facility with soap and water". [b-UN SDG] | |
| T2.3 Noise | C2.3.1<br>Exposure to noise | Proportion of the city inhabitants exposed to noise levels above international/national exposure limits | % | NOTE 1 – Relevant standards include but are not limited to:<br>[b-ISO 1996-2]<br>[b-ISO/TS 15666] | |
| T2.4 Environmental quality | C2.4.1<br>Compliance with WHO endorsed exposure guidelines | Application of WHO endorsed exposure guidelines for ICT installations in the city | YES/NO | NOTE 1 – WHO endorsed exposure guidelines are referred to in [ITU-T K-Sup.4].<br>NOTE 2 – ICT devices are regulated nationally and are not included. | |
| T2.4 Environmental quality | C2.4.2<br>Adoption of a consistent planning approval process with respect to EMF | Application of a consistent planning approval process with respect to EMF to enable efficient deployment of ICT systems | YES/NO | NOTE 1 – A consistent planning approval process between cities is preferred to individual city requirements to ensure efficient deployment [ITU-T K-Sup.4]. | |

| Topic | Indicator name | Description | Unit of measure | Notes | Mapping to SDG goals and targets |
|---|---|---|---|---|---|
| T2.4 Environmental quality | C2.4.3 Availability of EMF information | Availability of information for the public and other stakeholders and referencing WHO and ITU resources regarding compliance, health and installation issues | YES/NO | NOTE 1 – EMF-related information is referred to in [ITU-T K-Sup.4]. | |
| T2.4 Environmental quality | C2.4.4 Solid waste collection | Proportion of households with regular solid waste collection | % | NOTE 1 – Calculate as:<br>Numerator: Number of households that are served by solid waste collection.<br>Denominator: Total number of households.<br>NOTE 2 – SDG indicator 11.6.1 is "Proportion of urban solid waste regularly collected and with adequate final discharge with regard to the total waste generated, by cities". [b-UN SDG]<br>NOTE 3 – SDG indicator 12.4.2* is "Hazardous waste generated per capita and proportion of hazardous waste treated, by type of treatment".<br>[b-UN SDG] | 11.6<br>12.4<br>1.4 |
| T2.4 Environmental quality | C2.4.5 Solid waste treatment | Proportion of solid waste: a) disposed to sanitary landfills; b) burnt in an open area; c) incinerated; d) disposed to an open dump; e) recycled; f) other with regard to total amount of solid waste produced | % | NOTE 1 – Each treatment should be reported separately.<br>NOTE 2 – Calculate as:<br>Numerator: Total amount of solid waste that is (disposed to landfills / incinerated/ burnt in an open area / disposed in an open dump / recycled / other) (tonnes).<br>Denominator: Total amount of solid waste produced (tonnes).<br>NOTE 3 – SDG indicator 11.6.1 is "Proportion of urban solid waste regularly collected and with adequate final discharge with regard to the total waste generated by cities". [b-UN SDG]<br>NOTE 4 – SDG indicator 12.4.2* is "Hazardous waste generated per capita and proportion of hazardous waste treated, by type of treatment".<br>[b-UN SDG] | 11.6<br>12.4<br>1.4 |

| Topic | Indicator name | Description | Unit of measure | Notes | Mapping to SDG goals and targets |
|---|---|---|---|---|---|
| T2.4 Environmental quality | C2.4.6 Green areas and public spaces | Publically accessible green areas and public spaces per 100 000 inhabitants. | $m^2$ / 100 000 inhabitants | NOTE 1 – Green space includes parks and nature areas that are publically accessible.<br>NOTE 2 – Calculate as:<br>Numerator: Total area of green space in the city.<br>Denominator: One 100,000th of the city's population.<br>Express as: $m^2$ / 100 000 inhabitants.<br>NOTE 3 – SDG indicator 11.7.1 is "The average share of the built-up area of cities that is open space for public use for all, disaggregated by age group, sex and persons with disabilities". [b-UN SDG] | 11.7 |
| T2.5 Biodiversity | C2.5.1 Native species monitoring | Change of number of native species | Number | NOTE 1 – Taxonomic groups include:<br>Plants, birds and butterflies, mammals, insects, etc.<br>NOTE 2 – Methodology is described in the User's Manual for the City Biodiversity index.[b-CBD manual]<br>Expressed as number of native species increased:<br>0: maintaining or a decrease in the number of species,<br>1: 1 species increase,<br>2: 2 species increase,<br>3: 3 species increase,<br>4: 4 species or more increase.<br>NOTE 3 – Possible sources of data include government agencies in charge of biodiversity, city municipalities, urban planning agencies, biodiversity centres, nature groups, universities, publications, etc.<br>NOTE 4 – SDG indicator 15.5.1 is "Red list index". [b-UN SDG] | 2.5<br>15.5 |
| T2.6 Energy | C2.6.1 Access to Electricity | Proportion of households with access to electricity | % | NOTE 1 – Calculate as:<br>Numerator: Number of households in the city with a connection to the electrical system.<br>Denominator: Total number of households.<br>NOTE 2 – SDG indicator 7.1.1 is "Proportion of population with access to electricity". [b-UN SDG] | 7.1<br>1.4 |

| Topic | Indicator name | Description | Unit of measure | Notes | Mapping to SDG goals and targets |
|---|---|---|---|---|---|
| T2.6 Energy | C2.6.2<br>Renewable energy consumption | Proportion of renewable energy consumed in the city. | % | NOTE 1 – Calculate as :<br>Numerator: Total consumption of electricity from renewable sources.<br>Denominator: Total electricity consumption.<br>NOTE 2 – Renewable sources include geothermal, solar, wind, hydro, tide, wave energy, and biomass, etc.<br>NOTE 3 – SDG indicator 7.2.1 is "Renewable energy share in the total final energy consumption". [b-UN SDG] | 7.2 |
| T2.6 Energy | C2.6.3<br>Electricity consumption | Electricity consumption per capita | kWh / day / capita | NOTE 1 – Calculate as:<br>Numerator: Total consumption of electricity.<br>Denominator: Number of city inhabitants.<br>Express as kWh / day / capita. | |

## 8.3 Society and culture

This clause lists the core indicators defined for the society and culture area.

There are 20 indicators in this area, covering: student ICT capability, adult literacy, school enrolment, higher education, health records, sharing of medical resources, life expectancy, maternal mortality, doctors, city resilience plans, emergency response, information security, housing expenditure, informal settlements, connected libraries, cultural infrastructure, cultural resources online, public participation, gender income equity and opportunities for people with special needs.

| Topic | Indicator name | Description | Unit of measure | Notes | Mapping to SDG goals and targets |
|---|---|---|---|---|---|
| T3.1 Education | C3.1.1<br>Students ICT access | Proportion of students/pupils with classroom access to ICT facilities | % | NOTE 1 – ICT facilities can be measured with Internet connectivity, computer labs, ICT modules, digital learning etc.<br>NOTE 2 – Calculate as:<br>Numerator: Students/pupils with classroom access to ICT facilities.<br>Denominator: Total students/pupils enrolled in schools.<br>NOTE 3 – Students/pupils refer to school – aged population enrolled in primary and secondary schools. | 4.4 |

| Topic | Indicator name | Description | Unit of measure | Notes | Mapping to SDG goals and targets |
|---|---|---|---|---|---|
| | | | | NOTE 4 – Cities are encouraged to collect data both from public and private schools.<br>NOTE 5 – SDG indicator 4.4.1 is "Proportion of youth and adults with information and communication technology (ICT) skills, by type of skill". [b-UN SDG] | |
| T3.1 Education | C3.1.2 Adult literacy | Adult literacy rate | % | NOTE 1 – Adult literacy rate is defined as "the percentage of population aged 15 years and over who can both read and write with understanding a short simple statement on his/her everyday life. Generally, 'literacy' also encompasses 'numeracy', the ability to make simple arithmetic calculations " [b-ITU-D IDI]<br>NOTE 2 –The data may be collected from local statistics department, or may need to be extrapolated from national data.<br>Express as a percentage.<br>NOTE 3 – SDG indicator 4.6.1 is "Percentage of population in a given group achieving at least a fixed level of proficiency in functional (a) literacy and (b) numeracy skills, by sex. [b-UN SDG] | 4.6 |
| T3.1 Education | C 3.1.3 School enrolment | Proportion of school-aged population enrolled in schools | % | NOTE 1 – Calculate as:<br>Numerator: Number of students/pupils in primary and secondary levels in public and private schools.<br>Denominator: Total number of the school-aged population. | 4.1 |
| T3.1 Education | C3.1.4 Higher education ratio | Proportion of city inhabitants with tertiary education degrees | % | NOTE 1 – Tertiary education broadly refers to all post-secondary education, including but not limited to universities. Universities are clearly a key part of all tertiary systems, but the diverse and growing set of public and private tertiary institutions in every country—colleges, technical training institutes, community colleges, nursing schools, research laboratories, centres of excellence, distance learning centres, and many more—forms a network of institutions that support the production of the higher-order capacity necessary for development.<br>http://www.worldbank.org/en/topic/tertiaryeducation#what_why<br>NOTE 2 – Calculate as:<br>Numerator: Number of city inhabitants holding at least one tertiary education degree.<br>Denominator: Total adult population. | 4.3 |

| Topic | Indicator name | Description | Unit of measure | Notes | Mapping to SDG goals and targets |
|---|---|---|---|---|---|
| T3.2 Health | C3.2.1<br>Electronic health records | Proportion of city inhabitants with electronic health records | % | NOTE 1 – A health record contains information on weight, height, heart rate, BMI, etc. | 3.8 |
| T3.2 Health | C3.2.2<br>Sharing of medical resources | Proportion of hospitals, pharmacies and health care providers using ICT means for sharing of medical resources such as hospital beds, and medical information, especially electronic health records | % | NOTE 1 – Methodologies for sharing medical information include but are not limited to:<br>ITU-T H.860;<br>ISO/HL 7 10781;<br>ISO 13606 series;<br>ISO 13119;<br>ISO/TR 14292;<br>ISO/TR 20514;<br>ISO/TS 29585:2010.<br>NOTE 2 – The data may be collected from local statistics department, or may need to be extrapolated from national data.<br>NOTE 3 – Cities are encouraged to collect data both from public and private medical institutions. | 3.8 |
| T3.2 Health | C3.2.3<br>Life expectancy | Average life expectancy indicates the number of years a new-born infant would live. | Years | NOTE 1 – The data may be collected from local statistics department, or may need to be extrapolated from regional or national data.<br>NOTE 2 – It is also a possibility to extract this data from WHO tables.<br>http://www.who.int/healthinfo/statistics/LT_method.pdf?ua=1&ua=1 | |
| T3.2 Health | C3.2.4<br>Maternal mortality | Maternal deaths per 100 000 live births | Rate | NOTE 1 – Same as SDG indicator 3.1.1. [b-UN SDG] | 3.1 |
| T3.2 Health | C3.2.5<br>Doctors | Number of doctors per 100 000 inhabitants | Number / 100 000 inhabitants | NOTE 1 – Calculated as:<br>Numerator: General or specialized doctors working in the city.<br>Denominator: One 100 000th of the city's population.<br>Expressed as the number of doctors per 100,000 inhabitants.<br>NOTE 2 – SDG indicator 3.c.1 is "Health worker density and distribution". [b-UN SDG] | 3.c |

| Topic | Indicator name | Description | Unit of measure | Notes | Mapping to SDG goals and targets |
|---|---|---|---|---|---|
| T3.3 Safety – Disaster relief | C3.3.1<br>Resilience plans | Presence of vulnerability assessment, financial (capital and operating) plans and technical systems for disaster mitigation | checklist | NOTE 1 – Checklist: a) city infrastructures available for resilience; b) vulnerability assessment; c) financial (capital and operation) plans to mitigate vulnerabilities; d) technical systems to implement the plans.<br>NOTE 2 – This indicator shall be determined by the sum of YES answers reported.<br>NOTE 3 – Vulnerability to heat, drought, flooding, earthquakes, typhoon, tsunami and other natural hazards are investigated, and adoption of disaster management.<br>NOTE 4 – Data of vulnerability assessment can be derived from historical data (expert interviews) and global maps regarding heat, drought, flooding, earthquakes, typhoon, tsunami, etc.<br>NOTE 5 – reference: the United Nations Office for Disaster Risk Reduction http://www.unisdr.org/<br>NOTE 6 – SDG indicator 11.b.1 is "Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk<br>Reduction 2015-2030*a*". [b-UN SDG] | 11 b<br>13.1<br>13.2<br>13.3 |
| T3.3 Safety – Emergency | C3.3.2<br>Emergency Service Response Time | Average response time for emergency services | Minutes | NOTE 1 – Emergency services include police, fire control and others.<br>NOTE 2 – Expressed as the average number of minutes and seconds taken to respond to emergency calls from initial call to arrival on-site. | |
| T3.3 Safety – ICT | C3.3.3<br>Information security and privacy protection | Existence of systems, rules and regulations to ensure information security and privacy protection in public service | Checklist | NOTE 1 – The verification contains examination in four aspects, including a) legislation; b) regulations enforced in public service and facilities; c) regulations properly enforced for web services; and d) the coverage rate of qualified systems.<br>NOTE 2 – This indicator is determined by the sum of YES answers reported. | |
| T3.4 Housing | C3.4.1<br>Housing expenditure | Proportion expenditure of income for housing | % | NOTE 2 – Housing expenditure includes rent, mortgage, utility services, maintenance, energy efficiency repairs, and other repairs.<br>NOTE 1 – Calculate as:<br>Numerator: Housing expenditures.<br>Denominator: Total household income. | 11.1 |

| Topic | Indicator name | Description | Unit of measure | Notes | Mapping to SDG goals and targets |
|---|---|---|---|---|---|
| T3.4 Housing | C3.4.2<br>Informal settlements | Proportion of urban population living in slums, informal settlements or inadequate housing | % | NOTE 1 – Same as SDG indicator 11.1.1. [b-UN SDG]<br>NOTE 2 – Informal settlements include slums, informal settlements and inadequate housing as defined by UN-Habitat [b-UN-habitat sett.] | 11.1 |
| T3.5 Culture | C3.5.1<br>Connected libraries | Number of connected libraries per 100 000 population | Number / 100 000 inhabitants | NOTE 1 – Connected libraries are libraries which offer access to Internet and electronic media and represent an information hub. | 9.c<br>4.4 |
| T3.5 Culture | C3.5.2<br>Cultural infrastructure | Number of the cultural institutions per 100 000 inhabitants | Number / 100 000 inhabitants | NOTE 1 – "Cultural institution" means a public or non-profit institution within this state which engages in the cultural, intellectual, scientific, environmental, educational or artistic enrichment of the people of this state. "Cultural institution" includes, without limitation, aquaria, botanical societies, historical societies, land conservation organizations, libraries, museums, performing arts associations or societies, scientific societies, wildlife conservation organizations and zoological societies. "Cultural institution" does not mean any school or any institution primarily engaged in religious or sectarian activities.<br>http://www.oregonlaws.org/glossary/definition/cultural_institution | 8.9<br>11.4 |
| T3.5 Culture | C3.5.3 Cultural resources online | Proportion of cultural institutions and events for which online participation is offered. | % | NOTE 1 – Cultural resources online include: events and activities provided online, and watched or listened through electric/virtual media.<br>NOTE 2 – Calculated as:<br>Numerator: Number of cultural institutions and events for which online participation is offered.<br>Denominator: Total number of cultural institutions and events. | 11.4 |
| T3.6 Social inclusion | C3.6.1<br>Public participation | Promotion of inhabitants' participation in public affairs | Checklist | NOTE 1 – Checklist: a) existence of rules and regulations to promote the participation of inhabitants in public affairs; b) existence of systems to promote inhabitants' engagement, such as online information and ICT based feedback mechanism; c) existence of formal participatory process prior to policy making, major public projects etc.; d) existence of public decision-making to ensure gender and aging equity.<br>NOTE 2 – The value of this indicator is determined by the sum of YES answers relatively to the above checklist. | 16.7 |

| Topic | Indicator name | Description | Unit of measure | Notes | Mapping to SDG goals and targets |
|---|---|---|---|---|---|
| T3.6 Social inclusion | C3.6.2<br>Gender income equity | Ratio of average hourly earnings of female and male employees, by occupation, age group and persons with disabilities | Ratio | NOTE 1 – Calculated as :<br>Numerator: Average hourly earnings of female employees.<br>Denominator: Average hourly earnings of male employees.<br>NOTE 2 – SDG indicator 8.5.1 is "Average hourly earnings of female and male employees, by occupation, age group and persons with disabilities". [b-UN SDG] | 8.5<br>10.4<br>5.1 |
| T3.6 Social inclusion | C3.6.3<br>Opportunities for people with special needs | Existence of public services and benefits for people with special needs. | Checklist | NOTE 1 – Public services and benefits checklist:<br>a) Public buildings: infrastructure available; b) Education: higher education possible; c) Jobs: availability; d) ICT: availability of customized services and information.<br>NOTE 2 – People with special needs here indicate indigenous people, and persons with disabilities including age related disabilities.<br>NOTE 3 – SDG indicator 11.2.1 is "Proportion of the population that has convenient access to public transport, disaggregated by age group, sex and persons with disabilities". [b-UN SDG] | 11.2<br>11.7<br>1.3<br>4.5<br>4.a<br>8.5<br>10.2 |

# Appendix I

# Additional indicators

(This appendix does not form an integral part of this Recommendation.)

This appendix lists additional indicators that cities can select due to their economic power, population growth, geographic condition, etc. Also, some additional indicators are very "smart" and can be addressed by "smarter" cities. Therefore these indicators are optional, especially for self-benchmarking. Each additional indicator is labelled A (x.y.z), where (i) x denotes the area, (ii) y the topic and (iii) z the indicator.

## I.1 Economy

There are 21 additional indicators in this area, covering: electronic wireless and fixed broadband, mobile device, SMEs, creative industry, tourist industry, e-commence, electronic payment, knowledge economy, companies providing online services, water leakages, water supply monitoring, electricity supply monitoring, sporting facilities, EVs, traffic monitoring, public buildings sustainability, urban planning, open data and e-Public service.

| Topic | Indicator name | Description | Unit of measure | Notes | Mapping to SDG goals and targets |
|---|---|---|---|---|---|
| T1.1 ICT infrastructure | A1.1.1<br>Wireless broadband subscriptions | Wireless-broadband subscriptions per 100 inhabitants | Number / 100 inhabitants | NOTE 1 – Wireless broadband subscriptions include wireless broadband through satellite broadband, terrestrial fixed wireless broadband and mobile cellular network subscriptions.<br>NOTE 2 – The data may be collected from local statistics department, or may need to be extrapolated from national data.<br>NOTE 3 – SDG indicator 9.c.1 is "Proportion of population covered by a mobile network, by technology". [b-UN SDG]<br>NOTE 4 – SDG indicator 5.b.1 is "Proportion of individuals who own a mobile telephone, by sex". [b-UN SDG] | 9.c<br>5.b |

| Topic | Indicator name | Description | Unit of measure | Notes | Mapping to SDG goals and targets |
|---|---|---|---|---|---|
| T1.1 ICT infrastructure | A1.1.2<br>Fixed broadband subscriptions | Households with fixed (wired) broadband | % | NOTE 1 – Fixed (wired) broadband subscriptions refer to subscriptions for high-speed access to the public Internet (a TCP/IP connection). High-speed access is defined as downstream speed equal to, or greater than, 256 kbits/s.<br>NOTE 2 – Fixed (wired) broadband includes broadband through cable modem, DSL, fibre and other fixed (wired) broadband technologies (such as Ethernet LAN, and broadband-over-power line (BPL) communications).<br>NOTE 3 – Calculated as:<br>Numerator: Households with fixed (wired) broadband.<br>Denominator: Total households.<br>NOTE 4 – Mobile cellular network subscriptions are not included.<br>NOTE 5 – The data may be collected from local statistics department, or may need to be extrapolated from national data. | 9.c |
| T1.1 ICT infrastructure | A1.1.3<br>Household with a mobile device | Proportion of households with at least one smartphone or similar device | % | NOTE 1 – This should align with ITU-T reporting requirements. [b-ITU-D IDI]<br>NOTE 2 – The data may be collected from local statistics department, or may need to be extrapolated from national data.<br>NOTE 3 – Mobile device refers to a smartphone, and similar device, etc. | 9.c |
| T1.2 Innovation | A1.2.1<br>SMEs | Proportion of small and medium-sized enterprises (SMEs) | % | NOTE 1 – Calculate as :<br>Numerator: Number of SMEs.<br>Denominator: Total number of enterprises.<br>NOTE 2 – SDG indicator 9.3.1 is "Proportion of small-scale industries in total industry value added". [b-UN SDG] | 9.3<br>8.3 |

| Topic | Indicator name | Description | Unit of measure | Notes | Mapping to SDG goals and targets |
|---|---|---|---|---|---|
| T1.3 Employment | A1.3.1 Creative industry employment | Proportion of employees working in the creative industry | % | NOTE 1 – Creative industries refer to those ones that are based on individual creativity, skill and talent with the potential to create wealth and jobs through developing intellectual property.<br>This includes thirteen sectors: advertising, architecture, the art and antiques market, crafts, design, designer fashion, film, interactive leisure software (i.e., video games), music, the performing arts, publishing, software and television and radio.<br>http://s3platform.jrc.ec.europa.eu/documents/20182/84453/120420_CCI_Policy_Handbook_(FINAL).pdf<br>NOTE 2 – Expressed as a percentage. | |
| T1.3 Employment | A1.3.2 Tourism industry employment | Proportion of employees working in the tourism industry | % | NOTE 1 – SDG indicator 8.9.1is "Tourism direct GDP as a proportion of total GDP and in growth rate" [b-UN SDG] | 8.9 |
| T1.4 Trade – e-Commerce | A1.4.1 e-commerce purchase ratio | Proportion of population using e-commerce for purchase per year. | % | NOTE 1 – E-commerce can be defined generally as the sale or purchase of goods or services, whether between businesses, households, individuals or private organizations, through electronic transactions conducted via the internet or other computer-mediated (online communication) networks. | |
| T1.4 Trade – e-Commerce | A1.4.2 Electronic and mobile payment | Electronic payments system usage per 100 city inhabitants. | Number / 100 inhabitants | | |
| T1.4 Trade – Export/import | A1.4.3 Knowledge-intensive export/import | Proportion of exports/imports of knowledge-intensive goods and services. | % | NOTE 1 – Knowledge-intensive goods and services refers to OECD reports [b-OECD KE] | |

| Topic | Indicator name | Description | Unit of measure | Notes | Mapping to SDG goals and targets |
|---|---|---|---|---|---|
| T1.5 Productivity | A1.5.1 Companies providing online services | Proportion of registered companies providing online services | % | NOTE 1 – online services include e-commerce, e-learning, e-entertainment, cloud computing, etc.<br>NOTE 2 – Calculate as:<br>Numerator: Number of registered companies providing online serviced (including e-commerce, e-learning, e-entertainment, cloud computing, etc.).<br>Denominator: Total registered companies within the city. | |
| T1.6 Physical infrastructure – Water Supply | A1.6.1 Water Supply loss | Proportion of water leak in the water distribution system. | % | NOTE 1 – Calculate as:<br>Numerator: Volume of water supplied minus the volume of utilized water.<br>Denominator: Total volume of water supplied. | 9.1<br>9.4 |
| T1.6 Physical infrastructure – Water Supply | A 1.6.2 Water Supply ICT Monitoring | Proportion of the water distribution system monitored by ICT | % | NOTE 1 – Calculate as:<br>Numerator: length of water distribution system monitored by ICT.<br>Denominator: length of water distribution system. | |
| T1.6 Physical infrastructure – Electricity Supply | A 1.6.3 Electricity supply system management using ICT | Proportion of power substation and user points under automatic inspection using ICT | % | NOTE 1 – Calculate as:<br>Numerator: Number of power substation and user points under automatic inspection using ICT.<br>Denominator: Total number of power substation and user points. | |
| T1.6 Physical infrastructure – Health infrastructure | A1.6.4 Sporting facilities | Area of total public sports facilities per 100 000 inhabitants | $m^2$ / 100 000 inhabitants | NOTE 1 – Calculate as:<br>Numerator: $m^2$ total public sports facilities (free and paid).<br>Denominator: One 100,000th of the city's population. | |
| T1.6 Physical infrastructure – Transport | A1.6.5 Share of EVs | Proportion of EVs (BEV, PHEV, REEV/REX, FCEV) in public fleets | % | NOTE 1 – Calculate as:<br>Numerator: Number of EVs.<br>Denominator: Total number of vehicles. | |

| Topic | Indicator name | Description | Unit of measure | Notes | Mapping to SDG goals and targets |
|---|---|---|---|---|---|
| T1.6 Physical infrastructure – road infrastructure | A1.6.6<br>Traffic monitoring | Proportion of major streets monitored by ICT | % | NOTE 1 – Refer to major and arterial roads and highways.<br>NOTE 2 – Calculate as:<br>Numerator: Length of major streets monitored by ICT.<br>Denominator: Total major streets. | 9.1 |
| T1.6 Physical infrastructure – road infrastructure | A1.6.7<br>Pedestrian infrastructure | Portion of city with pedestrian, car free and traffic calming streets | km / km $^2$ | NOTE 1 – Calculate as:<br>Numerator: Total length of pedestrian, car free and traffic calming streets.<br>Denominator: Total city area. | |
| T1.6 Physical infrastructure – building | A1.6.8<br>Public building sustainability | Proportion of public buildings with sustainability certifications | % | NOTE 1 – Calculate as:<br>Numerator: Area of public buildings with certification to a recognized standard for ongoing building operations.<br>Denominator: Total area of public buildings.<br>NOTE 2 – Standards include but are not limited to: BREEAM, LEED, CASBEE, BOAM BEST, BCA Green Mark, etc. | 11.c |
| T1.6 Physical infrastructure – urban planning and public space | A1.6.9<br>Urban development and spatial planning | Existence of a strategic city planning documents promoting compact development, mixed urban land use; and avoiding urban sprawl | Yes/ No | NOTE 1 – SDG indicator 11.a.1* is "Proportion of population living in cities that implement urban and regional development plans integrating population projections and resource needs, by size of city". [b-UN SDG] | 11.3<br>11.a |
| T1.7 Public Sector | A1.7.1 Open data | Proportion of available open data of cities | % | NOTE 1 – Calculate as:<br>Numerator: Total number of open data sets published.<br>Denominator: Total number of open data sets that could be published following national rule. | |
| T1.7 Public Sector | A 1.7.2<br>e-Public Services adoption | Proportion adoption of electronic public services | % | NOTE 1 – Calculate as:<br>Numerator: Number of public service transactions conducted online.<br>Denominator: Total number of public service transactions (online and offline). | |

## I.2 Environment

There are 7 additional indicators in this area, covering air pollution monitoring, water saving, drainage system management, noise monitoring, protected natural area, energy saving, and public building energy consumption.

| Topic | Indicator name | Description | Unit of measure | Notes | Mapping to SDG goals and targets |
|---|---|---|---|---|---|
| T2.1 Air quality | A2.1.1<br>Air pollution monitoring system | Number of outdoor installations of ICT based air quality monitoring systems per $km^2$ | Number / $km^2$ | NOTE 1 – ICT based systems refer to air quality monitoring systems with sensors, which transmit measurements to a database where daily alerts and information are available and yearly summaries for each monitoring stations are computed.<br>NOTE 2 – Calculate as:<br>Numerator: Total number of outdoor installations of ICT based monitoring systems.<br>Denominator: Total city surface area. | 11.6<br>12.4 |
| T2.2 Water and Sanitation | A2.2.1<br>Water saving in households | Proportion of households with water saving installations | % | NOTE 1 – Calculate as:<br>Numerator: number of households with water saving installations.<br>Denominator: Total number of households.<br>NOTE 3 – SDG indicator 6.4.1* is "Change in water-use efficiency over time". [b-UN SDG] | 6.4 |
| T2.2 Water and sanitation | A2.2.2<br>Drainage system management | Proportion of drainage system ICT monitored | % | NOTE 1 – Water quantity observation stations are used as a reference for evaluating an index representing the density of the natural and artificial drainage system monitoring network. Each observation node is associated with a drainage area either for natural drainage (rivers, lakes) or for artificial systems (sewers, urban storm drains, etc.).<br>NOTE 2 – Calculate as:<br>Numerator: The sum of the total drainage areas that are covered by the monitoring nodes.<br>Denominator: The total drainage area of the river basin closed to the outlet (lake or ocean).<br>NOTE 4 – SDG indicator 6.5.1* is "Degree of integrated water resources management implementation (0-100)". [b-UN SDG] | 6.5<br>6.4 |

| Topic | Indicator name | Description | Unit of measure | Notes | Mapping to SDG goals and targets |
|---|---|---|---|---|---|
| T2.3 Noise | A2.3.1<br>ICT Noise monitoring | Number of outdoor installations with applied ICT based noise monitoring per $km^2$ | Number /$km^2$ | NOTE 1 – ICT based systems refer to noise monitoring systems with sensors, which transmit measurements to a database where daily alerts and information are available and yearly summaries for each monitoring station are computed.<br>NOTE 2 – Calculate as:<br>Numerator: Total number of outdoor installations of ICT based monitoring system.<br>Denominator: Total city surface area. | |
| T2.5 Biodiversity | A2.5.1<br>Protected natural area | Proportion of city area under environmental protection | % | NOTE 1 – Calculate as:<br>Numerator: Area of protected areas (hectares) reserved by law or other effective means.<br>Denominator: Total city area (hectares). | 11.4 |
| T2.6 Energy | A2.6.1<br>Energy saving in households | Proportion of households with energy saving installations | % | NOTE 1 – Calculate as:<br>Numerator: Number of households with energy saving installations.<br>Denominator: Total number of households. | 7.3 |
| T2.6 Energy | A2.6.2<br>Public buildings energy consumption | Annual energy consumption of public buildings | kWh / $m^2$ / year | NOTE 1 – Calculate as:<br>Numerator: Total electricity consumption by public buildings.<br>Denominator: Total floor space.<br>Calculate as kWh / $m^2$ / year. | |

## I.3 Society and culture

There are 10 additional indicators in this area, covering: e-learning, telemedicine, in-patient hospital beds, health insurance, disaster-related deaths and economic losses, disaster and emergency alert, child online protection (COP), cultural heritage, and Gini coefficient.

| Topic | Indicator name | Description | Unit of measure | Notes | Mapping to SDG goals and targets |
|---|---|---|---|---|---|
| T3.1 Education | A3.1.1 e-learning systems | Proportion of city inhabitants using e-learning systems . | % | NOTE 1 – SDG indicator 4.3.1 is "Participation rate of youth and adults in formal and non-formal education and training in the last 12 months". [b-UN SDG] | 4.3 |
| T3.2 Health | A3.2.1 Adoption of telemedicine | Proportion of patients involved in telemedicine programs | % | NOTE 1 – Telemedicine programs include services, such as e-consultation, e-monitoring, online health care advice and guidance etc. | 3.8 |
| T3.2 Health | A3.2.2 In-patient hospital beds | Number of in-patient public hospital beds per 100 000 inhabitants | Number / 100 000 Inhabitants | NOTE 1 – Calculate as: Numerator: Total number of in-patient hospital beds (public and private). Denominator: One 100,000th of the city's population. Express as hospital beds / 100 000 inhabitants. | |
| T3.2 Health | A3.2.3 Health insurance | Proportion of city inhabitants covered by health insurance | % | NOTE 1 – The data may be collected from local statistics department, or may need to be extrapolated from national data. | 3.8 |
| T3.3 Safety – Disaster relief | A3.3.1 Natural disaster-related deaths | Natural disaster related deaths per 100 000 inhabitants | Number / 100 000 Inhabitants | NOTE 1 – Calculated as: Numerator: Number of annual natural disaster related deaths. Denominator: One 100 000th of the city's population. Expressed as the number deaths per 100,000 inhabitants. NOTE 2 – SDG indicator 1.5.1 is "Number of deaths, missing persons and persons affected by disaster per 100,000 people ". [b-UN SDG] | 1.5 11.5 13.1 |

| Topic | Indicator name | Description | Unit of measure | Notes | Mapping to SDG goals and targets |
|---|---|---|---|---|---|
| T3.3 Safety – Disaster relief | A3.3.2<br>Disaster-related economic losses | Natural disaster related economic losses relative to gross domestic product | % | NOTE 1 – Calculate as:<br>Numerator: Economic losses (last annual reporting period) related to disasters.<br>Denominator: GDP of the city. | 11.5 |
| T3.3 Safety – emergency | A3.3.3 Disaster and emergency alert | Proportion of disasters and emergencies with timely alerts | % | NOTE 1 – Civil protection agencies are called to provide the list of events with the related alerting/risk level and also the quantifications of the misleading/worn alarms.<br>NOTE 2 – Calculate as:<br>Numerator: Number of disasters and emergencies with timely alerts.<br>Denominator: Number of disasters and emergencies. | 13.3<br>13.1<br>11.b |
| T3.3 Safety – ICT | A3.3.4<br>Child online protection (COP) | Existence of rules and regulations to ensure COP | Checklist | NOTE1 – The city could work against cyber bullying by ensuring safety in online public services (for the use of ICTs in schools, etc.).<br>NOTE 2 – The verification contains examination in four aspects, including i) COP legislation; ii) COP regulations enforced in public service and facilities; iii) COP regulations properly enforced for web services; and iv) the coverage rate of qualified COP systems.<br>NOTE 3 – This indicator is determined by the sum of the YES answers. | 1.3 |
| T3.5 Culture | A3.5.1<br>Protected cultural heritage sites | Proportion of city area related to protected cultural heritage sites | % | NOTE 1 – Calculate as:<br>Numerator: City area related to protected cultural heritage sites.<br>Denominator: Total city surface area. | 11.4 |
| T3.6 Social inclusion | A3.6.1<br>Gini coefficient | Income distribution in accordance with Gini coefficient | Number | | 10.4 |

# Appendix II

## Complete list of core and additional indicators

(This appendix does not form an integral part of this Recommendation.)

The following table lists the core indicators in clause 7 and additional ones in Appendix I.

| Topic | Reference | Indicator name | Core indicator | Additional indicator |
|---|---|---|---|---|
| T1.1 ICT infrastructure | C1.1.1 | Internet access in households | x | |
| T1.1 ICT infrastructure | C1.1.2 | household with a computer | x | |
| T1.1 ICT infrastructure | A1.1.1 | Wireless broadband subscriptions | | x |
| T1.1 ICT infrastructure | A1.1.2 | Fixed broadband subscriptions | | x |
| T1.1 ICT infrastructure | A1.1.3 | Household with a mobile device | | x |
| T1.2 Innovation | C1.2.1 | Research and development expenditure | x | |
| T1.2 Innovation | C1.2.2 | Patents | x | |
| T1.2 Innovation | A1.2.1 | SMEs | | x |
| T1.3 Employment | C1.3.1 | Employment Rate | x | |
| T1.3 Employment | A1.3.1 | Creative industry employment | | x |
| T1.3 Employment | A1.3.2 | Tourism industry employment | | x |
| T1.4 Trade – e-Commerce | A1.4.1 | e-commerce purchase ratio | | x |
| T1.4 Trade – e-Commerce | A1.4.2 | Electronic and mobile payment | | x |

| Topic | Reference | Indicator name | Core indicator | Additional indicator |
|---|---|---|---|---|
| T1.4 Trade – Export/import | A1.4.3 | Knowledge-intensive export/import | | x |
| T1.5 Productivity | C1.5.1 | Labour productivity | x | |
| T1.5 Productivity | A1.5.1 | Companies providing online services | | x |
| T1.6 Physical infrastructure – Water Supply | C1.6.1 | Availability of smart water meters | x | |
| T1.6 Physical infrastructure – Water Supply | A1.6.1 | Water supply loss | | x |
| T1.6 Physical infrastructure – Water Supply | A1.6.2 | Water supply ICT monitoring | | x |
| T1.6 Physical infrastructure – Electricity | C1.6.2 | Availability of smart electricity meters | x | |
| T1.6 Physical infrastructure – Electricity | C1.6.3 | Electricity system outage frequency | x | |
| T1.6 Physical infrastructure – Electricity | C1.6.4 | Electricity system outage time | x | |
| T1.6 Physical infrastructure – Electricity | A1.6.3 | Electricity supply management using ICT | | x |
| T1.6 Physical infrastructure – Health infrastructure | A1.6.4 | Sporting facilities | | x |
| T1.6 Physical infrastructure – transport | C1.6.5 | Public transport network | x | |
| T1.6 Physical infrastructure – transport | C1.6.6 | Road traffic efficiency | x | |
| T1.6 Physical infrastructure – transport | C1.6.7 | Real-time public transport information | x | |
| T1.6 Physical Infrastructure – transport | A1.6.5 | Share of EVs | | x |
| T1.6 Physical infrastructure – road infrastructure | A1.6.6 | Traffic monitoring | | x |
| T1.6 Physical infrastructure – road infrastructure | A1.6.7 | Pedestrian infrastructure | | x |

| Topic | Reference | Indicator name | Core indicator | Additional indicator |
|---|---|---|---|---|
| T1.6 Physical infrastructure – building | A1.6.8 | Public building sustainability | | x |
| T1.6 Physical infrastructure – urban planning and public space | A1.6.9 | Urban development and spatial planning | | x |
| T1.7 Public sector | A1.7.1 | Open data | | x |
| T1.7 Public sector | A1.7.2 | e- Public services adoption | | x |
| T2.1 Air quality | C2.1.1 | Air pollution | x | |
| T2.1 Air quality | A2.1.1 | Air pollution monitoring system | | x |
| T2.1 Air quality | C2.1.2 | GHG emissions | x | |
| T2.2 Water and sanitation | C2.2.1 | Quality of drinking water | x | |
| T2.2 Water and sanitation | A2.2.1 | Water saving in households | | x |
| T2.2 Water and sanitation | C2.2.2 | Access to improved water source | x | |
| T2.2 Water and sanitation | C2.2.3 | Water consumption | x | |
| T2.2 Water and sanitation | A2.2.2 | Drainage system management | | x |
| T2.2 Water and sanitation | C2.2.4 | Wastewater treated | x | |
| T2.2 Water and sanitation | C2.2.5 | Wastewater collection | x | |
| T2.2 Water and sanitation | C2.2.6 | Household sanitation | x | |
| T2.3 Noise | C2.3.1 | Exposure to noise | x | |
| T2.3 Noise | A2.3.1 | ICT Noise monitoring | | x |

| Topic | Reference | Indicator name | Core indicator | Additional indicator |
|---|---|---|---|---|
| T2.4 Environmental quality | C2.4.1 | Compliance with WHO endorsed exposure guidelines | x | |
| T2.4 Environmental quality | C2.4.2 | Adoption of a consistent planning approval process with respect to EMF | x | |
| T2.4 Environmental quality | C2.4.3 | Availability of EMF information | x | |
| T2.4 Environmental quality | C2.4.4 | Solid waste collection | x | |
| T2.4 Environmental quality | C2.4.5 | Solid waste treatment | x | |
| T2.4 Environmental quality | C2.4.6 | Green areas and public spaces | x | |
| T2.5 Biodiversity | C2.5.1 | Native species monitoring | x | |
| T2.5 Biodiversity | A2.5.1 | Protected natural area | | x |
| T2.6 Energy | C2.6.1 | Access to electricity | x | |
| T2.6 Energy | C2.6.2 | Renewable energy consumption | x | |
| T2.6 Energy | C2.6.3 | Electricity consumption | x | |
| T2.6 Energy | A2.6.1 | Energy saving in households | | x |
| T2.6 Energy | A2.6.2 | Public buildings energy consumption | | x |
| T3.1 Education | C3.1.1 | Students ICT access | x | |
| T3.1 Education | C3.1.2 | Adult literacy | x | |
| T3.1 Education | C3.1.3 | School enrolment | x | |

| Topic | Reference | Indicator name | Core indicator | Additional indicator |
|---|---|---|---|---|
| T3.1 Education | C3.1.4 | Higher education ratio | x | |
| T3.1 Education | A3.1.1 | e-learning systems | | x |
| T3.2 Health | C3.2.1 | Electronic health records | x | |
| T3.2 Health | C3.2.2 | Sharing of medical resources | x | |
| T3.2 Health | C3.2.3 | Life expectancy | x | |
| T3.2 Health | C3.2.4 | Maternal mortality | x | |
| T3.2 Health | C3.2.5 | Doctors | x | |
| T3.2 Health | A3.2.1 | Adoption of telemedicine | | x |
| T3.2 Health | A3.2.1 | In-patient hospital beds | | x |
| T3.2 Health | A3.2.3 | Health insurance | | x |
| T3.3 Safety – Disaster relief | C3.3.1 | Resilience plans | x | |
| T3.2 Safety – Disaster relief | A3.3.1 | Natural disaster-related deaths | | x |
| T3.3 Safety – Disaster relief | A3.3.2 | Disaster-related economic losses | | x |
| T3.3 Safety – Disaster relief | A3.3.3 | Disaster and emergency alert | | x |
| T3.3 Safety – Emergency | C3.3.2 | Emergency service response times | x | |
| T3.3 Safety – ICT | A3.3.4 | Child online protection (COP) | | x |
| T3.3 Safety – ICT | C3.3.3 | Information security and privacy protection | x | |

| Topic | Reference | Indicator name | Core indicator | Additional indicator |
|---|---|---|---|---|
| T3.4 Housing | C3.4.1 | Housing expenditure | x | |
| T3.4 Housing | C3.4.2 | Informal settlements | x | |
| T3.5 Culture | C3.5.1 | Connected libraries | x | |
| T3.5 Culture | C3.5.2 | Cultural infrastructure | x | |
| T3.5 Culture | C3.5.3 | Cultural resources online | x | |
| T3.5 Culture | A3.5.1 | Protected cultural heritage sites | | x |
| T3.6 Social inclusion | C3.6.1 | Public participation | x | |
| T3.6 Social inclusion | C3.6.2 | Gender income equity | x | |
| T3.6 Social inclusion | C3.6.3 | Opportunities for people with special needs | x | |
| T3.6 Social inclusion | A3.6.1 | Gini coefficient | | x |

# Appendix III

## KPI development in ITU-T

(This appendix does not form an integral part of this Recommendation.)

In February 2013, ITU established the Focus Group on Smart sustainable Cities (FG-SSC) to assess the standardization requirements of cities aiming to boost their social, economic and environmental sustainability through the integration of information and communication technologies (ICTs) in their infrastructures and operations. While embarking on the SSC journey, it is important for cities to be able to understand and assess the stage of the transition they are at so that they may take the required steps to progress further. It is also important for urban stakeholders to be able to measure the performance of various smart sustainable city ventures once they are initiated. In this regard, the FG-SSC developed a set of international key performance indicators (KPIs) for cities aiming to become SSC. The KPIs proposed by FG-SSC are in alignment with the definition of SSC and the framework provided by UN-Habitat in its City Prosperity Index.

The FG-SSC successfully completed its mandate in May 2015. The series of Technical Specifications and Reports on SSC KPIs are:

– Technical Specifications on overview of key performance indicators in smart sustainable cities, October 2014.
– Technical Specifications on KPIs related to the use of information and communication technology in smart sustainable cities, March 2015.
– Technical Specifications on key performance indicators related to the sustainability impacts of information and communication technology in smart sustainable cities, March 2015.
– Technical Report on key performance indicators definitions for Smart Sustainable Cities, March 2015.

The starting point of the methodological approach to the United Nations Economic Commission for Europe (UNECE) Smart Cities Indicators is the Smart City PROFILES that the Environment Agency Austria (EAA) developed for twelve Austrian cities in 2013.

Since many Austrian cities and municipalities were actively pursuing energy-saving and climate strategies, setting examples which could help develop a joint knowledge basis and disseminate best practice models represented a good strategy to support cities in fulfilling this goal. In fact, by obtaining a better understanding of the key factors of urban development with respect to climate and energy issues, profiles could provide important contributions as they characterize cities in terms of different areas of activity in urban development. The Smart City PROFILES developed by the EAA were conceived to help Austrian cities and municipalities create smart and sustainable urban strategies and to implement them.

The EAA established a set of 21 indicators with the aim of developing city profiles for Austrian cities which gave a full picture of the characteristics and special features of cities and municipalities and could be reproduced by other cities. The indicators focused on climate change mitigation and energy efficiency in five areas of activity in urban development: buildings and settlement structures; transport and mobility; technical infrastructure; economy and population; and policy, administration and governance. From the analysis of the indicators' results, city profiles were drafted. They provided information about relevant sectors of urban activities, including business and economy, demography, strategic urban planning, governance, etc., and especially about the use of energy and resources as well as about the potential for increasing efficiency.

The resulting recommendations enabled cities to make better evaluations of their current status and their development, in particular with respect to energy and climate change mitigation, but also to other aspects influencing the quality of life of their citizens and their competitiveness.

Due to the great diversity of the cities in the UNECE region, the Austrian Smart Cities PROFILES methodology, as well as the areas considered, was to be revised. Hence, a consortium of partners was established and the existing smart cities initiatives analysed.

In order to gather the most relevant indicators to evaluate smart and sustainable cities, the EAA scanned multiple initiatives whose output was the elaboration of indicators on sustainable urban development. They were analysed with regard to their relevance and practicability in low and middle income countries in the UNECE region. The key parameters of this assessment were:

– Name of publisher or organization that developed the indicator set
– Background information
– Addressed topics or indicators
– Data availability
– History of application (reference to cities)
– Sources of information, i.e., website, guidelines and other literature.

In addition to these initiatives, other relevant sources have been analysed such as: available statistical data at European and global level, i.e., EUROSTAT, Urban Audit, the World Bank, the WHO, the FAO, etc.; thematic maps on several issues, such as likelihood of drought, earthquakes, flooding, precipitations; other methods to assess the quality of urban features, such as perception surveys, checklists, expert judgments, etc.

From the above-mentioned assessment, ten development fields divided into three dimensions were identified. The three dimensions are: economy, environment, and society and culture. The development fields under the area "economy" are: economic development; and infrastructure and energy. The development fields under the area "environment" are: air, climate change and natural hazards; land and biodiversity; freshwater and oceans; and waste. The development fields under the area "society and culture" are: social issues; governance; health; education; and demography.

A preliminary set of top indicators for each development field was also defined. The preliminary set included 59 out of 456 indicators collected, and proposed 4 to 8 indicators per development field. For each indicator a description was provided according to the following parameters:

– Indicator title
– Source: the origin of the indicator
– Development field
– Sub-topic
– Literature: available guidelines and websites
– Relevance: only indicators with high relevance were chosen
– Feasibility (0 – 10): expert judgment with regard to feasibility
– Implementation: reference to regions where the indicator was already implemented
– Data availability: indication whether or not data is readily available; needs to be collected; is only available for certain regions, etc.
– Comments.

The results of the study were summarized in the report "Smart Urban Solutions in the UNECE Region – Preliminary study on a flexible indicator set for smart cities". [b-PST]

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**ENVIRONMENT AND ICTS, CLIMATE CHANGE, E-WASTE, ENERGY EFFICIENCY; CONSTRUCTION, INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT**

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*For further details, please refer to the list of ITU-T Recommendations.*

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| Series T | Terminals for telematic services |
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