



Key Performance Indicators (KPIs) and Standards for Smart Sustainable Cities

Smart Sustainable Cities
Training Programme,
Module SSC-3



Contents

- Aim of this Module
- Overview of KPIs for SSCs
- KPI definitions for SSCs
- KPI level and usage of ICT for SSCs
- Metrics and evaluation of KPIs for SSCs
- KPIs related to the sustainability impacts of ICT in SSCs
- Review of standardization activities and gaps for SSC



Aims of this Module

- To provide an overview of KPIs
- To enable you to understand the scope and priorities for SSCs
- To enable you to understand how ICT performance can be measured in its own sector
- To enable you to understand the impact of ICT on the KPIs of other sectors
- To show how emerging standards can allow comparisons to be made between one year and another or one city and another





KPI Overview



How do KPIs work?

- Key performance indicators define sets of values against which to measure
- These raw sets of values, which are fed to systems in charge of summarizing the information, are called **indicators**
- Indicators are identifiable and marked as possible candidates for KPIs
 - They can be summarized into sub-categories

Source: http://en.wikipedia.org/wiki/Performance_indicator



Benefits of SSC KPI Development

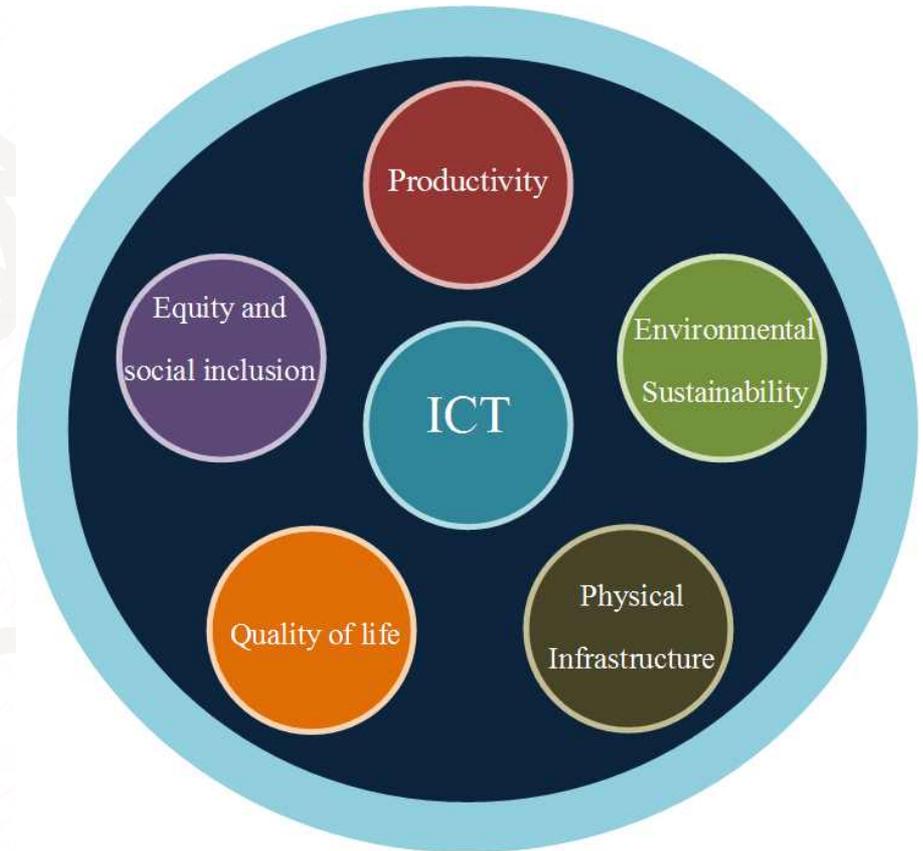
- For city dwellers and non-profit citizen organizations
 - by enabling them to understand the development and progress of SSC with respect to ICT's impact.
- For the development and operation of SSC organizations, including planning units, service providers, operation and maintenance organizations, among others
 - by helping them to fulfil the tasks of sharing information related to the use of ICTs and their impact on the sustainability of cities.
- For evaluation and ranking agencies, including academia
 - by supporting them in the selection of relevant KPIs for assessing the contribution from ICT in the development of SSC.

Source: FG-SSC Key performance indicators definitions for smart sustainable cities, page 7



Overview of KPIs #1

- The proposed set of KPIs focuses specifically on a set of **ICT related** indicators for smart sustainable cities but does not cover all KPIs of cities contained in the ISO standard 37120 [ISO 37120].
- The **dimensions** of KPIs can be categorized as
 - Information and Communication Technology
 - Environmental sustainability
 - Productivity
 - Quality of life
 - Equity and social inclusion
 - Physical infrastructure



Overview of KPIs #2

- Each dimension is subdivided into further KPIs
- One example is illustrated for 'ICTs' (D1)



ICT

D1.1 Network and access

D1.2 Services and information platforms

D1.3 Information security and privacy

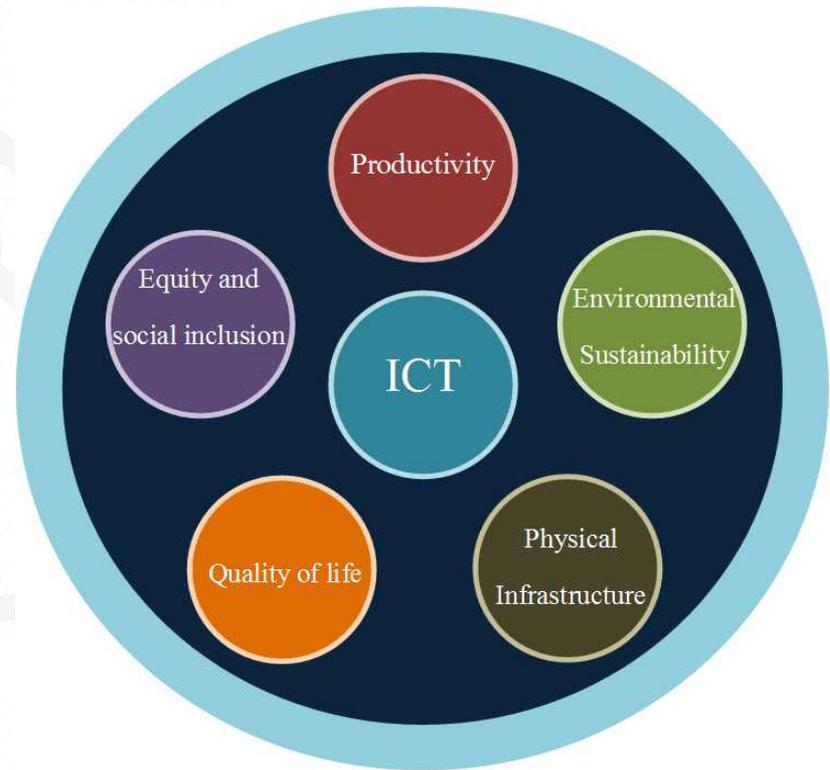
D1.4 Electromagnetic field

Source: FG-SSC “Overview of key performance indicators in smart sustainable cities”, Page 4



Overview of KPIs #3

- The other 5 dimensions are not specifically in the ICT sector but can benefit from the use of ICT to improve their own performance as measured by KPIs





Next: KPI Definitions for SSCs



Selection of KPIs

- is based on the following principles
 - **Comprehensiveness:** The set of indicators should cover all the aspects of SSC and be aligned to “ICT and its impact on the sustainability of cities”
 - The indices 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 cities according to different phases of urban development, which means the KPIs must be comparable over time and space.
 - **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
 - 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 or stage or development

Source FG-SSC “Key performance indicators related to the use of information and communication technology in smart sustainable cities”, Page 4



How are KPIs chosen?

- The FG-SSC made a comparative analysis of nineteen different index sets regarding KPIs and evaluation index systems of smart cities and sustainable cities, etc. *
- The ‘core indicators’ are chosen as applicable to all cities**
- ‘Additional-indicators’
 - Reflect the degree of smartness and sustainability which differs between cities
 - Thus, based on their stage of economic development or/and population growth etc., the cities can also select appropriate indicators among those listed in Appendix I and/or use new ones.

Source: *FG-SSC “Key performance indicators definitions for smart sustainable cities”,
Page 8 and

“Key performance indicators related to the sustainability impacts of information and
communication technology in smart sustainable cities”, page 2



Sub Dimensions of KPIs #1

- Each Dimension can be broken down into Sub-Dimensions
- For example a KPI for ICT can be broken down into
 - Network and access
 - Services and information platforms
 - Information security and privacy
 - Electromagnetic field
- (Each sub dimension may be given a **score** and **weighting** which contributes to the overall KPI)

Source: FG-SSC “Overview of key performance indicators in smart sustainable cities” Page 4





Sub Dimensions of KPIs #2

- Network and access
 - refers to the network layer in the Open Systems Interconnection (OSI) model, especially backbone and access networks, including optical broadband, wireless broadband and broadcasting network.
- Services and information platforms
 - refers to ICT services and equipment above the network layer, including software services and private handsets.

Source: FG-SSC “Overview of key performance indicators in smart sustainable cities”, Page 4



Sub Dimensions of KPIs #3

- Information security and privacy
 - refers to the security parts including privacy protection.
- Electromagnetic field
 - Application of exposure guidelines, consistent planning approval process and information for public should be considered with respect to Electromagnetic fields.

Source: FG-SSC “Overview of key performance indicators in smart sustainable cities”, Page 4



Other Sub-Dimensions #1

- Environmental sustainability
 - Air quality, CO2 emissions, Energy, Indoor pollution, water , soil and noise
- Productivity
 - Capital investment, Employment, Inflation, Trade, Savings, Export/import, Household income/consumption, Innovation, Knowledge economy
- Quality of life
 - Education, Health, Safety/security public place, Convenience and comfort

Source: FG-SSC “Overview of key performance indicators in smart sustainable cities”, Page 5



Other Sub-Dimensions #2

- Equity and social inclusion
 - Inequity of income/consumption (Gini coefficient)
 - (A Gini coefficient of zero expresses perfect equality, where all values are the same (for example, where everyone has the same income)).
 - Social and gender inequity of access to services and infrastructure
 - Openness and public participation
 - Governance
- Physical infrastructure
 - piped water, sewage systems, electricity, waste management, knowledge infrastructure, health infrastructure, transport, roads, buildings

Source: Source: FG-SSC “Overview of key performance indicators in smart sustainable cities”, Page 5&6



Are Indicators Quantifiable? Example

- It is desirable that each city can quantify continuously an achievement degree according to their goal following KPIs*
 - Indicators need to have a numerical value
 - Normally a high number is good and a low number is bad
- The KPIs should be quantitative and the historic and current data should be either available or easy to collect**.
- One example is an indicator for the sub-dimension “Network Facilities”
- The indicator is “Fixed (wired)-broadband subscriptions per 100 inhabitants”
 - This is qualified by being at a download rate of at least 256kbit/s



Source: *FG-SSC “Overview of key performance indicators in smart sustainable cities”

Page 1; ***”Key performance indicators related to the sustainability impacts of information and communication technology in smart sustainable cities”, page 5; and ****”Key performance indicators related to the use of information and communication technology in smart sustainable cities”, page 6

‘Independency’ is a Selection Principle for KPIs

- Mobile Networks are identified **independently** from fixed networks with the **smallest possible overlap**
- The indicator for Mobile Networks is defined as
 - “Wireless-broadband subscriptions per 100 inhabitants”
- It includes
 - satellite, terrestrial fixed wireless and mobile wireless subscriptions



Source FG-SSC “Key performance indicators related to the use of information and communication technology in smart sustainable cities”, pages 6&7



How many Indicators are needed?

- So far over 100 have been proposed by FG-SSC
 - Some will be **qualitative** rather than measurable quantities as in the previous two examples
 - They will be given subjective scores such as
 - 10=high
 - 1=low
- Not all human needs can be quantified!



Source FG-SSC “Key performance indicators related to the use of information and communication technology in smart sustainable cities”



Example: Smart City Indicators #1

EMERGING and SUSTAINABLE CITIES Initiative



- The emerging and sustainable cities initiative (ESCI)
 - was created by the Inter-American Development Bank (IDB) in 2010
 - in response to rapid and largely unregulated urbanization in the Latin American and Caribbean region,
 - It addresses three dimensions of sustainability:
 - environmental sustainability and climate change,
 - urban sustainability
 - fiscal sustainability and governance

Source: <http://www.iadb.org/en/topics/emerging-and-sustainable-cities/implementing-the-emerging-and-sustainable-cities-initiative-approach,7641.html>

ITU-T Focus Group on Smart Sustainable Cities: Key performance indicators definitions for smart sustainable cities Annex K



Example: Smart City Indicators #2

ESCI lists 107 Indicators

ICT appear in 69-71

List of Indicators

II. Urban Sustainability *(continued)*

# Topics	# Subtopic	# Indicator	Unit of Measurement
M Employment	M.1 Unemployment	67 Average annual unemployment rate	%
	M.2 Informal employment	68 Informal employment as a percentage of total employment	%
N Connectivity	N.1 Internet	69 Fixed broadband Internet subscriptions per 100 inhabitants	# of subscriptions per 100 residents
		70 Mobile broadband Internet subscriptions per 100 inhabitants	# of subscribed mobile phones per 100 residents
	N.2 Telephones	71 Mobile cellular phone subscriptions per 100 inhabitants	# of subscriptions per 100 residents
O Education	O.1 Quality of education	72 Adult literacy rate	%

Source: <http://www.iadb.org/en/topics/emerging-and-sustainable-cities/implementing-the-emerging-and-sustainable-cities-initiative-approach,7641.html>

ITU-T Focus Group on Smart Sustainable Cities: Key performance indicators definitions for smart sustainable cities Annex K



Example: Smart City Indicators #3

70

Mobile broadband Internet subscriptions per 100 residents

Topic:

Connectivity

Sub-Topic:

Internet

Definition

Number of mobile devices (such as cell phones, tablets, and smartphones) with a data subscription plan to access the Internet with speeds of 256 kbit/s or greater, per 100 people. This excludes mobile subscriptions via data cards or USB modems.

Methodology

This information is usually available from Internet service providers.

Benchmarks

Green	Yellow	Red
> 20%	10–20%	< 10%

Rationale

Broadband has a multiplicative effect on GDP, productivity, and employment. According to a recent study of 26 Latin American and Caribbean countries by the IDB, an increase of 10% in the number of broadband subscriptions per 100 inhabitants provokes, on average, increases in GDP of 3.19%, in productivity of 2.61%, and in employment of 67,016 jobs. Although Latin America and the Caribbean (LAC) has a high penetration of mobile phones, mobile broadband subscription is still very low. The majority of people use cellular phones to place voice calls, but still do not use them to access the Internet.

The measurement of mobile broadband subscription and its evolution will allow each municipality to assess its mobile broadband adoption compared to its mobile phone adoption and then identify issues (affordability and coverage) and opportunities for interventions, usage, and growth.

(Based on Zaballos, Antonio García and Rubén López-Rivas, "Socio-economic impact of broadband in LAC countries," IDB, 2003.)

Other organizations or agencies that use this indicator

Global Competitiveness Report (World Economic Forum). The ITU uses "standard mobile subscriptions with use of data communications at broadband speeds." The OECD uses "wireless broadband subscription." In the LAC region, data is only available for Mexico.

Coverage:

GSMA predicts that more than 80% people worldwide will have access to 3G networks by 2020 (up from 70% today/2015), while 4G networks will cover over 60% of the global population (up from 25% today).

Sources: ESCI

<http://www.iadb.org/en/topics/enging-and-sustainable-cities/implementing-the-emerging-and-sustainable-cities-initiative-approach,7641.html>

GSMA

<https://gsmaintelligence.com/research/2014/12/mobile-broadband-reach-expanding-globally/453/>

Weighting factors: Example

- An example from International Data Corporation (IDC)

Criteria	weighting
Smart government	20
Smart buildings	20
Smart mobility	20
Smart energy and environment	20
Smart services	20
Total	100



- In this case the indicators in each dimension are scaled to reach a score of 20
 - Each dimension can have a different weighting*

Source FG-SSC “Key performance indicators definitions for smart sustainable cities”





Next: KPIs related to the use of ICT in SSCs



Who may use the KPIs?

- City officials and municipal administrations
 - 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 non-profit organizations
 - enabling them to understand the development and progress of SSC
- City 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 and ranking agencies, including academia
 - supporting them in selection of relevant KPIs for assessing the contribution from ICT in the development of SSC



Source: FG-SSC “Overview of key performance indicators in smart sustainable cities” page 1, also “Key Performance Indicators (KPIs) related to the level and usage of Information and Communication Technology (ICT) in Smart Sustainable Cities”, page 5



How are KPIs Generated?

- Follow these steps
 - Data collection
 - select suitable data sources and data collections for each indicator
 - Data normalization
 - transform all the raw data into a normalized value for each indicator
 - Data aggregation
 - aggregate the normalized value of each indicator for each dimension
 - Data assessment
 - assess the result of all the dimensions for the final index
 - SSC evaluation
 - draw the conclusion from the final index

Year	As at end June		Annual Growth Rate		Population Density (per sq. km)	Median Age ⁴ (years)	Old-Age Support Ratio
	Total Population	Resident Population	Total Population	Resident Population			
	('000)		(%)				
2002	4,176.0	3,382.9	0.9	1.7	6,078	34.7	9.6
2003	4,114.8	3,366.9	0.2	1.6	5,934	35.0	9.7
2004	4,166.7	3,413.3	1.3	1.4	5,985	35.4	9.2
2005	4,265.8	3,467.8	2.4	1.6	6,112	35.8	8.9
2006	4,401.4	3,525.9	3.2	1.7	6,292	36.1	8.6
2007	4,588.6	3,583.1	4.3	1.6	6,508	36.4	8.5
2008	4,839.4	3,642.7	5.5	1.7	6,814	36.7	8.4
2009	4,987.6	3,733.9	3.1	2.5	7,022	36.9	8.3
2010	5,076.7	3,771.7	1.8	1.0	7,126	37.4	8.2
2011	5,183.7	3,789.3	2.1	0.5	n.a.	38.0	7.9

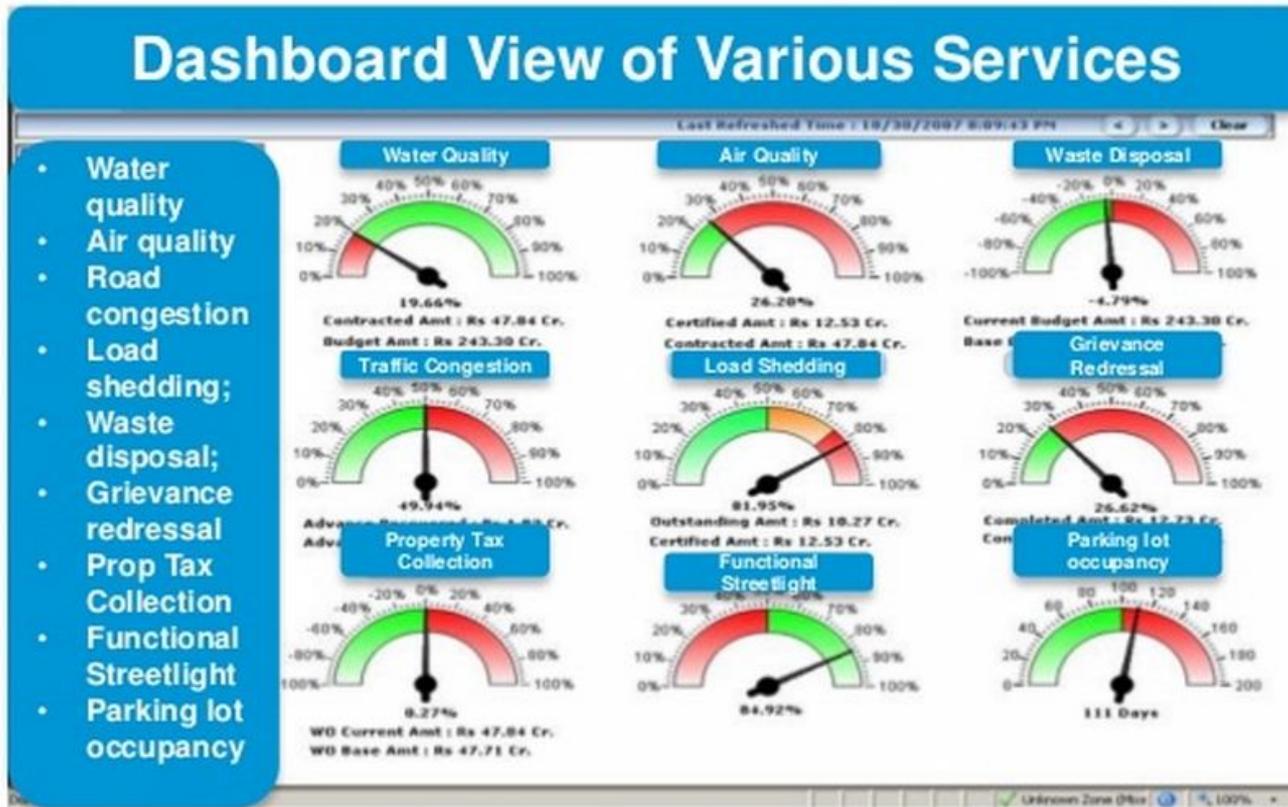
Sources: Singapore Department of Statistics, Population Trends 2011 and Singapore Census of Population 2010.



Example: Smart City Dashboard

Proposed by Cisco for Hyderabad

City Dashboard



Source: Prakash Kumar, Cisco, "Smart Cities, Global Experiences and Lessons for India"
<http://www.slideshare.net/prakash338/smart-cities-global-experiences-and-lessons-for-india-at-asci-hyderabad-25-apr-2013>

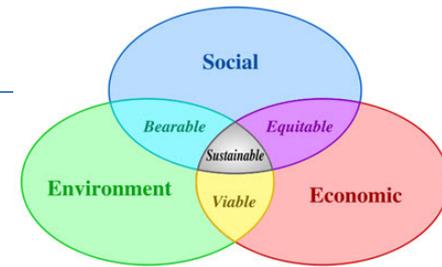




KPIs related to the sustainability impacts of ICT in SSCs



What is Meant by Sustainability?



- 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 “well-being” (safety, health, education) can be equally delivered to all regardless of 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, participation, and justice

Source: FG-SSC Technical Report on Key Performance Indicators (KPIs) related to the sustainability impacts of Information and Communication Technology (ICT) in Smart Sustainable Cities page 6





Next: Review of standardization activities and gaps for SSC





Standards may be classified into Four Categories

- Smart City management and assessment
- SSC services
- Information and Communication Technology (ICT)
- Buildings and physical infrastructures

Source: Source: FG-SSC “Technical Report on Standardization Roadmap for SSC”
pages 3-4



Challenges

- In addition to ITU-T, a number of other important standards bodies are working to scope out and develop Smart City and SSC standards.
- Standards may not necessarily reflect the complexity of dealing with a SSC as a system of systems

Source: Source: FG-SSC “Technical Report on Standardization Roadmap for SSC”, Page 6





Standards Gap Analysis#1

- FG-SSC
 - Possible topics for future Recommendations in ITU are identified in Technical Reports*
 - Examples include
 - "Overview of key performance indicators in smart sustainable cities"
 - "An overview of smart sustainable cities and the role of information and communication technologies"
 - "Smart sustainable cities: an analysis of definitions"
 - "Smart water management in cities"
 - "Electromagnetic field considerations in smart sustainable cities"
- 13 deliverables have been approved by the FG
 - 10 other reports are currently at a draft stage which could be candidates for future standards or ITU Recommendations. These are due to be completed in May 2015
- Note that Contribution 404 to the ITU-T Meeting in Kochi 8 - 19 December 2014 is entitled "Proposal to create a new Question on Smart Sustainable Cities"
 - It was agreed that a new Question, number 20, should be set up on this topic.

*Source: FG-SSC Draft Technical Report on Standardization Activities and Gaps for SSC and suggestions to SG5 page 7





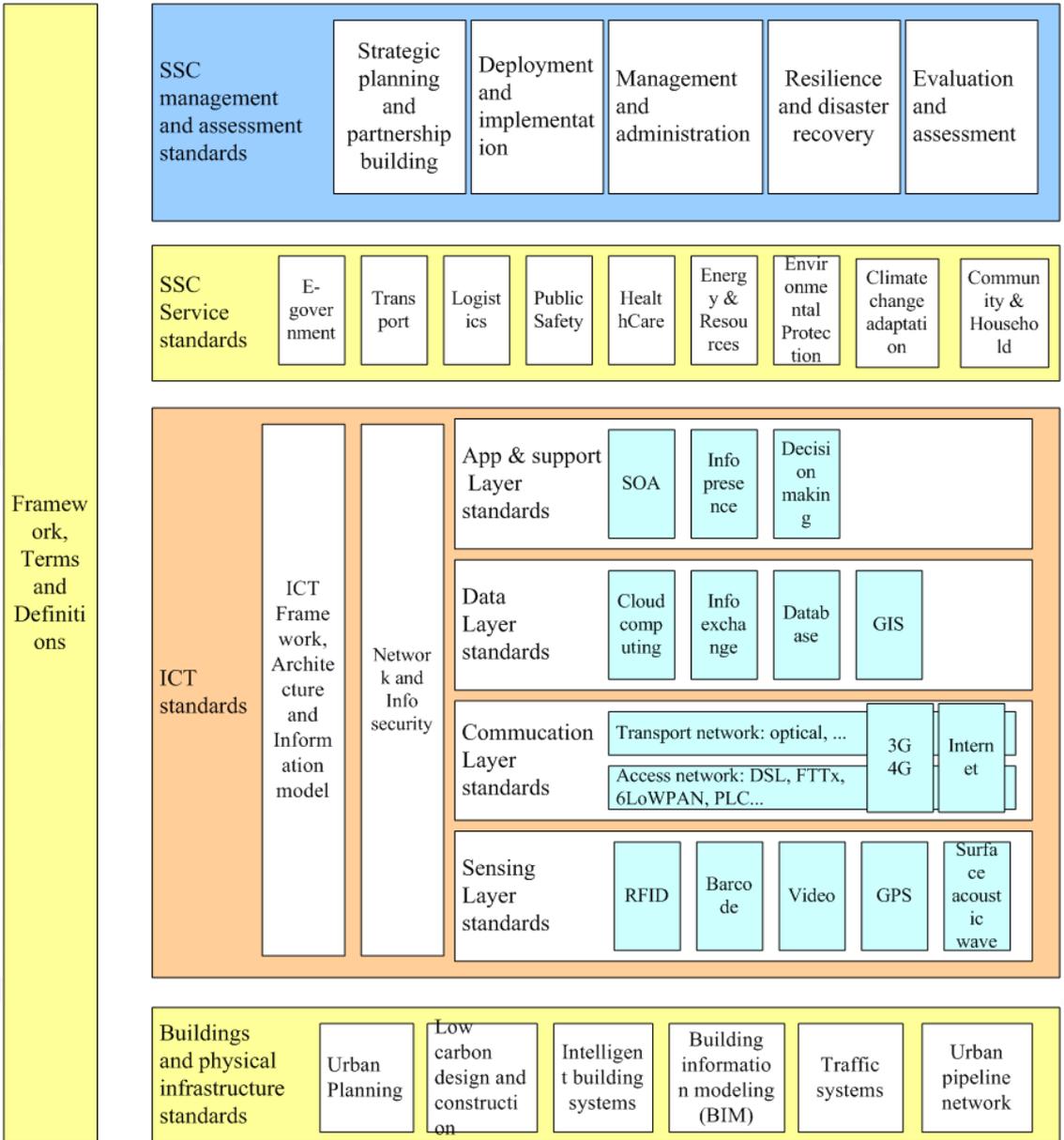
Standards Gap Analysis#2

Standardisation gaps were considered for each aspect in the Figure 1

28 Gaps have been identified

Most of these could be topics for ITU with collaboration with other SDOs

*Source: ITU-T Focus Group on Smart Sustainable Cities: “Standardization roadmap for smart sustainable cities” Page 7





Examples of SDOs working on standards for SSCs #1

Standards Developing Organizations (SDOs)

- International Organization for Standardization (ISO)
- ISO/AWI TR 37121
 - Approved new Work Item (AWI)
 - Inventory and review of existing indicators on sustainable development and resilience in cities
 - Under development
- ISO/DIS 37120
 - Draft International Standard
 - Sustainable development and resilience of communities -Indicators for city services and quality of life
 - Under development



FG-SSC “Technical Report on Standardization Activities for SSC” Page 104





Examples of SDOs working on standards for SSCs #2



- ISO also works on standards for many other dimensions of a SSC which are not the subject of ITU
- For example ISO 16346
 - Energy performance of buildings – Assessment of overall energy performance
 - Under development

FG-SSC “Technical Report on Standardization Activities for SSC”
Page 111





Examples of SDOs working on standards for SSCs #3



- ETSI
 - European Telecommunications Standards Institute
- For example TS 102 708
 - Intelligent Transport Systems (ITS)
 - Test specifications for High Data Rate (HDR) data transmission equipment operating in the 5.8 GHz ISM band
 - Under development

FG-SSC “Technical Report on Standardization Activities for SSC”
Pages 91-92



Examples of SDOs working on standards for SSCs #4

- The examples cited are only a few of the total of SDOs working on some aspects of Smart Cities/SSC
- The full list identified by the FG-SSC is
 - ICT Related SDOs
 - ANSI, BSI, CCSA, CCSA/TC 10, CEN/CENELEC, DIN/DKE, ETNO, ETSI, GISFI, IEC, IEEE, ISO, ISO/IEC JTC1, JTC1,TIA, TIA/CCSC
 - Other organisations
 - RECI (Spain), Carbon Disclosure Project, AHCIET, C40 Cities Climate Leadership Group, ICLEI, The City Protocol Society

FG-SSC “Technical Report on Standardization Activities for SSC”



Example of a regional organisation providing power targets for ICTs



The screenshot shows the website of the Joint Research Centre (JRC) of the European Commission, specifically the Institute for Energy and Transport (IET). The page is titled "ICT Codes of Conduct". It features a navigation menu with options like HOME, ABOUT, NEWSROOM, PUBLICATIONS, EVENTS, and ENERGY EFFICIENCY ACTIVITIES. The main content area includes a sub-header "ICT Codes of Conduct" and a paragraph explaining the energy consumption of ICTs, noting that stand-by power consumption is an increasing fraction of electricity use. A "CoC Menu" sidebar on the right lists various categories: Data Centres Energy Efficiency, Digital TV Services, Energy Consumption of Broadband Communication Equipment, Efficiency of External Power Supplies, AC Uninterruptible Power Systems, Events, and Publications. The page also includes a "Legal notice | Cookies | Contact | Search | English (en)" header.

- Codes of Conduct are available for
 - External Power Supplies, Digital TV Services, Unattended Power Supplies (UPS), Broadband Equipment, and Data Centres.
 - The CoC for BB equipment (modems routers etc) contains numerical targets for future years to 2016
 - This is reviewed approximately every 3 years

Source: <http://iet.jrc.ec.europa.eu/energyefficiency/ict-codes-conduct>



Conclusion

- An overview of KPIs has been presented
 - Including the scope and priorities for SSCs
 - Showing how ICT performance can be measured in its own sector
 - Including the impact of ICT on the KPIs of other sectors
 - Showing how emerging standards for KPIs can allow comparisons to be made between one year and another or one city and another

