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

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SERIES L: ENVIRONMENT AND ICTS, CLIMATE CHANGE, E-WASTE, ENERGY EFFICIENCY; CONSTRUCTION, INSTALLATION AND PROTECTION

OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT

Internet of things and smart cities and communities – Reserved

Key performance indicators related to the use of information and communication technology in smart sustainable cities

Recommendation ITU-T Y.4901/L.1601

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Recommendation ITU-T Y.4901/L.1601

Key performance indicators related to the use of information and communication technology in smart sustainable cities

Summary

Recommendation ITU-T Y.4901/L.1601 gives a general guidance to cities and provides the definitions of key performance indicators (KPIs) related to the use of information and communication technology (ICT) in the context of smart sustainable cities (SSCs).

This Recommendation is one of series of the Recommendations and Supplements that define KPIs. The series of KPI definitions documents also include:

- Recommendation ITU-T Y.4900/L.1600 on overview of key performance indicators (KPIs) in smart sustainable cities.

- Recommendation ITU-T Y.4902/L.1602 on key performance indicators (KPIs) related to the sustainability impacts of information and communication technology (ICT) in smart sustainable cities. This Recommendation lists the KPIs used for ICT impact on sustainability.

- Supplement ITU-T Y-Suppl. 39 on key performance indicators (KPIs) for smart sustainable cities. This document provides information regarding KPIs and evaluation index systems of smart cities, KPIs of sustainable cities, etc.

History

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Cities, information communication technology, ICT, key performance indicators, KPIs, metrics and evaluation, smart sustainable cities, SSCs, sustainability impacts.

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FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

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.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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Recommendation ITU-T Y.4901/L.1601

Key performance indicators related to the use of information and communication technology in smart sustainable cities

1   Scope

This Recommendation forms part of a series of Recommendations and Supplements focusing on the key performance indicators (KPIs) for smart sustainable cities (SSCs). It specifically provides the KPIs related to ICT adoption and use in the context of SSCs. Evaluating these indicators can help cities as well as their stakeholders understand the extent to which they may be perceived as SSC. The Recommendation describes applicability of KPIs, principles and dimensions as well as the definitions of corresponding indicators. To fit into the overall framework of city indicators the present Recommendation re-uses the categorization of UN Habitat's City Prosperity Index.

The sustainability of a smart city is based on four 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) 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.

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 and understand the progress related to the use of ICT for making cities smarter and more sustainable.

• City residents and their non-profit organizations, enabling them to understand the development and progress of SSCs.

• Development and operation organizations of SSC, including planning units, SSC-related producers and service providers, operation and maintenance organizations, helping them to fulfil the tasks of sharing information related to the use of ICT in the city.

• Evaluation agencies and academia, supporting them in selection of relevant KPIs for assessing the contribution from ICT in the development of SSC.

The intention of identifying the KPIs is to establish the criteria to evaluate ICT´s contributions in making cities smarter and more sustainable, and to provide the cities with the means for self-assessments. It is desirable that cities can quantify their achievement according to their goals.

This Recommendation lists the core indicators that are chosen to be applicable for all cities. The goals for moving towards increased smartness and sustainability differs between cities. Thus, based on their population growth, geographical locations, environmental conditions, demography etc., the cities can also select appropriate indicators among those listed in Appendix I and/or add new ones.

This Recommendation is applicable for both cities and city regions, which could be organized in different ways:

• A single city organized as one or more administrative units, or

• A union of cities in the neighbouring area that can share some services.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference 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 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 (2015), *Overview of key performance indicators 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), *Technical Report on EMF consideration in smart sustainable cities*.

[ITU-T Y-Sup.39]   ITU-T Y-series Recommendations – Supplement 39 (2015), *ITU-T Y.4900 Series – 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]: A urban geographical area with one (or several) local government and planning authorities.

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

3.1.3 smart sustainable cities [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

This Recommendation defines the following term:

3.2.1 ICT companies: Companies that provide products and/or services with respect to information and communication technologies.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

COP   Child Online Protection

DSL   Digital Subscriber Line

EMF   Electromagnetic Field

GDP   Gross Domestic Product

GHG   Greenhouse Gas

GIS   Geographic Information System

ICT   Information and Communication Technology

IDI   ICT Development Index

KPI   Key Performance Indicator

LAN   Local Area Network

SSC   Smart Sustainable City

WHO   World Health Organization

WiFi   Wireless Fidelity

5   General principles for selecting key performance indicators (KPIs)

The selection of KPIs is based on the following principles:

- **Comprehensiveness**: The set of indicators should cover all the aspects of SSC. The indicators of evaluation should be aligned to the measured subject, i.e., ICT and its impact on the sustainability of cities. The index system should reflect the level of general development in a certain aspect.

- **Comparability**: The KPIs should be defined in a way that data can be compared scientifically between different phases of urban development, which means the KPIs should be comparable over time and space for the same city. It should also be possible to extend and amend the set of KPIs according to the actual development.

- **Availability**: The KPIs should be quantitative and the historic and current data should be either available or easy to collect.

- **Independence**: The KPIs in the same dimension should be independent or almost-orthogonal i.e., overlap of the KPIs should be avoided as much as possible.

- **Simplicity**: The concept of each indicator should be simple and easy to understand. Also the calculation of the associated data should be intuitive and simple.

- **Timeliness**: The ability to produce KPIs with respect to emerging issues in SSC construction.

6   Key performance indicators

6.1   Sub-dimensions of KPIs

The sub-dimensions for each dimension are recorded in Table 1. These have been tailored[1] from Table 1 of [ITU-T Y.4900].

In Table 1 each dimension is identified by the letter Dx. The sub-dimensions are then classified by the label Dx.y where x denotes the dimension and y maps to sub-dimension.

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[1] Note that this list only contains the sub-categories for which indicators are defined in this Recommendation. For a total set of sub-categories refer to [ITU-T Y.4900].

Table 1 – Sub-dimension of KPIs

Dimension label	Dimension	Sub-dimension label	Sub-dimension
D1	Information and Communication Technology	D1.1	Network and access
		D1.2	Services and Information platforms
		D1.3	Information security and privacy
		D1.4	Electromagnetic field
D2	Environmental sustainability	D2.1	Air quality
		D2.5	Water, soil and noise
D3	Productivity	D3.1	Capital investment
		D3.4	Trade
		D3.8	Innovation
		D3.9	Knowledge economy
D4	Quality of life	D4.1	Education
		D4.2	Health
		D4.3	Safety/security public place
D5	Equity and social inclusion	D5.3	Openness and public participation
		D5.4	Governance
D6	Physical infrastructure	D6.1	Infrastructure/connection to services – piped water
		D6.2	Infrastructure/ connection to services – sewage
		D6.3	Infrastructure/ connection to services – electricity
		D6.8	Infrastructure/connection to services – road infrastructure
		D6.11	Building

6.2 Key performance indicators of SSC

This part of the Recommendation defines the core indicators applicable for all cities that want to become a SSC.

Each indicator is labelled (Ix.y.z), where (i) x denotes the dimension, (ii) y the sub-dimension and (iii) z the indicator.

The indicators listed in Appendix I are provided as additional indicators for consideration. Cities can select appropriate ones among those, and/or add new indicators, to evaluate the contributions of ICT to their SSC goals.

NOTE 1 – 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.

NOTE 2 – In this Recommendation the *e-service* concept (e.g., e-health, 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, m-banking, etc.). These ICT services and goods are also collectively known as *Smart services* (e.g., smart grid, smart lighting) and *smart 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 3 – In this Recommendation the term *city inhabitant* is used to refer to the people living in the city.

6.2.1 ICT

This clause lists the core indicators defined for ICT dimension.

There are 11 indicators in this dimension, covering *computer penetration, Internet access, fixed (wired)-broadband subscriptions, wireless-broadband subscriptions, social media, information security, COP, privacy protection and electromagnetic field (EMF) consideration in cities, etc*.

Sub-dimension	Indicator	Description
D1.1 Networks and access	I1.1.1 Availability of computers or similar devices	Proportion of households with at least one computer or similar device (tablet, smart phones, etc.) (*)
	I1.1.2 Availability of Internet access in households	Proportion of households with Internet access for any household member via a fixed or mobile network at any given time. (*)
	I1.1.3 Availability of fixed broadband subscriptions	Fixed (wired) broadband subscriptions per 100 inhabitants. (*) NOTE – 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. 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). Mobile cellular network subscriptions are not included.
	I1.1.4 Availability of wireless broadband subscriptions	Wireless-broadband subscriptions per 100 inhabitants (*) NOTE – Wireless broadband subscriptions include wireless broadband through satellite broadband, terrestrial fixed wireless broadband and mobile cellular network subscriptions.
D1.2 Services and information platforms	I1.2.1 Use of social media by the public sector	Use of social media by the public sector, to share information about regulations and to get feedback. NOTE – Social media refers to a group of Internet-based applications that allow the creation and exchange of user-generated content.

Sub-dimension	Indicator	Description
D1.3 Information security and privacy	I1.3.1 Information security of public services and systems	Proportion of incidents, due to illegal system access, unauthorized data storage or transmission, unauthorized hardware and software modifications, which lead to information disclosure or financial loss.
	I1.3.2 Existence of systems, rules and regulations to ensure Child Online Protection (COP)	Existence of rules and regulations to ensure COP. This also includes proportion of public web services and devices that ensure COP. NOTE – The city could work against cyber bullying by ensuring safety in online public services (for the use of ICT in schools etc.).
	I1.3.3 Existence of systems, rules and regulations to ensure privacy protection in public service	Existence of rules and regulations to ensure privacy protection in public service. This should also include proportion of public services and devices that ensure privacy protection. NOTE – This indicator evaluates the adoption of privacy preserving schemes, and other systems to ensure privacy of the city inhabitants. In addition, the rules, and regulations also require that institutions which offer consumers financial products or services like loans, financial advice, investment advice, or insurance; to safeguard sensitive and confidential information by explaining their information-sharing practices to their customers.
D1.4 Electromagnetic field	I1.4.1 Compliance with WHO endorsed exposure guidelines	Application of WHO endorsed exposure guidelines for ICT installations in the city.[2] NOTE – WHO endorsed exposure guidelines are referred to in [b-ITU-T K-Sup.4].
	I1.4.2 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 NOTE – A consistent planning approval process between cities is preferred to individual city requirements to ensure efficient deployment.
	I1.4.3 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.

NOTE – Indicators marked by (*) are based on ITU ICT Development Index (IDI) (https://www.itu.int/ITU-D/ict/publications/idi/index.html)

6.2.2 Environmental sustainability

This clause lists the core indicators defined for Environmental Sustainability.

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[2] ICT devices are regulated nationally and are not included.

There are three indicators in this dimension, covering *air quality, water resource and noise monitoring etc.*

Sub-dimension	Indicator	Description
D2.1 Air quality	I2.1.1 Application of ICT based monitoring system for particles and toxic substances	Proportion of city area covered by outdoor ICT based monitoring system for particles and toxic substances NOTE – This indicator captures the share of area for which air pollution (PM10, PM2.5, toxic substances etc.).is monitored through ICT
D2.5 Water, soil and noise	I2.5.1 Application of city water monitoring through ICT	Proportion of the city water resources (rivers, lakes etc.) monitored by ICT with respect to water pollution and quality. NOTE – Quality of drinking water forms part of Physical infrastructure.
	I2.5.2 Application of ICT based noise monitoring	Proportion of the city area with applied ICT based noise monitoring NOTE – This indicator measures how ICT is used to monitor how the city inhabitants are exposed to acoustical noise within city areas, especially focusing on noise sensitive areas.

6.2.3 Productivity

This clause lists the core indicators defined for productivity and economic sustainability.

There are eight indicators in this dimension, covering *expenditure of ICT R&D, expenditure of ICT projects, ICT companies ratio, ICT employers, intangible investment, e-commerce, e-services and cloud computing.*

Sub-dimension	Indicator	Description
D3.1 Capital investment	I3.1.1 ICT related Research and Development expenditure	Proportion of city GDP spent on ICT related Research and Development NOTE – This covers investment in ICT related Research and Development including academic research input.
	I3.1.2 Investment intensity in ICT projects enabling SSC	The amount of city investments in programs, initiatives and awards that enhance the smartness and sustainability of the city, expressed as proportion of city GDP. NOTE – These projects could be sponsored by grant makers, multilateral organizations and/or private sector.

Sub-dimension	Indicator	Description
D3.4 Trade	I3.4.1 Application of e-commerce transactions	Number of e-commerce transactions per 100 inhabitants through electronic and mobile payment.
D3.8 Innovation	I3.8.1 Research and Development intensity in ICT	Proportion of research and development intensive ICT companies among all companies. NOTE – Research and development intensive ICT companies refer to ICT companies with high focus on research and development efforts.
D3.9 Knowledge economy	I3.9.1 Intangible investments as a proportion of GDP	Proportion of intangible investments (e.g., Research and development, software, design, marketing, education and training) in new and existing businesses expressed as proportion of city GDP.
	I3.9.2 Employees belonging to ICT sector	Proportion of employees in ICT sector among all employees. NOTE – Employees in smart industries to be added if possible.
	I3.9.3 Companies providing e-services	Proportion of companies which provide network based services (including e-commerce, e-learning, e-entertainment, cloud computing etc.). NOTE – Data collection may be challenging due to data gaps.
	I3.9.4 Application of computing platforms	Proportion of companies that offer cloud computing and similar resources serving the public, other companies, government and other organizations.

6.2.4 Quality of life

This clause lists the core indicators defined for quality of life.

There are seven indicators in this dimension, covering *e-learning, electronic health records, electronic medical records, sharing medical information, telemedicine, anti-disaster and other safety measures.*

Sub-dimension	Indicator	Description
D4.1 Education	I4.1.1 Use of e-learning system	The proportion of city inhabitants using e-learning systems.
D4.2 Health	I4.2.1 Use of electronic health records	Proportion of city inhabitants with electronic health records.
	I4.2.2 Use of electronic medical records	Proportion of city inhabitants who have electronic medical records.
	I4.2.3 Sharing of medical resources and information among hospitals, pharmacies and other health care providers	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 medical records.
	I4.2.4 Adoption of telemedicine	Proportion of patients involved in telemedicine programs including services, such as e-consultation, e-monitoring, online health care advice and guidance etc.
D4.3 Safety/security public place	I4.3.1 Adoption of ICT for disaster management	Adoption of an ICT based disaster management system including disaster preparedness, prevention, mitigation, and response as applicable to the city. NOTE – Disasters may be natural or man-made.
	I4.3.2 Availability of ICT based safety systems	Availability of ICT based systems that increase the perceived safety. NOTE – This may include solutions such as video surveillance system, online information published by the police, online support for protection of women and children, community incident mapping etc.

6.2.5   Equity and social inclusion[3]

This clause lists the core indicators defined for equity and social inclusion.

There are six indicators in this dimension, covering *online city information, civic engagement, support for new city inhabitants, ICT literacy, online administering and support to persons with specific needs.*

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[3]   In general, equity and inclusion in relation to ICT are difficult to measure by defining specific indicators. Therefore, in addition to the indicators defined in dimension D5, cities are encouraged to disaggregate and analyse their data with respect to aspects such as gender, age, income, specific needs and geographic location/area.

Sub-dimension	Indicator	Description
D5.3 Openness and public participation	I5.3.1 Availability of online city information and feedback mechanisms	Proportion of city information available online and existence of ICT systems for easy access and anonymous feedback mechanism that enable cities to improve their governance. NOTE – Online city information include city plans, budget, minutes of city governance meetings etc.
	I5.3.2 Online civic engagement	Proportion of city inhabitants using online information and proportion of city inhabitants using ICT based feedback mechanism.
	I5.3.3 Online support for new city inhabitants	Availability of ICT based applications and services to provide establishment support for new city inhabitants. NOTE – New city inhabitants include people moving to the city and visitors
	I5.3.4 Existence of strategies, rules and regulations to enable ICT literacy among inhabitants	Existence of strategies, regulations, voluntary work or interest organizations to enhance ICT literacy among all city inhabitants. NOTE – This includes mechanisms that enable public knowledge and skill development.
D5.4 Governance	I5.4.1 Provision of online systems for administering public services and facilities	Proportion of public services and facilities (e.g., choice of schools, booking of public sports facilities, library services, etc.) that could be administered online. NOTE – This includes bookings, payments etc.
	I5.4.2 Application of services to support persons with specific needs	Proportion of public facilities and buildings that provide ICT based services and information to support persons with specific needs, and proportion of online public information customized for these persons. NOTE – Persons with specific needs here indicate indigenous people, and persons with disabilities including age related disabilities.

6.2.6 Physical infrastructure

This clause lists the core indicators defined for the physical infrastructure.

There are 13 indicators in this dimension, covering *the infrastructures including piped water, sewage, electricity, road infrastructure and building.*

Sub-dimension	Indicator	Description
D6.1 Infrastructure/ connection to services – piped water	I6.1.1 Water supply system management using ICT	Proportion of the water supply systems under automatic monitoring using ICT so as to ensure water quality and reduce leakage.
	I6.1.2 City fresh water sources monitored using ICT	Proportion of the city fresh water sources monitored using ICT with respect to availability.
	I6.1.3 Availability of smart water meters	Proportion of the water consumers (including households, companies, etc.) with ICT based water meters.
D6.2 Infrastructure/ connection to services – sewage	I6.2.1 Sewage system management using ICT	Proportion of the sewage system monitored using ICT NOTE – Monitoring includes both inspection and controlling.
	I6.2.2 Drainage system management using ICT	Proportion of the drainage systems monitored in real-time using ICT. NOTE – Monitoring includes both inspection and controlling.
D6.3 Infrastructure/ connection to services – electricity	I6.3.1 Availability of smart electricity meters	Proportion of the electricity consumers (including households, companies, etc.) with ICT based electricity meters.
D6.8 Infrastructure/ connection to services – road infrastructure	I6.8.1 Availability of traffic monitoring using ICT	Proportion of streets with traffic monitoring using ICT (e.g., using sensors to produce traffic volume maps, etc.).
	I6.8.2 Availability of parking guidance systems	Proportion of parking lots and street parking spaces with ICT based parking guidance systems.
	I6.8.3 Availability of real-time traffic information	Proportion of public transport stops and stations with real-time traffic information available (via electronic bus bulletin boards, smartphone apps, etc.) NOTE – Public transportation includes e.g., metro, bus, tram, train and ferry.
	I6.8.4 Street lighting management using ICT	Proportion of street lamps under automatic management using ICT (e.g., light/sound control and solar power charging). NOTE – Management covers both inspection and regulation.
	I6.8.5 Gas system management using ICT	Proportion of gas supply systems under automatic monitoring using ICT.

Sub-dimension	Indicator	Description
D6.11 Building	I6.11.1 Automatic energy management in buildings	Proportion of public and private sector buildings using ICT based systems to automatically regulate and reduce energy needs.
	I6.11.2 Integrated management in public buildings	Proportion of public buildings using integrated ICT systems to automate building management and create flexible, effective, comfortable and secure environment. NOTE – ICT systems include building management, communication and control systems, etc.

Appendix I

Additional indicators

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

The indicators listed in the following table are provided as additional indicators for consideration. Cities can select appropriate ones among those, and/or add new indicators, in order to evaluate the contributions of ICT to their SSC goals. Each additional indicator is labelled (Ax.y.z), where (i) x denotes the dimension, (ii) y the sub-dimension and (iii) z the indicator.

Sub-dimension	Indicator	Description
D1.1 Networks and access	A1.1.1 Availability of mobile-cellular telephones	Mobile-cellular telephone subscriptions per 100 inhabitants (*).
	A1.1.2 International Internet bandwidth	International Internet bandwidth (bit/s) per Internet user (*) NOTE – This is the sum of used capacity of all Internet exchanges offering international bandwidth. If capacity is asymmetric, then the incoming capacity is used. International Internet bandwidth (Mbit/s) per Internet user is calculated by converting to bits per second and dividing by the total number of Internet users.
	A1.1.3 Use of Internet by city inhabitants	Proportion of inhabitants using internet.
	A1.1.4 Coverage rate of digital broadcasting network	Proportion of digital broadcasting network covering families in the city.
	A1.1.5 Availability of ultra high speed wireline connection	Proportion of households with access to downstream speeds equal to, or greater than, 30 Mbits/s.
	A1.1.6 Availability of high-speed mobile broadband.	Proportion of city area which provides access to downstream speeds equal to, or greater than, 10 Mbits/s.
	A1.1.7 Availability of WiFi in public areas	Number of WiFi hotspots at certain points in the city centre.
	A1.1.8 Availability of smart phones and tablets	Number of smart phones and tablets per 100 inhabitants.
	A1.1.9 Quality of fixed broadband	Mean-download speed (fixed)
	A1.1.10 Quality of mobile broadband	Cell-edge performance (mobile)
D1.2 Services and information platforms	A1.2.1 Availability of electronic and mobile payment platforms	Existence of electronic and mobile payment platforms to facilitate access to city services for city inhabitants.

| Sub-dimension	Indicator	Description
D3.9 Knowledge economy	A3.9.1 Intangible investments in comparison with total investments	Proportion of intangible investments (e.g., research and development, software, design, marketing, education and training) in new and existing businesses related to overall investments. NOTE – Such investments are related to the knowledge economy [b-OECD KE], and include investments in emerging high technology and in upgrading of traditional areas.
	A3.9.2 Application of Geographic Information System (GIS)	Proportion of e-service companies with core business related to GIS serving the public, companies, government and other organizations.
	A3.9.3 Application of big data	Proportion of e-service companies with core business related to big data storage and analysis serving the public, companies, government and other organizations.
D4.1 Education	A4.1.1 Application of e-learning in schools	Proportion of pupils in primary and secondary schools having access to e-learning systems.
	A4.1.2 Application of e-learning in academic studies	Proportion of students aiming at an academic degree performing their education mainly through e-learning systems.
D5.3 Openness and public participation	A5.3.1 Availability of cultural resources online	Proportion of cultural institutions and events in the city for which online participation is offered. NOTE – The indicator measures how ICT increases the availability of cultural resources, such as museums, galleries, etc., to a broader audience.
D5.4 Governance	A5.4.1 Existence of strategy, rules and regulations to enable the use of public data	Existence of a framework to enable the use of public data of cities.
D6.1 Infrastructure/ connection to services – piped water	A6.1.1 Availability of visualised real-time information regarding water use	Proportion of users with real-time information on quantum of water usage and water use pattern.

Sub-dimension	Indicator	Description
D6.3 Infrastructure/ connection to services – electricity	A6.3.1 Electricity supply system management using ICT	Proportion of power substation and user points under automatic inspection using ICT. NOTE – Management of electricity supply is an important ICT task, but data may not be available to cities.
	A6.3.2 Availability of visualised real-time information regarding electricity use	Proportion of users with real-time information on quantum of electricity usage and electricity use pattern.
D6.8 Infrastructure/ connection to services – road infrastructure	A6.8.1 Availability of visualised real-time information regarding gas use	Proportion of users with real-time information on quantum of gas usage and gas use pattern.
	A6.8.2 Availability of online bike/car sharing system	Proportion of city area covered by an online bike/car sharing system
	A6.8.3 Use of real-time navigation	Proportion of real-time navigation users compared to all navigation system users.
NOTE – Indicators marked by (*) are based on ITU ICT Development index (https://www.itu.int/ITU-D/ict/publications/idi/index.html)		

Appendix II

UN habitat city prosperity index

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

In the Wheel of Prosperity as defined by UN Habitat, the "spokes" are the five dimensions of prosperity: productivity, infrastructure development, quality of life, equity and social inclusion, and environmental sustainability.
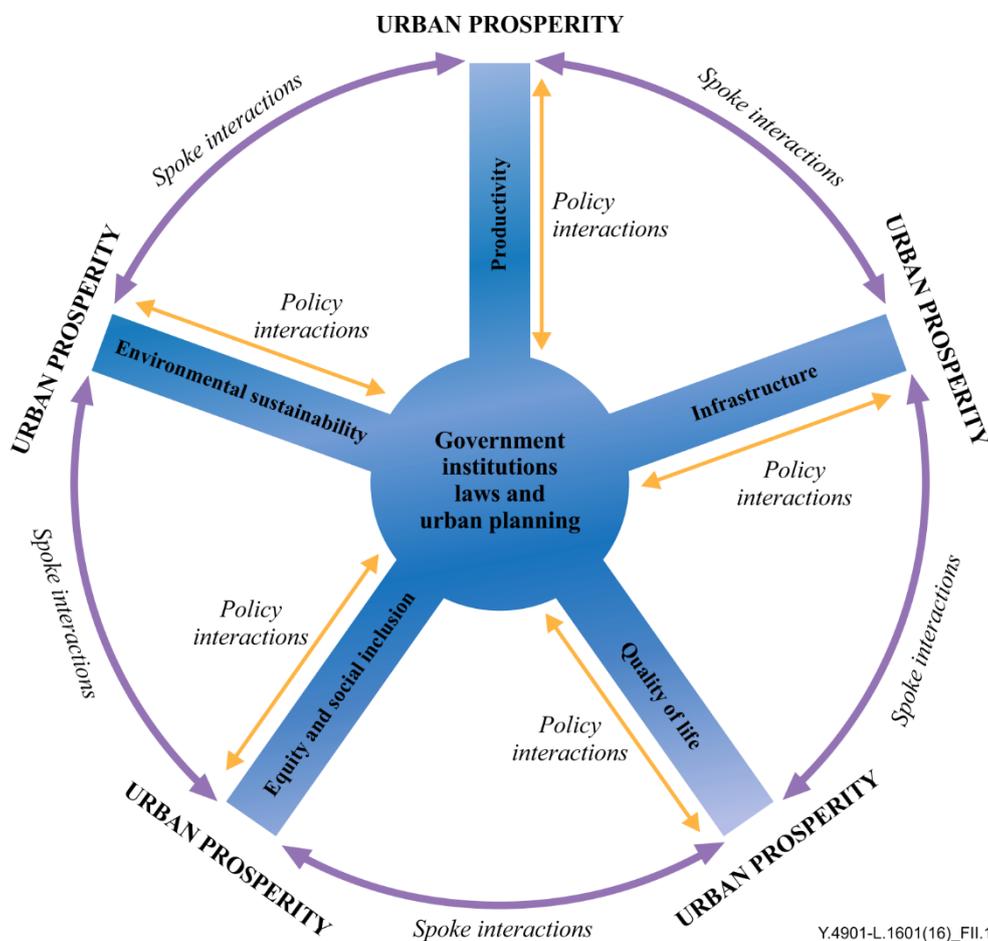
In the City Prosperity Index each dimension has its own index and it might be built up by a number of indices. The basic City Prosperity Index as reported in a publication consists of the following sub-indices and indicators:

Dimension	Definition/variables
Productivity	The productivity index is measured through the city product, which is composed of the variables: capital investment, formal/informal employment, inflation, trade, savings, export/import, and household income/consumption. The city product represents the total output of goods and services (value added) produced by a city´s population during a specific year.
Quality of life	The quality of life index is a combination of four sub-indices: education, health, safety/security and public space. The sub-index education includes literacy, primary, secondary and tertiary enrolment. The sub-index health includes life expectancy, under-five mortality rates, HIV/AIDS, morbidity and nutrition variables.
Infrastructure development	The infrastructure development index combines two sub-indices: one for infrastructure and another for housing. The infrastructure sub-index includes: connection to services (piped water, sewage, electricity and ICT), waste management, knowledge infrastructure, health infrastructure, transport and road infrastructure. The housing sub-index includes building materials and living space.
Environmental sustainability	The environmental sustainability index is made of four sub-indices: air quality (PM10), CO_2 emissions, energy and indoor pollution.
Equity and social inclusion	The equity and social inclusion index combines statistical measures of inequity of income/consumption (Gini coefficient) and social and gender inequity of access to services and infrastructure.

Reference:

UN Habitat report "State of the World's cities 2012/2013 Prosperity of Cities", Table 1.1.3, p 18.

There is also an extended City Prosperity Index with more indicators and a plan to include Governance as a sixth dimension. Furthermore, specific work has been done on Streets as a driver for prosperity.

UN Habitat (2013), *State of the World's Cities 2012/2013, Prosperity of Cities*: http://www.unhabitat.org/pmss/listItemDetails.aspx?publicationID=3387

UN Habitat (2013), *Streets as Public Spaces and Drivers of Urban Prosperity*: http://www.unhabitat.org/pmss/listItemDetails.aspx?publicationID=3513

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