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|  | ITU-T Focus Group on Smart Sustainable Cities | | | |
|  | **Key performance indicators definitions for smart sustainable cities** | | | |
|  | Focus Group Technical Report | | | |



FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating, and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The procedures for establishment of focus groups are defined in Recommendation ITU-T A.7. ITU-T Study Group 5 set up the ITU-T Focus Group on Smart Sustainable Cities (FG-SSC) at its meeting in February 2013. ITU-T Study Group 5 is the parent group of FG-SSC.

Deliverables of focus groups can take the form of technical reports, specifications, etc., and aim to provide material for consideration by the parent group in its standardization activities. Deliverables of focus groups are not ITU-T Recommendations.

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| --- |
| **SERIES OF FG-SSC TECHNICAL REPORTS/SPECIFICATIONS**  Technical Report on "Smart sustainable cities: a guide for city leaders"  Technical Report on "Master plan for smart sustainable cities"  Technical Report on "An overview of smart sustainable cities and the role of information and communication technologies"  Technical Report on "Smart sustainable cities: an analysis of definitions"  Technical Report on "Smart water management in cities"  Technical Report on "Electromagnetic field (EMF) considerations in smart sustainable cities"  Technical Specifications on "Overview of key performance indicators in smart sustainable cities"  Technical Report on "Information and communication technologies for climate change adaptation in cities"  Technical Report on "Cybersecurity, data protection and cyber resilience in smart sustainable cities"  Technical Report on "Integrated management for smart sustainable cities"  Technical Report on "Key performance indicators definitions for smart sustainable cities"  Technical Specifications on "Key performance indicators related to the use of information and communication technology in smart sustainable cities"  Technical Specifications on "Key performance indicators related to the sustainability impacts of information and communication technology in smart sustainable cities"  Technical Report on "Standardization roadmap for smart sustainable cities"  Technical Report on "Setting the stage for stakeholders’ engagement in smart sustainable cities"  Technical Report on "Overview of smart sustainable cities infrastructure"  Technical Specifications on "Setting the framework for an ICT architecture of a smart sustainable city"  Technical Specifications on "Multi-service infrastructure for smart sustainable cities in new-development areas"  Technical Report on "Intelligent sustainable buildings for smart sustainable cities"  Technical Report on "Anonymization infrastructure and open data in smart sustainable cities"  Technical Report on "Standardization activities for smart sustainable cities" |

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**Key performance indicators definitions for smart sustainable cities**

About this Technical Report

This Technical Report has been prepared as a contribution to the International Telecommunication Union's (ITU) Focus Group on Smart Sustainable Cities – Working Group 3 (WG3).

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Additional information and materials relating to this Technical Report can be found at: [www.itu.int/itu-t/climatechange](http://www.itu.int/itu-t/climatechange). If you would like to provide any additional information, please contact Cristina Bueti (ITU) at [tsbsg5@itu.int](http://www.siemens.com/entry/cc/en/greencityindex.htm).

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Executive Summary

This Technical Report is a deliverable of the ITU-T Focus Group on Smart Sustainable Cities (FG-SSC) and is part of a series of Technical Reports and Technical Specifications focusing on key performance indicators (KPIs) for smart sustainable cities (SSC). This Technical Report is intended to supplement and provide further background on the content provided in the “Technical Specifications on overview of key performance indicators in smart sustainable cities”, which was approved during the FG-SSC meeting held in Geneva, October 2014. It is also intended to complement the “Technical Specifications on key performance indicators related to the use of information and communication technology in smart sustainable cities” and the “Technical Specifications on key performance indicators related to the sustainability impacts of information and communication technology in smart sustainable cities”.

This Technical Report provides a comparative analysis of nineteen different index sets. Supplementary information on each of the approaches reviewed is presented in the annexes, thus providing a comprehensive background of the resources that formed the FG-SSC series of KPIs Technical Reports and Technical Specifications.

In order to ensure the inclusion of a wide array of perspectives, the indexes reviewed originate from international sources, national/regional sources, city organization sources, academic sources, and company sources. By doing so, the analysis evidenced the broad set of perspectives and approaches used to measure and assess the performance of SSC, and in particular, the role of ICTs in urban sustainability, thus demonstrating the importance of KPIs development for smart sustainable cities.

This Technical Report is structured around four main sections. Section one provides the introductory background and scope. Section 3 presents a series of key definitions used as the basis for this Technical Report. Section 5 presents the comparative analysis of indicators, structured around the five dimensions that characterize SSC strategies (i.e. ICT, environmental sustainability, productivity, quality of life, equity and social inclusion, and physical infrastructure). Based on this analysis, section 6 offers reflections and concluding remarks.

The comparative review presented in this Technical Report provides a valuable background for the discussions held by the members of ITU's FG-SSC, particularly for the exchanges that took place between the members of Working Group 3 focused on KPIs and metrics. It also helps to understand the development of the series of KPIs Technical Reports and Technical Specifications, confirming ITU-T FG-SSC commitment to the development of robust metrics that can serve as the basis for the development of standards in this field.

1 Introduction

Within the context of an increasingly interconnected society, information and communication technologies (ICTs) are playing a role as part of novel approaches to address urban challenges. They are an intrinsic component of smart sustainable cities (SSC), contributing to the improvement of citizens' quality of life, the provision of public services, and the achievement of sustainable development goals, among others.

Both established as well as emerging ICTs, including mobile broadband, Internet of things, cloud computing, big data, and next-generation networks (NGNs), have been involved in the establishment of smart sustainable city strategies. Many of these tools are being deployed globally, giving momentum to the next revolution of technology and industry that combine intelligent and sustainable features. However, as the design and implementation of SSC strategies continues to unfold, it becomes vital to develop robust indicators that allow to monitor, measure, and better understand both the technical requirements, as well as the social and environmental implications of ICTs use in urban settings.

In order to further enhance the understanding of how ICT solutions can make cities smarter and more sustainable, as well as to support decision-makers, practitioners and citizens alike in the development of novel approaches to urban development, ITU-T Focus Group on Smart Sustainable Cities (FG-SSC) is developing a set of key performance indicators (KPIs) to measure and assess ICT's impact on SSC.

1.1 Scope

The purpose of this Technical Report is to serve as a supplement to the content presented in the series of KPIs Technical Reports (TRs) and Technical Specifications (TSs) developed by FG-SSC, by presenting an overview of the analysis and the background resources used to show the development of those TRs and TSs.

This Technical Report provides a general overview of a key set of indicators related to the use of information and communication technology (ICT) and corresponding impacts on city sustainability in smart sustainable cities (SSC). It is intended for an audience of SSC decision-makers and strategists, interested in gaining a more in-depth understanding of existing knowledge and approaches to indexes and KPIs for SSC. This Technical Report illustrates the vast body of resources gathered on the evaluation index systems of smart cities and KPIs for sustainable cities, among others, that served as a background for the development of related series of KPIs Technical Reports and Technical Specifications. The resources presented in this Technical Report were analysed with respect to common elements, and a set of indicators focusing on ICT and its contribution to smart sustainable cites was developed.

2 References

[ITU-T TR SSC Def] *Technical Report on smart sustainable cities: an analysis of definitions* (2014).

[ITU-T TR EMF Con] *Technical Report on electromagnetic field (EMF) consideration in smart sustainable cities* (2014).

[UN-Habitat report] UN-Habitat report(2013)*, State of the World’s cities 2012/2013 Prosperity of Cities.*

[OECD KE] Organisation for Economic Co-operation and Development (1996)*, The knowledge-based economy.*

3 Definitions

3.1 Terms defined elsewhere

This Technical Report uses the following terms defined elsewhere:

**3.1.1 knowledge economy** [OECD KE]: "An economy whose most important elements are the possession, control, production and utility of knowledge and intelligent resources", while 'knowledge based economy' is an expression "coined to describe trends in advanced economies towards greater dependence on knowledge, information and high skill levels, and the increasing need for ready access to all of these by the business and public sectors".

**3.1.2** **smart sustainable cities** [ITU-T TR SSC Def]: 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 and environmental aspects.

3.2 Terms defined in this Technical Report

This Technical Report defines the following term:

### 3.2.1 City sustainability

The sustainability of a 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 well-being (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.

4 Abbreviations and acronyms

This Technical Report uses the following abbreviations and acronyms:

3G Third Generation mobile networks

AIDS Acquired Immune Deficiency Syndrome

API Application Programming Interface

BB BroadBand

CAGR Compound Annual Growth Rate

CBD Central Business District

CIC China Institute of Communications

ECDL European Computer Driving License

EHR Electronic Health Record

EMF Electromagnetic Field

ERMC European Ranking of Middle-sized Cities

ESCI Emerging and Sustainable Cities Initiative

EUSI European System of Social Indicators

EV Electric Vehicle

FDI Foreign Direct Investment

FTTx Fibre to the x (B – building, business; H – Home; C – Cabinet, Curb)

GCIF Global City Indicators Facility

GDP Gross Domestic Product

GHG Green House Gas

GIS Geographic Information System

GP General Practitioner

GPC Global Protocol for Community scale GHG emissions

HDV Heavy Duty Vehicle

HIV Human Immunodeficiency Virus infection

HQ HeadQuarter

HSPA+ Evolved High-Speed Packet Access

IBM International Business Machine

ICLEI International Council for Local Environmental Initiatives

ICT Information and Communication Technology

IDC International Data Corporation

IDI ICT Development Index

IP Internet Protocol

IPPU Industrial Processes and Product Uses

ISCED International Standard Classification of Education

ISO International Organization for Standardization

ITS Intelligent Transport System

ITU International Telecommunication Union

KIS Knowledge-Intensive Services

KPIs Key Performance Indicators

LDV Light Duty Vehicle

LTE Long Term Evolution

MOHURD Ministry Of Housing and Urban-Rural Development, China

OECD Organization for Economic Co-operation and Development

PC Personal Computer

PCT Patent Cooperation Treaty

PM10 Particulate Matter up to 10 micrometres in size

PPP Purchasing Power Parity

PPS Prospective Payment System

R&D Research and Development

RES Renewable Energy Source

RFID Radio Frequency Identification

RMB Ren Min Bi

SDR Special Drawing Rights

SIM Subscriber Identity Module

SSC Smart Sustainable Cities

SWB Subjective Well-Being

TEN Trans-European Network

TR Technical Report

TS Technical Specifications

TTC Telecommunication Technology Committee (TTC) of Japan

UNEP United Nations Environment Programme

UNFCCC United Nations Framework Convention on Climate Change

UN-Habitat United Nations Human Settlements Programme

WG Working Group

WiFi Wireless Fidelity

5 Analysis of key performance indicators systems

This section provides an analysis of nineteen different sets of index systems and KPIs related to the use of ICTs and sustainability in cities. As demonstrated in the Technical Specifications on “Overview of key performance indicators in smart sustainable cities”, the identification of these indicators is vital to assess how the use of ICTs can have an impact on the sustainability of cities, in order to provide grounds for standardization.

Box 1 highlights some of the stakeholders and the benefits associated to the development of KPIs for SSC.

**Box. 1: 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.

The analysis in this Technical Report is conducted through a comparison based on the key dimensions and sub-dimensions that characterize smart sustainable cities, namely:

|  |  |
| --- | --- |
| SSC dimension | No. of indicators/sub-dimensions |
| **ICT** | 14 indicators / cover network facilities and information facilities |
| **Environmental sustainability** | 14 indicators / cover environment and energy and natural resources |
| **Productivity** | 12 indicators / cover innovation and economic sustainability |
| **Quality of life** | 22 indicators / cover convenience and comfort, security and safety, health care, and education and training |
| **Equity and social inclusion** | 11 indicators / cover openness and public participation, social sustainability, and governance sustainability |
| **Physical infrastructure** | 15 indicators / cover building, transport, sanitation, and municipal pipe network |

These different dimensions and sub-dimensions are developed in further detail in the Technical Reports and Technical Specifications that are part of the FG-SSC KPI series (i.e. "Overview of key performance indicators in smart sustainable cities", "Key performance indicators related to the use of information and communication technology in smart sustainable cities", and "Key performance indicators related to the sustainability impacts of information and communication technology in smart sustainable cities").

A comparative analysis of nineteen different index sets is summarized in Table 5-1. As per the objectives and the scope of this Technical Report, supplementary information on each of the approaches reviewed is presented in the annexes, providing a comprehensive background of the resources that formed the FG-SSC KPIs series.

In order to ensure the inclusion of a wide array of perspectives, the indexes reviewed originate from five different sources: international sources, national/regional sources, city organization sources, academic sources, and company sources, as follows:

* International sources:

a) The International Organization for Standardization (ISO), smart community infrastructures (Annex A);

b) The International Telecommunication Union (ITU), ICT development index (IDI) (Annex B);

c) UN-Habitat, city prosperity index (Annex C).

* National/regional sources:

d) China Institute of Communications, evaluation index system of a smart City (Annex D);

e) China, Ministry of Housing and Urban-Rural Development (MOHURD), index system of a pilot smart city (Annex E);

f) European Union, European common indicators (EU research initiative "Towards a local sustainability profile") (Annex F);

g) Italy, smart city and smart statistics (Annex G);

h) Japan, Sub working group for SSC of the Telecommunication Technology Committee, index system of SSC (Annex H).

* City organization sources:

i) Global city indicators facility, global city indicators (Annex I);

j) International Council for Local Environmental Initiatives (ICLEI), global protocol for community scale greenhouse gas (GHG) emissions (GPC) (Annex J);

k) Inter-American Development Bank, indicators of the emerging and sustainable cities initiative (ESCI) (Annex K).

* Academic sources:

l) Centre of Regional Science (SRF), Vienna University of Technology, European smart cities, ranking of European medium-sized cities (Annex L);

m) Leibnitz Institute, European system of social indicators (Annex M);

n) Boyd Cohen, Smart Cities Wheel (Annex N).

* Company sources:

o) Ericsson, networked society city index (Annex O);

p) IBM, smarter city assessment (Annex P);

q) IDC, smart cities index (Annex Q);

r) pricewaterhousecoopers (PwC), cities of opportunity index (Annex R);

s) Siemens, green city index (Annex S).

This body of knowledge was analysed and compiled in two tables:

Table 5-1 compares the different indexes, identifying whether or not they include indicators related to the key SSC dimensions and sub-dimensions identified above.

Table 5-2 contributes further to this analysis, by identifying the number of similar indicators that exist between the different set of indicators and the SSC dimensions, as well as the percentage of similar indicators and the distribution of these indicators.

| Table 5-1 – Comparison of KPIs between index systems and sets of KPIs | | | | | | | | | | | | | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Dimension | Sub-  dimension | Indicators | ISO | | IDI | UN-Habitat | CIC | MOHURD | ECI | Italy | TTC | GCIF | GPC | ESCI | ERMC | EUSI | Wheel | Ericsson | IBM | IDC | PwC | Siemens |
| **D1 ICT** | **D1.1 Network facilities** | I1.1.1 Fixed (wired)-broadband subscriptions per 100 inhabitants |  | | X |  | X | X |  | X |  | X |  | X |  |  |  | X | X | X |  |  |
| I1.1.2 International Internet bandwidth (bit/s) per Internet user | X | | X |  | X |  |  | X | X |  |  |  | X |  |  | X | X | X | X |  |
| I1.1.3 Wireless-broadband subscriptions per 100 inhabitants |  | | X |  | X | X |  | X |  | X |  | X |  |  |  | X | X | X |  |  |
| I1.1.4 Percentage of households with Internet access | X | | X |  | X |  |  | X |  | X |  |  |  |  |  | X | X | X | X |  |
| I1.1.5 Coverage rate of next-generation broadcasting network | X | |  |  |  | X |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| I1.1.6 EMF compliance framework in place |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| I1.1.7 Planning legislation incorporates ICT networks and antenna requirements |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| I1.1.8 ICT EMF information availability to the public |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **D1.2 Information facilities** | I1.2.1 Percentage of enterprises providing network-based services (e‑commerce, e‑learning, e‑entertainment, cloud computing) | X | |  |  | X |  |  | X |  |  |  |  |  |  |  |  |  |  |  |  |
| I1.2.2 Proportion of business based on cloud computing |  | |  |  | X | X |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| I1.2.3 Proportion of business based on GIS (location, navigation, etc.) |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| I1.2.4 Percentage of households with at least one computer |  | | X |  | X |  |  | X |  |  |  |  | X |  |  | X |  | X |  |  |
| I1.2.5 Level of cyber-security |  | |  |  | X |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| I1.2.6 Ratio of children online protection |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **D2 Environmental sustainability** | **D2.1 Environment** | I2.1.1 Proportion of information published on environmental quality |  | |  |  | X |  |  |  |  |  |  |  |  |  |  |  |  | X |  |  |
| I2.1.2 Progress degree of ICT in the protection of main city water resources |  | |  |  | X |  |  |  | X |  |  | X |  | X |  |  | X | X |  |  |
| I2.1.3 Effect of flood control monitoring by means of ICT measures |  | |  |  |  |  |  |  |  |  |  | X |  |  |  |  | X | X |  |  |
| I2.1.4 Proportion of water pollution control by means of ICT measures |  | |  |  | X |  |  |  | X | X |  | X |  | X |  | X | X | X |  | X |
| I2.1.5 Proportion of air pollution monitoring by means of ICT measures |  | |  | X | X |  | X | X |  |  |  | X |  | X |  | X |  | X | X | X |
| I2.1.6 Proportion of toxic substances monitoring by means of ICT measures |  | |  |  | X |  |  |  | X |  |  |  |  |  |  |  |  |  |  |  |
| I 2.1.7 Proportion of noise monitoring by means of ICT measures |  | |  |  | X |  | X |  |  |  |  | X |  |  |  |  |  |  |  |  |
| I2.1.8 Solid waste disposal management with ICT measures | X | |  | X | X |  |  |  | X | X |  | X |  | X |  | X |  | X | X | X |
| **D2.2 Energy and natural resources** | I2.2.1 Improvement of civilian electricity usage (per capita) with ICT measures |  | |  |  | X |  |  | X | X |  |  | X | X |  |  |  |  |  |  | X |
| I2.2.2 Improvement of industrial electricity usage (per GDP) with ICT measures |  | |  | X | X |  |  | X | X |  |  | X | X |  |  |  |  | X |  |  |
| I2.2.3 Improvement of civilian water usage (per capita) with ICT measures |  | |  |  |  | X |  | X | X |  |  | X | X |  |  |  |  |  |  | X |
| I2.2.4 Improvement of industrial water usage (per GDP) with ICT measures |  | |  |  |  | X |  | X | X |  |  |  | X |  |  |  |  |  |  |  |
| I2.2.5 Improvement of fossil fuel usage with ICT measures (per GDP) | X | |  | X |  | X | X | X | X |  |  |  |  |  |  | X |  |  |  | X |
| I2.2.6 Improvement of rare metal/noble metal usage (per GDP) with ICT measures |  | |  |  |  |  |  |  | X |  |  |  |  |  |  |  |  |  |  |  |
| **D3 Productivity** | **D3.1 Innovation** | I3.1.1 Percentage of R&D expenditure in GDP |  | |  |  |  |  |  | X | X |  |  |  | X |  |  |  |  |  |  |  |
| I3.1.2 Ratio of knowledge-intensive enterprises |  | |  |  |  |  |  | X |  |  |  |  | X |  |  |  |  |  | X |  |
| I3.1.3 Revenue share of knowledge-intensive enterprise |  | |  |  |  |  |  |  |  |  |  | X |  |  |  |  |  |  |  |  |
| I3.1.4 Patent number per 100,000 inhabitant |  | |  |  |  |  |  | X |  |  |  |  | X |  |  | X |  |  |  |  |
| I3.1.5 Importance as decision-making centre (HQ, etc.) |  | |  |  |  |  |  |  |  |  |  |  | X |  |  |  |  |  |  |  |
| I3.1.6 SSC new projects opportunities |  | |  |  |  |  |  |  |  |  |  |  |  |  |  | X |  |  | X |  |
| I3.1.7 Penetration of teleworking system |  | |  |  |  |  |  | X |  |  |  |  |  |  |  |  |  | X |  |  |
| I3.1.8 Improvement of traditional industry with ICT |  | |  |  | X | X |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **D3.2 Economic sustainability** | I3.2.1 Percentage of knowledge economy in total investment |  | |  | X |  | X |  | X |  |  |  |  |  |  |  |  |  |  | X |  |
| I3.2.2 Percentage of knowledge economy in GDP |  | |  |  |  |  |  | X |  |  |  |  |  |  |  |  |  |  | X |  |
| I3.2.3 Employment rate in knowledge-intensive sectors |  | |  | X |  | X |  | X | X |  |  | X | X | X |  | X |  | X | X |  |
| I3.2.4 Percentage of e-commerce transaction amount |  | |  |  | X | X |  | X | X |  |  |  |  |  |  | X | X | X |  |  |
| **D4 Quality of life** | **D4.1 Convenience and comfort** | I4.1.1 Satisfaction with online commercial and financial services |  | |  |  | X | X |  |  | X |  |  |  |  | X | X |  | X | X |  |  |
| I4.1.2 Satisfaction with environmental safety |  | |  |  | X | X |  |  |  |  |  |  |  | X |  |  |  |  |  |  |
| I4.1.3 Convenience of government services |  | |  |  | X | X | X | X |  |  |  |  | X |  |  |  | X |  |  |  |
| I4.1.4 Convenience of smart traffic information administration and service |  | |  |  | X | X |  |  |  |  |  | X |  |  | X |  |  | X |  |  |
| I4.1.5 Satisfaction with quality of public transport |  | |  |  | X |  |  |  |  |  |  | X | X | X |  |  | X | X | X |  |
| I4.1.6 Satisfaction with crime prevention and security control |  | |  |  | X |  |  |  | X |  |  | X | X | X |  |  |  |  | X |  |
| I4.1.7 Satisfaction with countermeasures against disaster |  | |  |  |  |  |  | X |  |  |  | X |  |  |  |  |  |  |  |  |
| I4.1.8 Satisfaction with food drug safety monitoring |  | |  |  | X |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| I4.1.9 Convenience of urban medical care |  | |  |  | X |  |  |  |  |  |  |  |  | X |  |  |  |  |  |  |
| I4.1.10 Convenience for citizens to access education resource |  | |  |  | X |  |  |  |  |  |  | X | X | X |  |  |  |  |  |  |
| I4.1.11 Perception of proof against risk of poverty |  | |  |  |  |  |  |  |  |  |  | X | X | X | X |  |  |  |  |  |
| I4.1.12 Satisfaction with housing conditions |  | |  |  |  |  |  |  |  |  |  | X |  | X |  |  |  |  | X |  |
| **D4.2 Security and safety** | I4.2.1 Accident prediction ratio |  | |  | X |  |  |  |  | X |  |  |  |  |  |  |  |  |  |  |  |
| I4.2.2 Penetration of ICT for disaster prevention |  | |  |  | X |  |  |  |  |  |  |  |  |  |  |  | X | X |  |  |
| I4.2.3 Publication rate of disaster alert |  | |  |  | X |  |  |  |  |  |  | X |  |  |  |  | X | X |  |  |
| I4.2.4 Penetration of city video surveillance |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | X |  |  |
| **D4.3 Health care** | I4.3.1 Percentage of archiving electronic health records for residents |  | |  |  | X |  |  | X |  |  |  |  |  |  |  |  |  |  |  |  |
| I4.3.2 Usage rate of electronic medical records |  | |  |  | X |  |  | X |  |  |  |  |  |  |  |  |  |  |  |  |
| I4.3.3 Sharing rate of resource and information among hospitals |  | |  |  | X |  |  | X |  |  |  |  |  |  |  |  |  |  |  |  |
| I4.3.4 Coverage rate of household e-health services |  | |  |  |  |  |  | X |  |  |  |  |  |  |  |  |  |  |  |  |
|  | **D4.4 Education and training** | I4.4.1 Effectiveness of hatching smart tech from knowledge centres (research centres, universities etc.) |  |  | |  | X |  |  |  |  |  |  |  | X |  |  |  |  |  |  |  |
| I4.4.2 Penetration of e-learning system |  |  | |  | X |  |  | X |  |  |  |  |  |  |  |  |  | X |  |  |
| **D5 Equity and social inclusion** | **D5.1 Openness and public participation** | I5.1.1 Immigration-friendly environment contributed by ICT measures |  |  | |  |  |  |  |  |  |  |  |  | X |  |  |  |  |  |  |  |
| I5.1.2 Improvement of turnout at city hearings by means of ICT |  |  | | X | X | X |  | X |  |  |  | X | X | X |  |  |  | X |  |  |
| I5.1.3 Online civic engagement |  |  | | X | X | X |  | X |  | X |  |  | X | X |  |  |  | X |  | X |
| **D5.2 Social sustainability** | I5.2.1 Feasibility of appealing online |  |  | | X | X |  |  | X |  |  |  |  |  | X |  |  |  | X |  |  |
| I5.2.2 Atmosphere of free online comment |  |  | |  | X | X |  | X |  |  |  |  |  | X |  |  |  | X |  |  |
| I5.2.3 Contribution in increasing consciousness of citizenship and social coherence |  |  | |  | X |  |  | X |  |  |  |  | X | X |  |  |  |  |  |  |
| **D5. 3 Governance sustainability** | I5.3.1 Digital access to urban planning and budget document |  |  | |  | X | X |  | X |  |  |  | X |  |  | X |  |  | X |  |  |
| I5.3.2 Appliance of smart community services |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | X |  |  |
| I5.3.3 Penetration rate of government online services |  |  | | X | X | X |  | X |  |  |  |  |  |  | X |  |  | X |  |  |
| I5.3.4 Percentage of government information open |  |  | |  | X | X |  | X |  |  |  | X |  |  | X |  |  | X |  |  |
| I5.3.5 Penetration of smart impediment removal (accessibility) system |  |  | |  |  | X |  |  |  |  |  | X |  |  |  |  |  |  |  |  |

| Table 5-1 – Comparison of KPIs between index systems and sets of KPIs | | | | | | | | | | | | | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Dimension | Sub-  dimension | Indicators | ISO | | IDI | UN-Habitat | CIC | MOHURD | ECI | Italy | TTC | GCIF | GPC | ESCI | ERMC | EUSI | Wheel | Ericsson | IBM | IDC | PwC | Siemens |
| **D6 Physical infrastructure** | **D6.1 Building** | I6.1.1 Application level of energy saving technologies in public buildings |  |  | |  | X |  |  |  |  |  |  | X |  | X |  |  |  | X |  |  |
| I6.1.2 Percentage of public buildings with integrated technologies |  |  | |  | X |  |  | X |  |  |  |  |  |  |  |  | X | X |  |  |
|  | I6.1.3 Proportion of smart home automation adoption |  |  | |  | X |  |  |  |  |  |  |  |  |  |  |  | X | X |  |  |
| **D6.2 Transport** | I6.2.1 Coverage of installation of road sensing terminals | X |  | |  | X |  |  |  |  |  |  |  |  |  |  |  |  | X |  |  |
| I6.2.2 Coverage of parking guidance systems |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | X |  |  |
| I6.2.3 Coverage of electronic bus bulletin board |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  | X |  |  |
| **D6.3 Sanitation** | I6.3.1 Sewage discharge management with ICT measures | X |  | | X |  | X |  |  |  |  |  | X |  |  |  |  | X | X |  | X |
| I6.3.2 Improvement of waste water recycling with ICT measures | X |  | | X |  | X |  | X |  |  |  | X |  |  |  |  | X | X |  | X |
| **D6.4 Municipal pipe network** | I6.4.1 Drainage system management with ICT measures | X |  | | X |  | X |  |  |  |  |  |  |  |  |  |  | X | X |  |  |
| I6.4.2 Lighting system management with ICT measures |  |  | |  |  | X |  |  |  |  |  |  |  |  |  |  |  | X |  |  |
| I6.4.3 Gas system management with ICT measures | X |  | |  |  | X | X |  |  |  |  |  |  |  |  |  |  | X |  |  |
| I6.4.5 Water saving smart metering |  |  | |  |  | X |  |  |  |  |  |  |  |  |  |  | X | X |  | X |
| I6.4.6 Electricity supply system management with ICT measures | X |  | | X |  | X | X |  |  |  |  | X |  |  |  |  | X | X |  |  |
| I6.4.7 Improvement of underground pipelines and spatial integrated administration with ICT measures |  |  | |  |  | X |  |  |  |  |  |  |  |  |  |  |  | X |  |  |

| Table 5-2 – Proximity statistics of KPIs for SSC | | | |
| --- | --- | --- | --- |
| Source | Number of similar indicators | Percentage of similar indicators (%) | Distribution of indicators |
| **ISO** | 7 | 7.95 | Internet access and bandwidth, broadcasting network, ratio of network enterprises, solid waste, fossil fuel, road sensing, sewage management, water recycling, gas management, electricity supply |
| **IDI** | 5 | 5.68 | Internet access and bandwidth, broadband subscription, wireless subscription, home computer |
| **UN-Habitat** | 11 | 12.5 | Air pollution, solid waste, industrial electricity, fossil fuel, knowledge economy, employment, accident prediction, political participation, appealing online, government online services, sewage management, water recycling, electricity supply |
| **CIC** | 47 | 53.41 | Internet access and bandwidth, broadband subscription, wireless subscriptions, ratio of network enterprises, cloud computing, home computer, cybersecurity, environmental information, water resource protection, pollution (water, air, toxic, noise, solid waste), civilian and industrial electricity, traditional industry improvement, e-commerce, e-finance, environmental safety, government services, smart traffic, public transport, security control, food and drug safety, medical care, education access, disaster alert and prevention, electronic health records, smart tech hatching, e-learning, political participation, appealing online, online freedom, social coherence, e-governance openness, government online services, building energy saving, smart building, smart home, road sensing |
| **MOHURD** | 22 | 25 | Broadband subscription, wireless subscriptions, broadcasting, cloud computing, civilian and industrial water, fossil fuel, traditional industry improvement, knowledge economy, employment, e-commerce, e-finance, environmental safety, government services, smart traffic, political participation, online freedom, e-governance openness, government online services, smart impediment, sewage management, water recycling, lighting management, gas management, smart metre, electricity supply, underground pipelines spatial integrated administration |
| **ESCI** | 29 | 4.55 | Air and noise pollution, fossil fuel, government services, gas management, electricity supply |
| **Italy** | 36 | 40.91 | Internet access and bandwidth, broadband and wireless subscriptions, ratio of network enterprises, home computer, air pollution, civilian and industrial electricity, civilian and industrial water, fossil fuel, R&D expenditure, knowledge enterprise, patent, teleworking, knowledge economy, employment, e-commerce, government services, counter-disaster satisfaction, electronic health records, household e-health, e-learning, political participation, appealing online, online freedom, social coherence, e-governance openness, government online services, smart building, water recycling |
| **TTC** | 13 | 14.77 | Internet bandwidth, water resource protection, pollution (water, toxic, solid waste), civilian and industrial electricity, civilian and industrial water, fossil fuel, rare metal, R&D expenditure, employment, e-commerce, e-finance, security control, accident prediction, political participation |
| **GCIF** | 6 | 6.82 | Broadband and wireless subscriptions, Internet access, water and solid waste pollution, anti-poverty, political participation |
| **GPC** | 0 | 0 |  |
| **ESCI** | 29 | 32.95 | Broadband and wireless subscriptions, water resource protection, flood control, water pollution (water, air, noise, solid waste), civilian and industrial electricity, civilian water, smart tech revenue, employment, smart traffic, public transport, security control, counter-disaster satisfaction, education access, anti-poverty, housing comfort, disaster alert, immigration convenience, political participation, e-governance openness, smart impediment, building energy saving, sewage management, water recycling, electricity supply |
| **ERMC** | 21 | 23.86 | Internet bandwidth, civilian and industrial electricity, civilian and industrial water, R&D expenditure, knowledge enterprise, patent, decision-making centre, employment, government services, public transport, security control, education access, anti-poverty, hatching smart tech, political participation, social coherence |
| **EUSI** | 19 | 21.59 | Water resource protection, pollution (water, air, solid waste), employment, e-finance, environmental safety, public transport, security control, medical care, education access, anti-poverty, housing comfort, political participation, appealing online, online freedom, social coherence, building energy saving |
| **Smart Cities Wheel (Boyd Cohen)** | 6 | 6.82 | e-finance, smart traffic, anti-poverty, e-governance openness, government online services |
| **Ericsson** | 13 | 14.77 | Internet access and bandwidth, broadband and wireless subscriptions, home computer, flood control, pollution (water, air, solid waste), fossil fuel, patent, smart tech opportunities, employment, e-commerce |
| **IBM** | 15 | 17.05 | Internet access and bandwidth, broadband and wireless subscriptions, water resource protection, flood control, water pollution, e-commerce, e-finance, government services, public transport, disaster alert and prevention, smart building, smart home, sewage management, water recycling, smart metre, electricity supply |
| **IDC** | 36 | 40.91 | Internet access and bandwidth, broadband and wireless subscriptions, home computer, environmental information, water resource protection, pollution (water, air, solid waste), industrial electricity, teleworking, employment, e-commerce, e-finance, smart traffic, public transport, disaster alert and prevention, video surveillance, e-learning, political participation, appealing online, online freedom, e-governance openness, smart community, government online services, building energy saving, smart building, smart home, road sensing, parking guidance, electronic bus bulletin, sewage management, water recycling, lighting management, gas management, smart metre, electricity supply, underground pipelines spatial integrated administration |
| **PwC** | 12 | 13.64 | Internet access and bandwidth, air pollution, solid waste, knowledge enterprise, opportunities, knowledge economy, employment, public transport, security control, housing comfort |
| **Siemens** | 7 | 7.95 | Pollution (water, air, solid waste), civilian electricity and water, fossil fuel, sewage management, water recycling, smart metre |

Legend to Tables 5-1 and 5-2: Sources and indicators

ISO: ISO/TC 268/SC1

IDI: ITU, ICT development index

UN-Habitat: UN-Habitat City Prosperity Index

CIC: China Institute of Communications

MOHURD: China, Ministry of Housing and Urban-Rural Development

ECI: European common indicators

Italy: Italy, smart city and smart statistics

TTC: Sub working group for SSC of TTC in Japan

GCIF: Global city indicators facility

GPC: Global Protocol for Community scale GHG emissions

ESCI: Emerging and sustainable cities initiative

ERMC: European smart cities, European ranking of medium-sized cities

EUSI: European system of social indicators

Wheel: Boyd Cohen: Index system of SSC, Smart Cities Wheel

Ericsson: Ericsson, networked society city index

IDC: Spain, IDC smart cities index

IBM: IBM, smarter city assessment

PwC: PwC, cities of opportunities index

Siemens: Green city index

6 Conclusions

This Technical Report collects a number of indicators that have been developed for cities by global, national, regional, academic and company stakeholders. The analysis evidenced the broad set of perspectives and approaches that exist in this field, but most importantly and common to all, it showed the importance attributed to measuring, monitoring, and learning from ICT usage in smart sustainable cities.

The content and supplementary information contained in this Technical Report allows the following general reflections:

– Although the specific categorization used differs between indexes, frequently used categories are economy, environment and – to some extent – governance. These are areas that have been recognized to be at the core of SSC strategies.

– The social aspect of sustainability is addressed in different ways by specific sets of indicators. Some have a main category for social aspects and add sub-categories, others do not include the social as an individual category, but instead use several categories that are related to social aspects.

– Despite the specific and sometimes diverging approaches to measuring the role of ICTs in smart city contexts, the sources reviewed confirmed the relevance of the key dimensions and sub-dimensions identified by the FG-SSC for the development of SSC KPIs. They also suggest the appropriateness of looking into ICT aspects, environmental sustainability, productivity, quality of life, equity and social inclusion, and non-ICT infrastructure development, as crucial components of smart sustainable cities.

The comparative review conducted provides a valuable background for the discussions held by the members of ITU's FG-SSC, particularly for the exchanges that took place among the members of Working Group 3 focused on KPI and metrics.

The review also helped to inform, complement and substantiate the development of the FG-SSC series of KPIs Technical Reports and Technical Specifications, specifically “Technical Specifications on overview of key performance indicators in smart sustainable cities”, “Technical Specifications on key performance indicators related to the use of information and communication technology in smart sustainable cities” and “Technical Specifications on key performance indicators related to the sustainability impacts of information and communication technology in smart sustainable cities”.

Annex A  
  
ISO: Index system of smart city

Source: ISO/TC 268/SC1, Smart community infrastructures, with possible directions for the development of metrics. http://www.iso.org/iso/home/standards\_development/list\_of\_iso\_technical\_committees/iso\_technical\_committee.htm?commid=656967

Table A.1 – Example of "community infrastructures"

|  |  |  |
| --- | --- | --- |
| 1 | Energy | Power grid, gas, fuels (gas station), etc. |
| 2 | Water | Water treatment process, water for industrial use, treated water, sewage disposal, etc. |
| 3 | Mobility | Road, railroad, airport, port, river, etc. |
| 4 | Waste | Waste recovery, recycling, etc. |
| 5 | ICT | Information processing, Internet, carrier, broadcasting, etc. |

Table A.2 – Examples of "performance (to be technically improved)"

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | Societal | Convenient | Viewpoint of resident |
| Comfortable |
| Secure |
| Safe |
| 2 | Economic | Management efficiency | Viewpoint of community managers |
| Vitalization of industry |
| Rotation of generation of the residents |
| 3 | Environmental | Global warming | Viewpoint of environmentalists, world opinions |
| Natural resources saving |
| Protection of biodiversity |

Annex B  
  
ITU: ICT development index (IDI)

Source: ITU Measuring the Information Society

[http://www.itu.int/ITU-D/ict/publications/idi/](http://www.itu.int/ITU-D/ict/publications/idi)

Eleven indicators for measuring the ICT development in countries are divided into three categories: ICT infrastructure and access, ICT use and ICT skills.

a) ICT infrastructure and access indicators

*1. Fixed-telephone subscriptions per 100 inhabitants*

*2. Mobile-cellular telephone subscriptions per 100 inhabitants*

*3. International Internet bandwidth (bit/s) per Internet user*

*4. Percentage of households with a computer*

*5. Percentage of households with Internet access*

b) ICT use indicators

*1. Percentage of individuals using the Internet*

*2. Fixed (wired)-broadband subscriptions per 100 inhabitants*

*3. Wireless-broadband subscriptions per 100 inhabitants*

c) ICT skills indicators

*1. Adult literacy rate*

*2. Secondary gross enrolment ratio*

*3. Tertiary gross enrolment ratio*

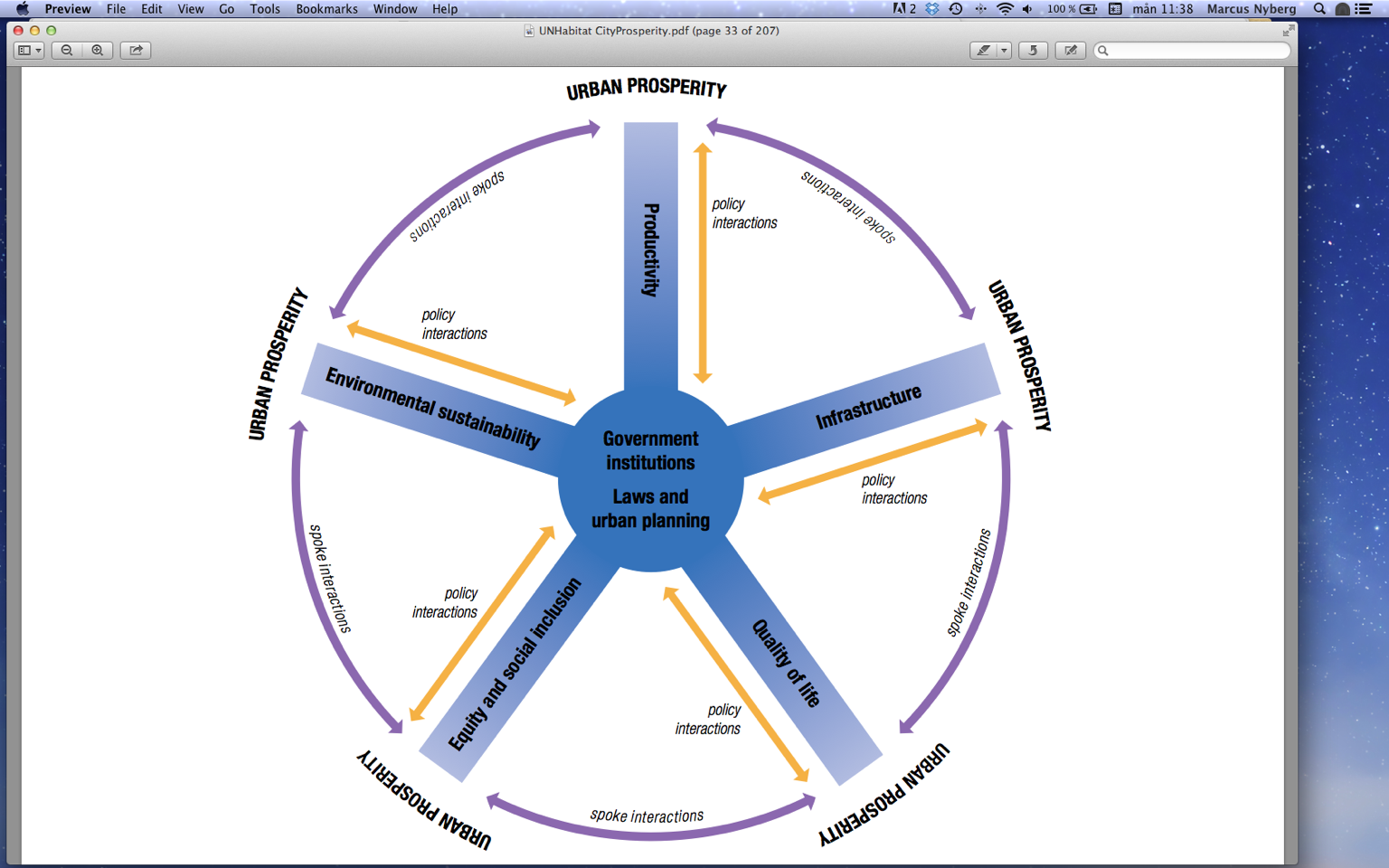
Annex C  
  
UN-Habitat: City prosperity index

Source: UN-Habitat report "State of the World's cities 2012/2013 Prosperity of Cities"

(Table 1.1.3, p. 18)

[http://www.unhabitat.org/pmss/listItemDetails.aspx?publicationID=3387](http://www.smartcities.edu/?publicationID=3387)

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:

Table C.1 – City Prosperity Index

|  |  |
| --- | --- |
| 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 gods 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, and 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), CO2 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. |

There is also an extended "City Prosperity Index" with more indicators and a plan to include governance as a sixth dimension. Furthermore, a specific work has been made on Streets as a driver for prosperity, available at: <http://www.unhabitat.org/pmss/listItemDetails.aspx?publicationID=3513>

Annex D  
  
China Institute of Communications (CIC): Index system of smart city

Source: http://www.china-cic.org.cn/english/index.htm

The evaluation index system of a smart city includes four major indexes: the information infrastructure, smart applications, support system, and value implementation. These four major indexes form the evaluation system of a smart city with the guidance of other elements, such as the network infrastructure, the construction of public support service system, and smart application, reflecting the level of value implementation of a smart city.

The evaluation index system of a smart city can be divided into four dimensions, including 19 second-level indexes and 57 third-level indexes [1]. This index system comprehensively considers various aspects, such as the infrastructure development level of urban information network, comprehensive competitiveness, policies and regulations, green and low-carbon, and culture and technology. It also includes software conditions, such as the intelligent transport administration, the medical education system, the capability of environmental protection network and industrial sustainable development, and the cultural and scientific quality of citizens. This system can embody and index the abstract smart city, forming a distinct guidance, ensuring a more efficient urban administration, a more liveable urban environment, and a continuously increasing happiness index of residents.

| Table D.1 – Evaluation index system of SSC | | | |
| --- | --- | --- | --- |
| No. | First-level index | Second-level index | Third-level index |
| **1** | **Information infrastructure** | Network infrastructure | Coverage rate of FTTx |
| Coverage rate of wireless networks |
| Household network bandwidth on average |
| Penetration rate of broadband users |
| Coverage rate of mobile phones |
| Penetration rate of 3G users |
| Cloud platform | Percentage of serving enterprises |
| Industrial output of cloud computing |
| Information security | Physical safety index |
| Data safety index |

| Table D.1 – Evaluation index system of SSC | | | |
| --- | --- | --- | --- |
| No. | First-level index | Second-level index | Third-level index |
| **2** | **Smart applications** | Smart e-government | Penetration rate of government online services |
| Support degree of information resource on decision-making |
| Percentage of online administration in the overall amount of work |
| Increasing rate of the public basic satisfaction of the government work |
| Smart transport | Capability of traffic information administration and service |
| Installation rate of smart sensing terminals |
| Smart logistics | Usage rate of informatization in logistics companies |
| Percentage of e-commence transaction amount in logistics |
| Usage rate of RFID tags in items |
| Smart tourism | Application level of telecommunication and information technologies |
| Integration and sharing level of tourism |
| Smart energy | Reliability of energy utilization |
| Usage efficiency of energy |
| Application level of new energies |
| Smart building | Application level of information networks |
| Application level of environmental protection and energy saving technologies |
| Smart environmental protection | Proportion of automated inspection on environmental quality |
| Proportion of significant pollution source monitoring |
| Smart medical care | Percentage of archiving electronic health records for residents |
| Usage rate of electronic medical records |
| Sharing rate of resource and information among hospitals |
| Smart education | Sharing level of educational resource |
| Level of optimization in the course of education |
| Promotion level of educational quality and benefits |
| Smart home | Percentage of smart home installation |
| Interaction rate of home informatization |
| Expenses of home informatization |
| **3** | **Support system** | Policies and regulations | Complete rate of policies and regulations |
| Guidance capability of policies and regulations |
| Specifications and standards | Complete rate of information standards |
| Complete rate of equipment standards |
| Complete rate of technical standards |
| Personnel training | Proportion of related publicity and training personnel in overall population |
| Quantity of employees in smart industries |
| Percentage of population with college degrees or higher in total population |
| **4** | **Value implementation** | Green city (developing more scientifically) | Proportion of new energy vehicles |
| Proportion of digital energy saving in buildings |
| Declining rate of energy consumption per ten thousand Ren Min Bi (RMB) of GDP |
| Liveable city (managing more efficiently) | Satisfaction degree of network resources |
| Convenience degree of traffic information access |
| Convenience degree of government services |
| Convenience degree of urban medical care |
| Convenience degree of educational resource access |
| Safe city (live better) | Satisfaction degree in food safety |
| Satisfaction degree in environmental safety |
| Satisfaction degree in traffic safety |
| Satisfaction degree in prevention and control of crime and security |

Annex E  
  
China, Ministry of Housing and Urban-Rural Development (MOHURD):  
 Index system of national pilot smart city

Source: Ministry of Housing and Urban-Rural Development, China

MOHURD published the evaluation index system of the national pilot smart city in January 2013, which can be divided into four dimensions, including 11 second-level indexes and 57 third-level indexes. Each third-level index has been defined and has an indicator [3].

Table E.1 – Evaluation index system of MOHURD

| First-level index | Second-level index | Third-level index |
| --- | --- | --- |
| Guarantee system and infrastructure | Guarantee system | Smart city plan and implementation scheme |
| Organization guarantee |
| Policy and regulation |
| Budget and sustainability |
| Operation and management |
| Network infrastructures | Wireless network |
| Broadband network |
| Next-generation broadcasting network |
| Public platform and database | Public database |
| Public platform |
| Information security |
| Smart construction and liveability | City construction management | Urban and rural planning |
| Digital city management |
| Construction market management |
| Real estate management |
| Horticulture |
| Historic heritage protection |
| Building energy saving |
| Green building |
| Functional improvement of city | Waterworks |
| Drainage system |
| Water saving application |
| Gas system |
| Garbage classification and disposal |
| Heat supply system |
| Lighting system |
| Underground pipelines and spatial integrated administration |
| Smart governance and service | Governance service | Decision-making support |
| Open information |
| Online service |
| Governance service integrated system |
| Basic public services | Basic public education |
| Employment services |
| Social insurance |
| Social services |
| Health care |
| Public culture and sports |
| Service for the handicapped |
| Basic housing guarantee |
| Application service | Intelligent transport system (ITS) |
| Smart energy |
| Smart environmental protection |
| Smart land resource administration |
| Smart emergency response |
| Smart safety |
| Smart logistics |
| Smart community |
| Smart housing |
| Smart payment |
| Smart finance |
| Smart industry and economy | Industry planning | Industry planning |
| Innovation investment |
| Industry upgrading | Industrial factors agglomeration |
| Traditional industry upgrading |
| Development of emerging industry | Hi-tech industry |
| Modern service industry |
| Other emerging industry |

Annex F  
  
EU: European common indicators

Source: European Comission, [http://ec.europa.eu/environment/urban/common\_indicators.htm](mailto:tsbsg5@itu.int)

Ambiente Italia (2003), European Common Indicators – Towards a local sustainability profile, final project report, 2003. <http://www.cityindicators.org/Deliverables/eci_final_report_12-4-2007-1024955.pdf>

The European Common Indicators (ECI) project was an EU project with the subtitle "Towards a Local Sustainability Profile" finalized in 2003, which developed an indicator system and collected data for cities from 14 different countries. Data and information from 42 urban areas was processed in the project. Ten indicators were listed and matched towards six different sustainability principles.

The six sustainability principles were:

1. Equality and social inclusion (access for all to adequate and affordable basic services, e.g. education, employment, energy, health, housing, training, transport);

2. Local governance/empowerment/democracy (participation of all sectors of the local community in local planning and decision-making processes);

3. Local/global relationship (meeting local needs locally, from production to consumption and disposal, meeting needs that cannot be met locally in a more sustainable way);

4. Local economy (matching local skills and needs with employment availability and other facilities, in a way that poses minimum threat to natural resources and the environment);

5. Environmental protection (adopting an ecosystem approach, minimizing the use of natural resources and land, generation of waste and emission of pollutants, enhancing biodiversity);

6. Cultural heritage/quality of the built environment (protection, preservation and rehabilitation of historic, cultural and architectural values, including buildings, monuments, events, enhancing and safeguarding attractiveness and functionality of spaces and buildings).

For an indicator to be accepted, it should meet at least three of the principles. Indictors are shown in the figure below. Each indicator is described in methodological sheets in the reference and a list of the indicators is given below.

Table F.1 – Principles of European Common Indicators

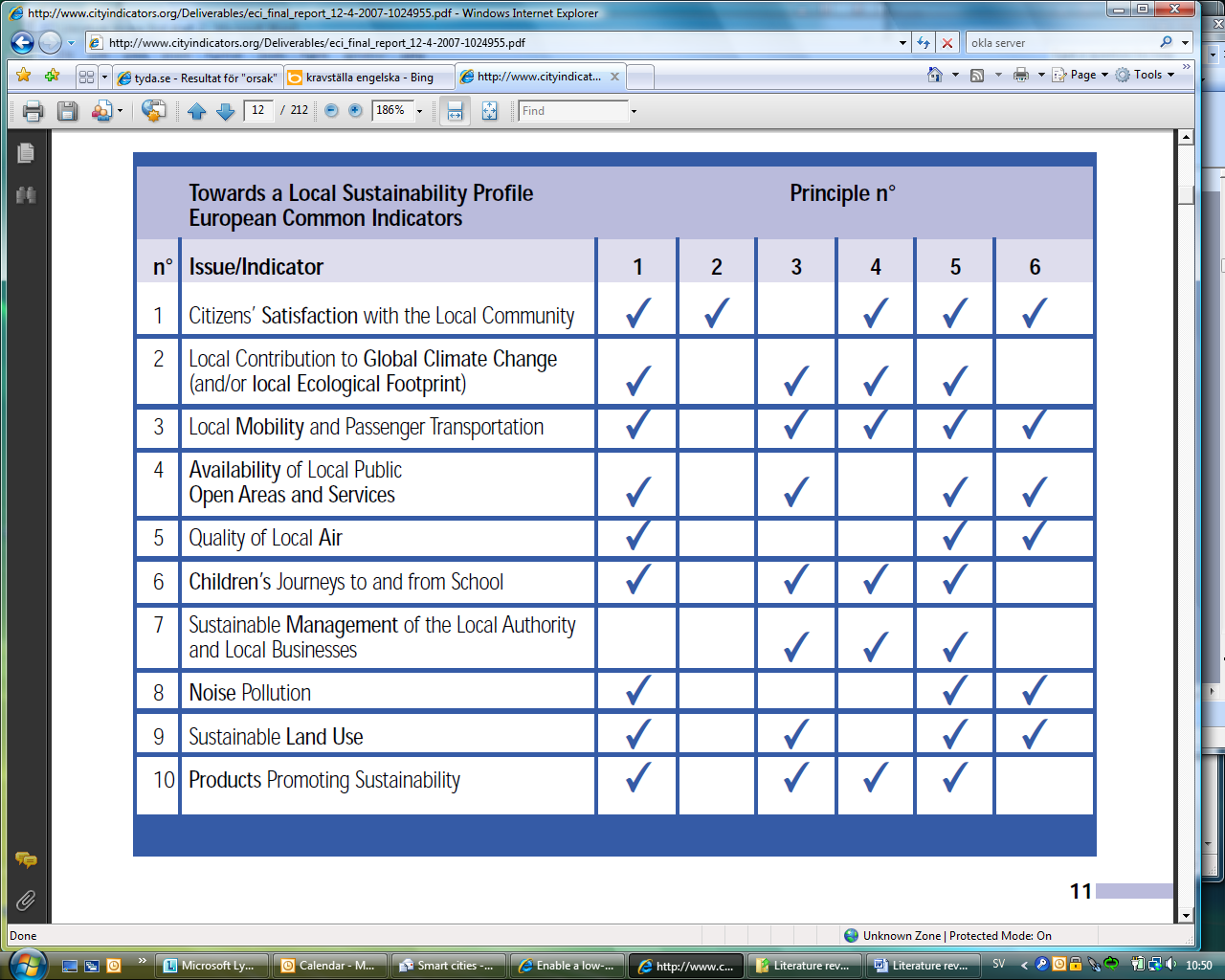
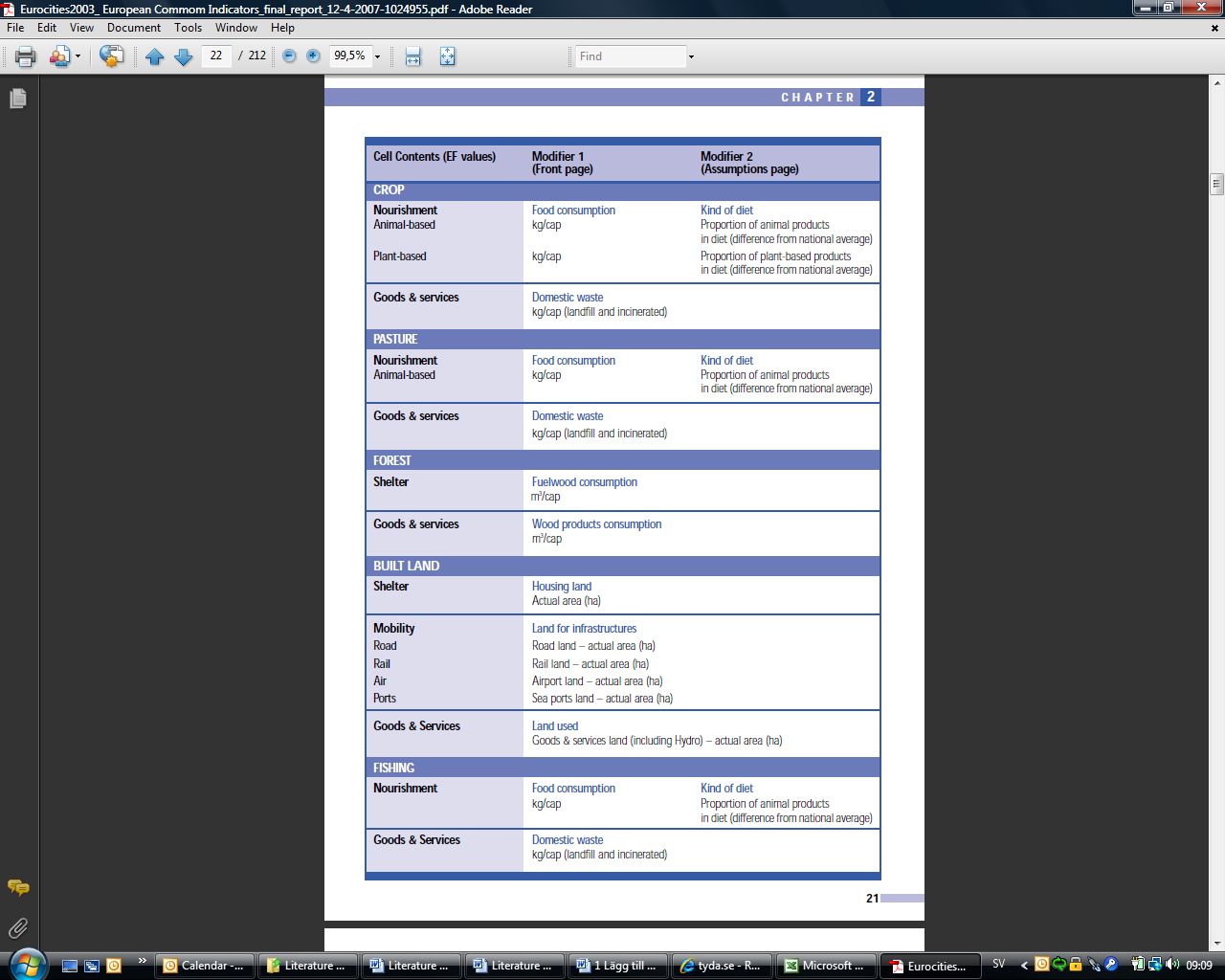
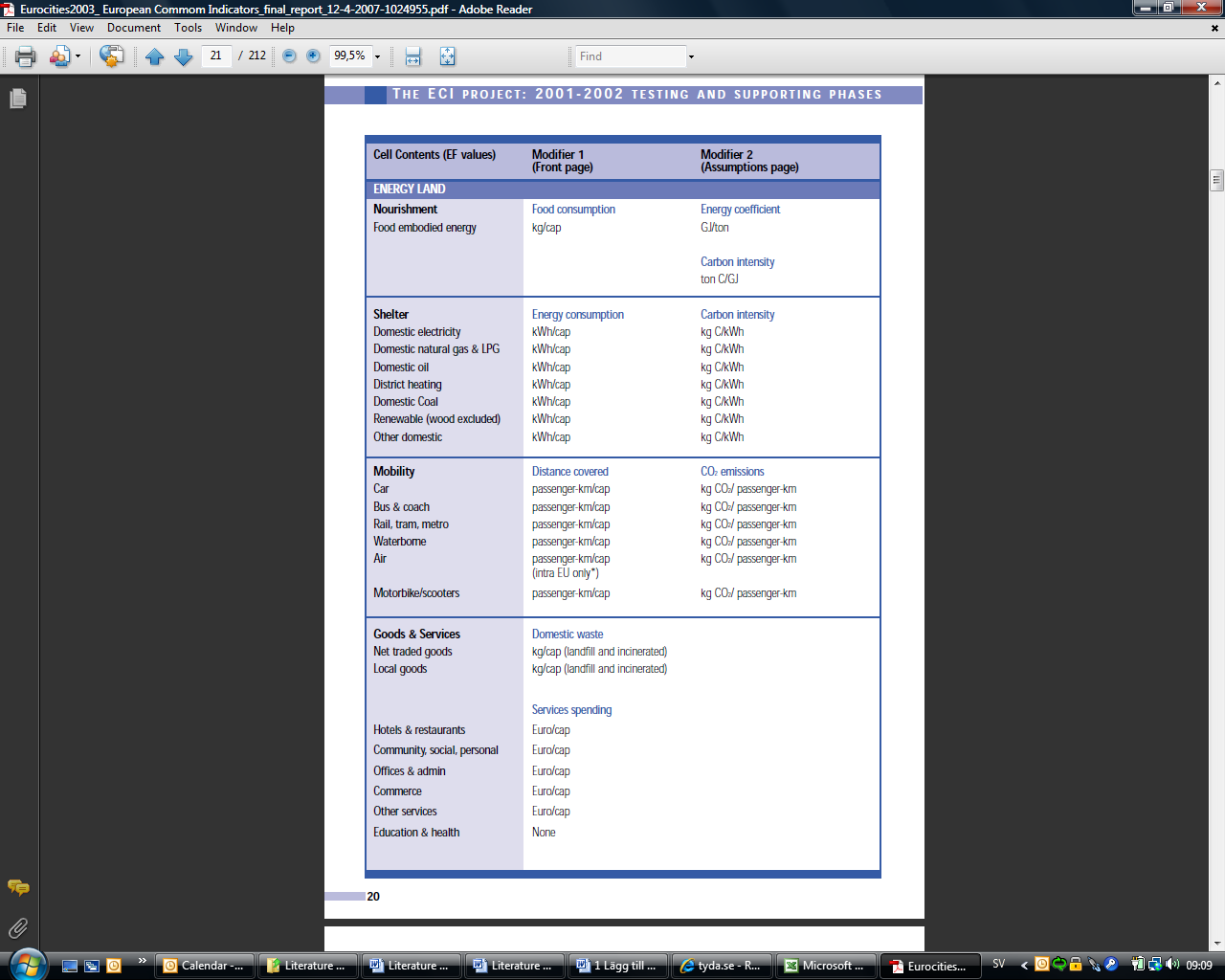


Table F.2 – List of European Common Indicators



Annex G

Italy: Index system of smart city and smart statistics

Source:

FG-SSC-I-0058, Smart Cities and Smart Statistics

FG-SSC-I-0076, Proposal from Italy on document SSC-0057-rev-1

FG-SSC-I-0116, Proposal of indicators for Working Group 3 (WG3)

The six main dimensions of development are the following:

**1 – Economy***:* The ability to create employment, the presence of innovative companies, good quality universities and advanced research institutes, and advanced telematics infrastructure.

**2 – Environment**: The intelligent use of resources promoting a sustainable development based on recycling and waste reduction, adopting rational building criteria, and protecting and managing urban green areas.

**3 – Governance**: The adoption of policies for boosting territorial development and inter-municipal networking capacity can enable a city to involve its citizens in issues of public importance, promote awareness and use technologies to digitize and simplify administrative procedures.

**4 – Living**: Advanced services for improving the quality of life (home care, childcare, aged care facilities) can enable a city to promote its own tourist image with intelligent online promotion (city routes and thematic maps).

**5 – Mobility**: A city where it is easy to get from one place to another, with an innovative and efficient system of public transport that promotes the use of vehicles with low environmental impact, which regulates access to historic town centres, and makes them more liveable (pedestrian walkways).

**6 – People**:The citizens of a city are active and participate in public life, and where a city can maximize its social capital and foster peaceful coexistence.

Smart sustainable city can be analysed through the six dimensions described above. A synthetic index of a smart sustainable city is as follows:

* *sscSupply*: Smart and sustainable services provided by the city;
* *sscUse*: Usage of smart services by the citizens;
* *sscNet*: Extent of smart services in the city area;
* *sscDE*: Level of degree of expertise of "smart citizens";
* *sscIndex*: Synthetic index that combine the four KPIs (sscSupply, sscUse, sscNet, and sscDE).

**sscIndex**

**sscSupply**

**sscUse**

**sscNet**

**sscDE**

Figure G.1 – Cities' KPI

Figure G.1 shows the four indicators and the smart sustainable city global indicator (sscIndex).

Table G.1 shows in details the KPIs of a smart city for each dimension.

Table G.1 – Cities' KPIs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Level | KPIs | | | |
| City | sscSupply | sscUse | sscNet | sscDE |
| 1– Economy | 1.1 ecoSupply | 1.2 ecoUse |  |  |
| 2– Environment | 2.1 envSupply | 2.2 envUse |
| 3– Governance | 3.1 govSupply | 3.2 govUse |
| 4– Living | 4.1 livSupply | 4.2 livUse |
| 5– Mobility | 5.1 mobSupply | 5.2 mobUse |
| 6– People | 6.1 peoSupply | 6.2 peoUse |

Table G.2 shows in details the indicators for building the "Supply" and "Use" KPIs for the six dimensions.

| Table G.2 – Indicators for "Supply" and "Use" KPIs | | |
| --- | --- | --- |
| Dimension | KPI | Indicator |
| 1.  Economy | 1.1 ecoSupply | 1.1.1 Percentage of ICT companies in GDP\*  1.1.2 Ratio of patents per 1 million inhabitants\*  1.1.3 Number of top R&D centres/universities\*  1.1.4 Average available of mobile broadband bandwidth per urban resident\* |
|  | 1.2  ecoUse | 1.2.1 Percentage of workers in ICT companies  1.2.2 Percentage of graduates at top universities  1.2.3 Ratio of contracts in broadband (per 1,000 inhabitants) |
| 2.  Environment | 2.1  envSupply | 2.1.1 Ratio of smart buildings for 1,000 urban resident\*  2.1.2 Percentage of waste disposal recycling  2.1.3 Ratio of days of healthy air breathing within a year (index of quality of air)\*  2.1.4 Amount of CO2 emission per capita (CO2 released to the atmosphere from factories, vehicles, draught animals raised for food per capita)\* |
|  | 2.2  envUse | 2.2.1 Level of energy saving technologies (degree of energy efficient technologies applied in all the services and industries, including solar power, electric vehicles, energy conservation electric appliances, etc.)\*  2.2.2 Percentage of renewable energy sources (RES) on total consumption (solar, wind, tide power and so on)\* |
| 3. Governance | 3.1 govSupply | 3.1.1 Level of digital services provided by smart city (e.g.: fee payment for applications on mobile phones or via the web)  3.1.2 Level of emergency warning systems (through mobile phones and online)  3.1.3 Level of decision-making online system offered by the city (e.g.: polls, referendums, etc.)\* |
|  | 3.2 govUse | 3.2.1 Percentage of citizens who use digital services (e.g.: fee payment for applications on mobile phones or via the web)  3.2.2 Percentage of citizens' participation in online decision-making (through polls, referendums, etc.)\* |
| 4. Living | 4.1 livSupply | 4.1.1 Level of health centres (hospitals, pharmacies, general practitioners (GPs), paediatricians, etc.) with archiving electronic health records (EHRs)\*  4.1.2 Level of telemedicine services offered by the city (e.g.: telemonitoring, teleconsultation, telerehabilitation, etc.)  4.1.3 Level of digital schools (Internet, digital boards, etc.)  4.1.4 Average amount of leisure for inhabitant |
|  | 4.2 livUse | 4.2.1 Ratio of patients with electronic health records (per 1,000 patients)\*  4.2.2 Ratio of patients enrolled in programmes of telemedicine services (per 1,000 patients)  4.2.3 Percentage of students enrolled in digital schools |
| 5. Mobility | 5.1 mobSupply | 5.1.1 Level of teleworking in public administration  5.1.2 Level of integrated digital system for mobility |
|  | 5.2 mobUse | 5.2.1 Ratio of people using the teleworking system (per 1,000 workers)  5.2.2 Percentage of citizens using digital mobility information system |
| 6. People | 6.1  peoSupply | 6.1.1 Level of online interaction between residents and municipality  6.1.2 Level of digital universities (e.g.: online courses, etc.) |
|  | 6.2 peoUse | 6.2.1 Ratio of people using the e-learning system (per 1,000 citizens)\*   * + 1. Percentage of students enrolled in digital universities |
| \* Indicates the reference in FG-SSC-0094-r1 proposed by Fiberhome Technologies Group. | | |

Table G.3 shows in details the indicator for building the "Net" and "DE" KPIs for smart city.

| Table G.3 – Indicators for "Net" and "DE" KPIs | | |
| --- | --- | --- |
|  | KPI | Indicator |
| City | sscNet | 0.3.1 Percentage of buildings covered by fixed broadband (or percentage of city area covered by broadband)  0.3.2 Percentage of city area covered by mobile broadband  0.3.3 Percentage of public offices integrated into the network (sharing data, notification of significant events, consultation, etc.)  0.3.4 Percentage of online administrative services (digital certificates, administrative judicial, etc.) |
| sscDE | 0.4.1 Percentage of citizens with Internet access  0.4.2 Percentage of citizens with certified e-mail  0.4.3 Percentage of citizens with digital signature  0.4.4 Percentage of citizens with computer driving licenses (such as a European computer driving license (ECDL), computer science courses, etc.)  0.4.5 Percentage of citizens who use regularly Internet for purchases, payments, reservations (at least once a month) |

Annex H  
  
Japan: Index system of SSC being discussed in the sub working group for SSC of the Telecommunication Technology Committee (TTC)

Source: Telecommunication Technology Committee, Japan

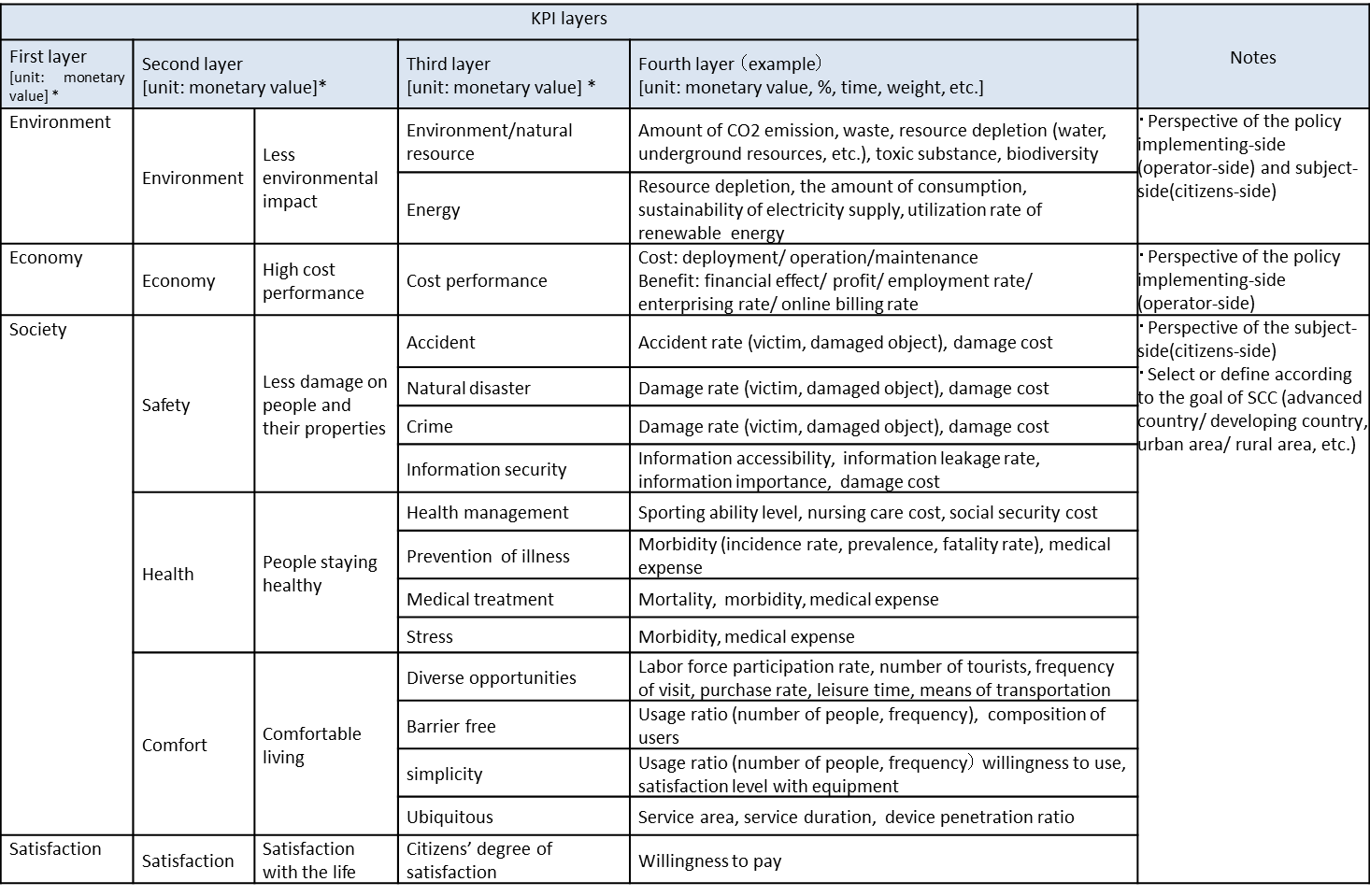
http://www.ttc.or.jp/e/

Structure of KPI [8]:

The Telecommunication Technology Committee (TTC) in Japan has formed a sub working group for SSC meetings to discuss the index system of SSC.

With the proposed KPIs of SSC [8], indicators are divided into four layers for simplicity, and positioned "environment, economy, society, satisfaction" as the first layer. Since the notion of "society" is broad, it is further split into "safety", "health", and "comfort," then positioned in the second layer. The third layer includes indicators such as "information security" and "ubiquitous" from the ICT perspective. The fourth layer includes data to calculate the KPIs in the third layer. The main feature of the KPIs is that various units are used for data in the fourth layer as indicated in Table H.1, while all other layers use a monetary value as the unit.

Table H.1 – Structure of KPIs



\* Indicates using a monetary value as the unit.

**Fujitsu’s practice on Evaluation Method regarding Value and Environmental Impact of Cities**

Fujitsu presently published an article “Development of Quantitative Evaluation Method regarding Value and Environmental Impact of Cities” based on its experiences to participate in the planning and building of SSCs in various regions of Japan. It intends to evaluate both the value and environmental impact of ICT solutions in cities as a whole and to achieve a balance between ease of living, economic growth and environmental considerations.

The URL of the article is “[http://www.fujitsu.com/downloads/MAG/vol50-2/paper13.pdf](http://www.gesis.org/fileadmin/upload/dienstleistung/daten/soz_indikatoren/eusi/paper9.pdf)”

Annex I  
  
GCIF: Global city indicators facility

Source: Global city indicators, <http://www.cityindicators.org/>

The global city indicators facility (GCIF) provides an established set of city indicators claiming to use a globally standardized methodology that allows for global comparability of city performance and knowledge sharing. City services are divided into education, electricity, finance, recreation, fire and emergency response, governance, health, safety, solid waste, transport, urban planning, wastewater, and water. Quality of life factors are: civic engagement, culture, economy, environment, shelter, social equity, technology and innovation.

Table I.1 – Profile indicators

| Profile indicators list | |
| --- | --- |
|  | Indicators |
| **People** | Total city population |
| Population density (per square kilometre) |
| Percentage of country's population |
| Percentage of population that are children (0-14) |
| Percentage of population that are youth (15-24) |
| Percentage of population that are adult (25-64) |
| Percentage of population that are senior citizens (65+) |
| Male to female ratio (# of males per 100 females) |
| Annual population change |
| Population dependency ratio |
| Percentage of population that are new immigrants |
| Percentage of population that are migrating from elsewhere in the country |
| **Housing** | Total number of households |
| Total number of occupied dwelling units (owned and rented) |
| Persons per unit |
| Dwelling density (per square kilometre) |
| **Economy** | Average household income (USD) |
| Annual inflation rate based on average of last five years |
| Cost of living |
| Income distribution (Gini coefficient) |
| Country's GDP (USD) |
| Country's GDP per capita (USD) |
| City product (USD) |
| City product as a percentage of country's GDP |
| Total employment |
| Employment percentage change based on the last five years |
| Number of businesses per 1,000 Population |
| Annual average unemployment rate |
| Commercial/industrial assessment as a percentage of total assessment |
| **Government** | Type of government (e.g. local, regional, county) |
| Gross operating budget (USD) |
| Gross operating budget per capita (USD) |
| Gross capital budget (USD) |
| Gross capital budget per capita (USD) |
| **Geography and climate** | Region |
| Climate Type |
| Land area (square kilometres) |
| Percentage of non-residential area (square kilometres) |
| Annual average temperature (Celsius) |
| Average annual rain (mm) |
| Average annual snowfall (cm) |

Table I.2 – City services and quality of life indicators

| Performance indicators list | | |
| --- | --- | --- |
| City services | Core indicator | Supporting indicator |
| **Education** | Student/teacher ratio | Percentage of school-aged population enrolled in schools |
|  | Percentage of students completing primary and secondary education: survival rate | Percentage of male school-aged population enrolled in schools |
|  | Percentage of students completing primary education | Percentage of female school-aged population enrolled in schools |
|  | Percentage of students completing secondary education |  |
| **Fire and emergency response** | Number of fire-fighters per 100,000 population | Response time for fire department from initial call |
|  | Number of fire related deaths per 100.000 population |  |
| **Health** | Number of in-patient hospital beds per 100.000 population | Number of nursing and midwifery personnel per 100.000 population |
|  | Number of physicians per 100,000 population |  |
|  | Average life expectancy |  |
|  | Under age five mortality per 1,000 live births |  |
| **Recreation** |  | Square meters of public indoor recreation space per capita |
|  |  | Square meters of public outdoor recreation space per capita |
| **Safety** | Number of police officers per 100,000 population | Violent crime rate per 100,000 population |
|  | Number of homicides per 100,000 population |  |
| **Solid waste** | Percentage of city population with regular solid waste collection | Percentage of the city's solid waste that is disposed of in an incinerator |
|  | Percentage of city's solid waste that is recycled | Percentage of the city's solid waste that is burned openly |
|  | Percentage of the city's solid waste that is disposed of in an open dump |
|  | Percentage of the city's solid waste that is disposed of in a sanitary landfill |
|  | Percentage of the city's solid waste that is disposed of by other means |
| **Transport** | Km of high capacity public transit system per 100,000 population | Number of two-wheel motorized vehicles per capita |
|  | Km of light passenger transit system per 100,000 population | Commercial air connectivity (number of non-stop commercial air destinations) |
|  | Number of personal automobiles per capita | Transport fatalities per 100,000 population |
|  | Annual number of public transit trips per capita |  |
| **Wastewater** | Percentage of city population served by water collection | Percentage of the city's wastewater receiving primary treatment |
|  | Percentage of the city's wastewater that has received no treatment | Percentage of the city's wastewater receiving secondary treatment |
|  | Percentage of the city's wastewater receiving tertiary treatment |
| **Water** | Percentage of city population with potable water supply service | Total water consumption per capita (litres/day) |
|  | Domestic water consumption per capita (litres/day) | Percentage of water loss |
|  | Percentage of city population with sustainable access to an improved water source | Average annual hours of water service interruption per household |
| **Electricity** | Percentage of city population with authorized electrical service | Total electrical use per capita (kWh/year) |
|  | Total residential electrical use per capita (kWh/year) | The average number of electrical interruptions per customer per year |
|  | Average length of electrical interruptions (in hours) |  |
| **Finance** | Debt service ratio (debt service expenditure as a percent of a municipality's own-source revenue) | Tax collected as percentage of tax billed |
|  | Own-source revenue as a percentage of total revenues |  |
|  | Capital spending as a percentage of total expenditures |  |
| **Governance** | Percentage of women employed in the city government workforce |  |
| **Urban planning** | Jobs/housing ratio | Areal size of informal settlements as a percent of city area |
|  | Green area (hectares) per 100,000 population |  |

| Quality of life | Core indicator | Supporting indicator |
| --- | --- | --- |
| **Civic engagement** | Voter participation in last municipal election (as a percent of eligible voters) | Citizen's representation: number of local officials elected to office per 100,000 population |
| **Culture** |  | Percentage of jobs in the cultural sector |
| **Economy** | City product per capita | Percentage of persons in full time  employment |
| City unemployment rate |  |
| **Environment** | PM10 concentration | Greenhouse gas emissions measured in tonnes per capita |
| **Shelter** | Percentage of city population living in slums | Percentage of households that exist without registered legal titles |
|  | Number of homeless people per 100,000 population |
| **Social equity** |  | Percentage of city population living in poverty |
| **Technology and innovation** | Number of Internet connections per 100,000 population | Number of new patents per 100,000 population per year |
|  | Number of higher education degrees per 100,000 population |
| Number of telephone connections (landlines and cell phones) per 100,000 population |
| Number of landline phone connections per 100,000 population |
| Number of cell phone connections per 100,000 population |

Annex J  
  
ICLEI: Global protocol for community scale GHG emissions (GPC)

Source: ICLEI, http://www.iclei.org/details/article/global-protocol-for-community-scale-ghg-emissions-gpc.html

The Global Protocol for Community scale GHG emissions (GPC) was developed by ICLEI and C40 and supported by the World Bank, UN-Habitat and others.

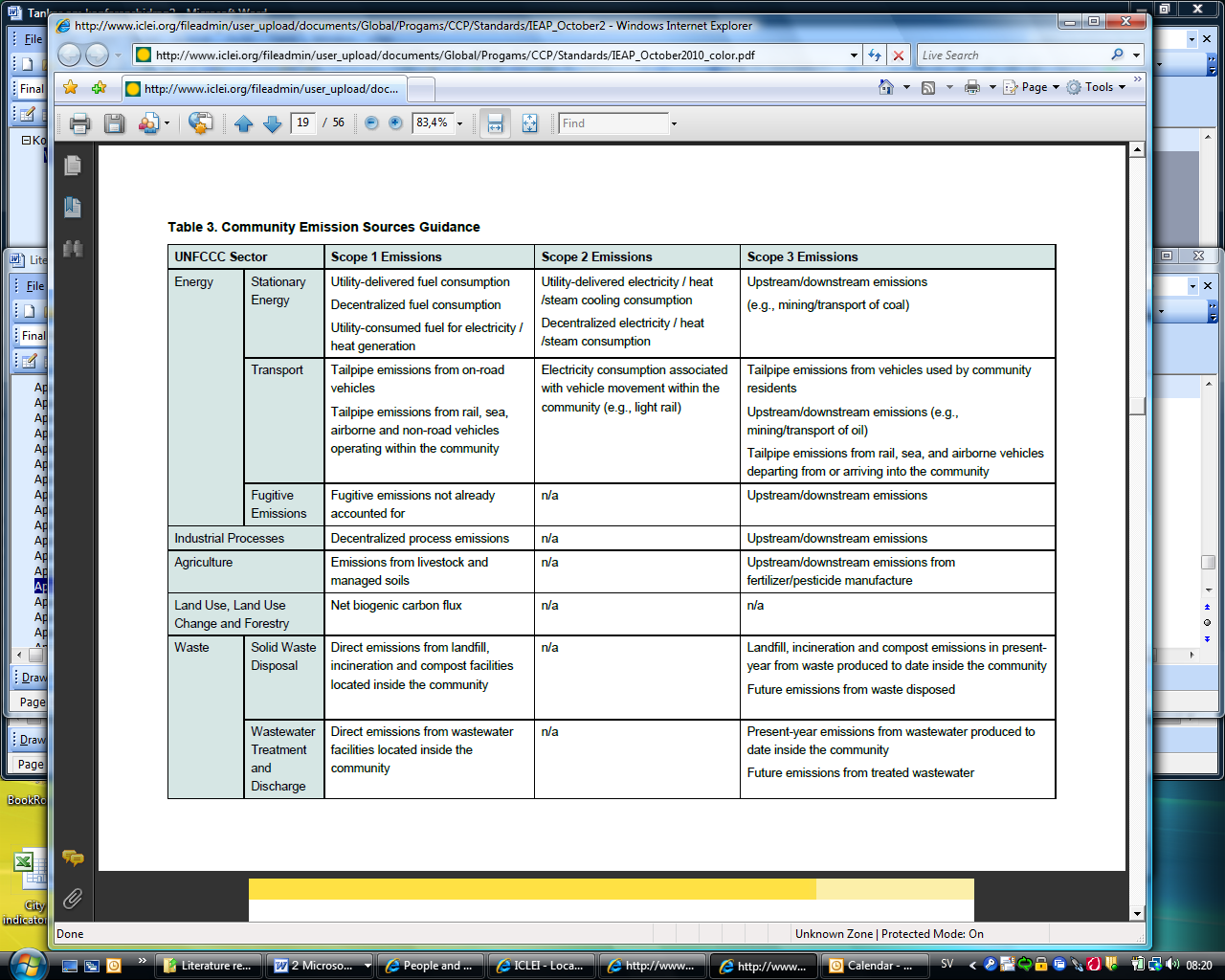
In GPC, the emissions summing up to the total community emissions are divided into sectors and subsectors, see below. For each subsector, direct emissions (scope 1) and indirect emissions (scope 2) should be reported. In addition, communities are asked to report direct emissions accounted for elsewhere and scope 3 emissions related to main sectors.

Table J.1 – Sector/Subsector of GPC

|  |  |
| --- | --- |
| Sector | Subsector |
| Stationary units | Residential, commercial/industrial facilities, energy generation, and industrial energy use as subsectors |
| Mobile units | On-road transportation (cars, light duty vehicle (LDV), heavy duty vehicle (HDV), buses, others), railways (including urban metro/rail transport system), water-borne navigation, aviation, off-road |
| Waste | Solid waste, biological treatment of waste, waste incineration and open burning, wastewater treatment and discharge |
| IPPU | Industrial processes and product uses |

This protocol is a development of the international local government GHG emissions analysis protocol (IEAP) published by ICLEI in 2009 (international local government GHG emissions analysis protocol (IEAP), version 1.0. October 2009, available at [http://carbonn.org/fileadmin/user\_upload/carbonn/Standards/IEAP\_October2010\_color.pdf](http://ec.europa.eu/environment/urban/common_indicators.htm) ). The IEAP consists of principles that should be adhered to when inventorying GHG emissions from a community.

Table J.2 – Protocol of GPC



Annex K  
  
ESCI: Indicators of the emerging and sustainable cities initiative

Source: Inter-American Development Bank,

[http://www.iadb.org/en/topics/emerging-and-sustainable-cities/implementing-the-emerging-and-sustainable-cities-initiative-approach,7641.html](http://www.unhabitat.org/pmss/listItemDetails.aspx)

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 (LAC) region, and the resulting urgent need to deal with the sustainability issues faced by the region's rapidly growing intermediate-size cities. It addresses three dimensions of sustainability: environmental sustainability and climate change, urban sustainability, and fiscal sustainability and governance.

Table K.1 – indicators of environmental sustainability and climate change of ESCI

| I. Environmental sustainability and climate change | | | |
| --- | --- | --- | --- |
| #Topics | #Subtopic | #Indicator | #Unit of measurement |
| **A. Water** | A.1 Water coverage | 1. Percentage of households with home connections to the city's water network | % |
| A.2 Efficiency in the use of water | 2. Annual water consumption per capita | L/person/day |
| A.3 Efficiency in the water supply service | 3. Continuity of water service | hr/day |
| 4. Water quality | % |
| 5. Non-revenue water | % |
| A.4 Availability of water resources | 6. Remaining number of years of a positive water balance | Years |

| I. Environmental sustainability and climate change | | | |
| --- | --- | --- | --- |
| #Topics | #Subtopic | #Indicator | #Unit of measurement |
| **B. Sanitation and**  **drainage** | B.1 Sanitation coverage | 7. Percentage of households with a home connection to the sewer system | % |
| B.2 Wastewater treatment | 8. Percentage of wastewater that is treated according to national standards | % |
| B.3 Effectiveness of drainage | 9. Percentage of dwellings damaged by the most intense flooding in the last 10 years | % |
| **C. Solid waste**  **management** | C.1 Solid waste collection coverage | 10. Percentage of population with regular municipal solid waste collection | % |
| C.2 Adequate final disposal of solid waste | 11. Percentage of the city's municipal solid waste disposed of in sanitary landfills | % |
| 12. Remaining life of the site where the landfill is located | Years |
| 13. Percentage of the city's municipal solid waste that is disposed of in open dumps, controlled dumps, or bodies of water or is burnt | % |
| C.3 Treatment of solid waste | 14. Percentage of the city's municipal solid waste that is composted | % |
| 15. Percentage of the city's municipal solid waste that is separated and classified for recycling | % |
| 16. Percentage of the city's municipal solid waste that is used as an energy resource | % |
| **D. Energy** | D.1 Energy coverage | 17. Percentage of the city's households with an authorized connection to electrical energy | % |
| 18. Percentage of the city's households with an authorized connection to the network of natural gas supply | % |
| 19. Average number of electrical interruptions per year, per customer | #/yr/customer |
| 20. Average length of electrical interruptions | hr/customer |
| D.2 Energy efficiency | 21. Total annual electrical consumption per residential household | kWh/household/yr |
| 22. Energy intensity of the economy | kg of oil equivalent per USD 1,000 GDP |
| 23. Existence, monitoring, and enforcement of energy efficiency regulations | Yes/No |
| D.3 Alternative and renewable energy | 24. Percentage of renewable energy in total energy generation | % |
| **E. Air quality** | E.1 Air quality control | 25. Existence, monitoring, and enforcement of air quality regulations | Yes/No |
| E.2 Concentration of pollutants in the air | 26. Air quality index | # |
| 27. PM10 concentration | 24-hour average PM10 in μg/m3 |
| **F. Mitigation of climate change** | F.1 GHG emission measurement systems | 28. Existence and monitoring of greenhouse gas inventory | Yes/No |
| F.2 Total GHG emissions | 29. Per capita greenhouse gas emissions | Annual tons of CO2e per capita |
| 30. Greenhouse gas emissions per GDP | kg/USD of GDP |
| F.3 Mitigation plans and objectives | 31. Existence of mitigation plans with reduction targets by sector and a monitoring system in place | Yes/No |
| **G. Noise** | G.1 Noise control | 32. Existence, monitoring, and enforcement of regulations on noise pollution | Yes/No |
| **H. Vulnerability to natural disasters in the context of climate change** | H.1 Climate change adaptation capacity and extreme natural events | 33. Existence of risk maps | Yes/No |
| 34. Existence of adequate contingency plans for natural disasters | Yes/No |
| 35. Existence of effective early warning systems | Yes/No |
| 36. Disaster risk management in city development planning | Yes/No |
| 37. Percentage of deliverables of the disaster risk management planning instruments that have been completed | Yes/No |
| 38. Budget allocation for disaster risk management | Yes/No |
| H.2 Sensitivity to natural disasters | 39. Critical infrastructure at risk due to inadequate construction or placement in areas of non-mitigable risk | % |
| 40. Percentage of households at risk due to inadequate construction or placement in areas of non-mitigable risk | % |

Table K.2 – indicators of urban sustainability of ESCI

| II. Urban sustainability | | | |
| --- | --- | --- | --- |
| #Topics | | #Subtopic | #Indicator | #Unit of measurement |
| **I. Land use, planning, and zoning** | I.1 Density | 41. Annual growth rate of the urban footprint | % annual |
| 42. (Net) urban population density | Residents/km2 |
| I.2 Housing | 43. Substandard housing | % |
| 44. Quantitative housing shortage | % |
| I.3 Green and recreational areas | 45. Green area per 100,000 residents | hectares/100,000 residents |
| 46. Public recreational area per 100,000 residents | hectares/100,000 residents |
| I.4 Land use planning | 47. Existence and active implementation of a land use plan | Yes/No and implementation |
| 48. Up-to-date, legally binding master plan | Yes to both criteria/ Yes to only one criterion/No to both criteria |
| **J. Urban inequality** | J.1 Poverty | 49. Percentage of the population below the poverty line | % |
| J.2 Socio-spatial segregation | 50. Percentage of housing located in informal settlements | % |
| J.3 Income inequality | 51. Income Gini coefficient |  |
| **K. Mobility/ transportation** | K.1 Balanced transportation infrastructure | 52. Kilometres of road per 100,000 population | km |
| 53. Kilometres of roads dedicated exclusively to public transit per 100,000 population | km |
| 54. Kilometres of bicycle path per 100,000 population | km |
| 55. Kilometres of sidewalk and pedestrian path per 100,000 population | km |
| 56. Modal split (specifically public transport) | % |
| K.2 Clean transportation | 57. Average age of public transport fleet | Years |
| K.3 Safe transportation | 58. Transportation fatalities per 1,000 population | Deaths per 1,000 population |
| K.4 Reduced congestion | 59. Average travel speed on primary thoroughfares during peak hours | km/h |
| 60. Number of automobiles per capita | Vehicles per capita |
| K.5 Planned and managed transportation | 61. Transportation planning and management system | Yes/No |
| K.6 Affordable transportation | 62. Affordability index | % |
| K.7 Balanced demand | 63. Jobs-to-housing ratio | Ratio |
| **L. Competitiveness**  **of the economy** | L.1 Regulation of business and investment | 64. Days to obtain a business licence | # of days |
| L.2 Strategic infrastructure | 65. Existence of a logistics platform | Yes/No |
| L.3 Gross product | 66. GDP per capita of the city | USD per capita |
| **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 | % |
| 73. Percentage of students passing standardized reading tests | % |
| 74. Percentage of students passing standardized math tests | % |
| 75. Student-teacher ratio | Students/teachers |
| O.2 Attendance | 76. Percentage of three- to five-year-olds receiving comprehensive early childhood development services | % |
| 77. Percentage of six- to 11-year-olds enrolled in school | % |
| 78. Percentage of 12- to 15-year-olds enrolled in school | % |
| 79. Percentage of 16- to 18-year-olds enrolled in school | % |
| O.3 Higher education | 80. University seats per 100,000 people | # per 100,000 residents |
| **P. Security** | P.1 Violence | 81. Homicides per 100,000 residents | # per 100,000 residents |
| 82. Prevalence of partner violence – last 12 months | % |
| 83. Prevalence of partner violence – lifetime | % |
| 84. Robberies per 100,000 residents | # every 100,000 residents |
| 85. Larcenies per 100,000 residents | # every 100,000 residents |
| P.2 Citizens' confidence in security | 86. Percentage of citizens who feel safe | % |
| 87. Victimization rate | % |
| **Q. Health** | Q.1 Level of health | 88. Life expectancy at birth | Years |
| 89. Male life expectancy at birth | Years |
| 90. Female life expectancy at birth | Years |
| 91 Under-five mortality rate (per 1,000 live births) | Deaths/1,000 live births |
| Q.2 Provision of health services | 92. Doctors per 100,000 residents | Doctors/100,000 residents |
| 93. Hospital beds per 100,000 residents | Beds/100,000 residents |

Table K.3 – indicators of fiscal sustainability and government of ESCI

|  |  |  |  |
| --- | --- | --- | --- |
| III. Fiscal sustainability and government | | | |
| #Topics | #Subtopic | #Indicator | #Unit of measurement |
| **R. Participatory public management** | R.1 Citizen participation in planning of government's public management | 94. Existence of a participatory planning process | Yes/Qualified,  Yes/No |
| 95. Existence of participatory budgeting | Yes/No and %  of the budget |
| R.2 Public reporting | 96. Public reporting sessions per year | # |
| III. Fiscal sustainability and government | | | |
| #Topics | #Subtopic | #Indicator | #Unit of measurement |
| **S. Modern public management** | S.1 Modern processes of public management of the municipal budget | 97. Existence of a multi-annual budget | Yes/No and years |
| 98. Remuneration of personnel based on a system of performance indicators | Yes/No and % of personnel |
| S.2 Modern systems of public management of the municipal government | 99. Existence of electronic systems for tracking the municipality's management | Yes,  electronic/  Yes, manual/  No |
| 100. Existence of electronic procurement system | Yes/Qualified,  Yes/No |
| **T. Transparency** | T.1 Transparency and auditing of the government's public management | 101. Transparency index | # |
| 102. Municipal government accounts audited | % |
| 103. Municipal companies' accounts audited by a third party | % |
| **U. Taxes and financial autonomy** | U.1 Municipal revenue and taxes | 104. Own-source revenue as a percentage of total revenue | % |
| 105. Total transfers as a percentage of total revenue | % |
| 106. Earmarked transfers as a percentage of total transfers | % |
| 107. Revenue from other sources (external donors) as a percentage of total revenue | % |
| U.2 Collection management | 108. Utility cost recovery | % |
| 109. Taxes collected as a percentage of taxes billed | % |
| **V. Expenditure**  **management** | V.1 Quality of public spending | 110. Performance indicators and goals for tracking budget execution | Yes/No |
| 111. Gross operating budget (current expenditure as percentage of total expenditures) | % |
| 112. Gross capital budget (capital expenditure as percentage of total expenditures) | % |
| 113. Annual growth rate of current expenditure | % annual |
| 114. Budget's alignment with plan | Yes/No |
| **W. Debt** | W.1 Contingent liabilities | 115. Contingent liabilities as a percentage of own revenue | % |
| W.2 Sustainability of municipal debt | 116. Debt service ratio | % |
| 117. Debt growth | % |

Annex L  
  
Vienna University of Technology: European ranking of medium-sized cities

Source: Vienna University of Technology,|  
http://www.smart-cities.eu/download/smart\_cities\_final\_report.pdf

The ranking has six characteristics (smart economy, smart mobility, smart environment, smart people, smart living, smart governance), 31 factors, and 74 indicators [4]. (ERMC)

Table L.1 – indicators of European ranking of medium-sized cities

| Characteristics | Factors | Indicators |
| --- | --- | --- |
| **Smart economy** | **Innovative spirit** | R&D expenditure in % of GDP |
| Employment rate in knowledge-intensive sectors |
| Patent applications per inhabitant |
| **Entrepreneurship** | Self-employment rate |
|  | New business registered |
| **Economic image and trademarks** | Importance as decision-making centre (HQ, etc.) |
| **Productivity** | GDP per employed person |
| **Flexibility of labour market** | Unemployment rate |
| Proportion in part-time employment |
| **International embeddedness** | Companies with HQ in the city quoted on national stock market |
| Air transport of passengers |
| Air transport of freight |
| ***Ability to transform*** | 0 |
| **Smart mobility** | **Local accessibility** | Public transport network per inhabitant |
| Satisfaction with access to public transport |
| Satisfaction with quality of public transport |
| **(Inter-)national accessibility** | International accessibility |
| **Availability of ICT-infrastructure** | Computers in households |
| Broadband Internet access in households |
| **Sustainable, innovative and safe transport** | Green mobility share (non-motorized individual traffic) |
| Traffic safety |
| Use of economical cars |
| **Smart environment** | **Attractivity of natural conditions** | Sunshine hours |
| Green space share |
| **Pollution** | Summer smog (ozone) |
| Particulate matter |
| Fatal chronic lower respiratory diseases per inhabitant |
| **Environmental protection** | Individual efforts on protecting nature |
| Opinion on nature protection |
| **Sustainable resource management** | Efficient use of water (use per GDP) |
| Efficient use of electricity (use per GDP) |
| **Smart people** | **Level of qualification** | Importance as knowledge centre (top research centres, top university, etc.) |
| Population qualified at level 5-6 of ISCED |
| Foreign language skills |
| **Affinity to lifelong learning** | Book loans per resident |
| Participation in lifelong learning in % |
| Participation in language courses |
| **Social and ethnic plurality** | Share of foreigners |
| Share of nationals born abroad |
| **Flexibility** | Percentage of getting a new job |
| **Creativity** | Share of people working in creative industries |
| **Cosmopolitanism/open-mindedness** | Votes turnout at European elections |
| Immigration-friendly environment (attitude towards immigration) |
| Knowledge about EU |
| **Participation in public life** | Voters turnout at city elections |
| Participation in voluntary work |
| **Smart living** | **Cultural facilities** | Cinema attendance per inhabitant |
| Museums visits per inhabitant |
| Theatre attendance per inhabitant |
| **Health conditions** | Life expectancy |
| Hospital beds per inhabitant |
| Doctors per inhabitant |
| Satisfaction with quality of health system |
| **Individual safety** | Crime rate |
| Death rate by assault |
| Satisfaction with personal safety |
| **Housing quality** | Share of housing fulfilling minimal standards |
| Average living area per inhabitant |
| Satisfaction with personal housing situation |
| **Education facilities** | Student per inhabitant |
| Satisfaction with access to educational system |
| Satisfaction with quality of educational system |
| **Touristic attractivity** | Importance as tourist location (overnights, sights) |
| Overnights per year per resident |
| **Social cohesion** | Perception on personal risk of poverty |
| Poverty rate |
| **Smart governance** | **Participation in decision-making** | City representatives per resident |
| Political activity of inhabitants |
| Importance of politics for inhabitants |
| Share of female city representatives |
| **Public and social services** | Expenditure of the municipal per resident in prospective payment system (PPS) |
| Share of children in day care |
| Satisfaction with quality of schools |
| **Transparent governance** | Satisfaction with transparency of bureaucracy |
| Satisfaction with fight against corruption |
| ***Political strategies and perspectives*** | 0 |

Annex M  
Leibnitz Institute: European system of social indicators

Source: Berger-Schmitt R. and Noll H.-H. (2000), "Conceptual framework and structure of a European system of social indicators". Towards a European system of social reporting and welfare measurement, A TSER-project financed by the European Commission, Centre for Survey Research and Methodology (ZUMA), Social Indicators Department, Mannheim, 2000.  
[http://www.gesis.org/fileadmin/upload/dienstleistung/daten/soz\_indikatoren/eusi/paper9.pdf](http://www.fastcoexist.com/1680538/what-exactly-is-a-smart-city)

A European cooperation called the *European System of Social Indicators* (EUSI), originally a project sponsored by EC, has focused on listing relevant indicators, instead of constructing an index. Life quality, social unity and sustainability are being measured by objective and subjective indicators. The *European System of Social Indicators* (EUSI) documentation defines three goals and each goal lists a set of indicators.

Table M.1 – goals of European System of Social Indicators (EUSI)

|  |
| --- |
| Goal 1: Economic and social progress, improvement of quality of life |
| • Promotion of employment – combat unemployment  • Enhancement of education  • Use of ICT  • Improving of public health  • Social security of people  • Improvement of personal safety  • Reduction of environmental pollution and the improvement of environmental protection |
| Goal 2: Strengthening the economic and social cohesion |
| • Reduction of regional disparities  • Equal opportunities for men and women  • Equal opportunities for disabled people  • Combat social exclusion and discrimination  • Encouraging solidarity between people  • Enhancement of physical connections (transport)  • Developing Trans-European Networks (TENs) in areas of energy, transport and telecommunications |
| Goal 3: Sustainable development |

The third goal is related to the commitment of sustainable development. The challenge of a sustainable Europe is to achieve economic growth based on higher employment rates, less environmental pollution and improved resource efficiency of energy and raw materials. Below is a list of the measuring points for each domain and goal.

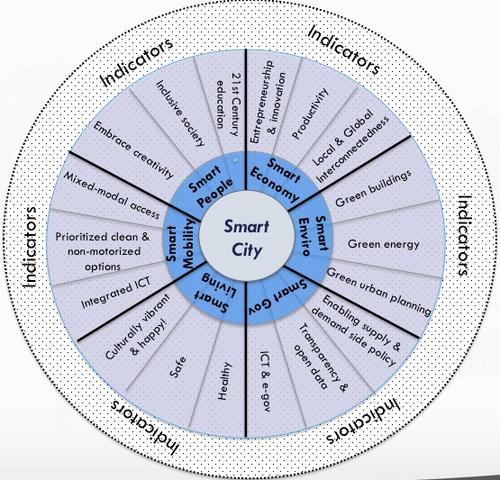
Table M.2 – measuring points for life domain of European System of Social Indicators (EUSI)

|  |  |
| --- | --- |
| Life domain: population | |
| Goal dimensions | Measurement dimensions |
| Social structure |  |
| demographic structure | population size and growth |
| population structure (age, marital status) |
| population density and agglomeration |
| migration / foreigners |

|  |  |  |
| --- | --- | --- |
| Life domain: households and families | | |
| Goal dimensions | | Measurement dimensions |
| reduction of disparities/inequalities | | equal opportunities/inequalities of : |
| 1: women and men regarding |
| A: engagement in house work and child care, |
| B: attitudes towards gender roles |
| 2: generations regarding |
| A: availability of family relations |
| Strengthening social connections and ties – social capital | | existence and intensity of family relations |
| care for old ages household members |
| quality of relations between household members |
| Preservation of human capital | | household performances in educating and caring for children |
| Social structure – demographic structure | | Structure of private households and families |
| marriages and divorces |
| Social structure – values and attitudes | | attitudes towards marriage |
| attitudes towards family and children |
| Life domain: housing | | |
| Goal dimensions | | Measurement dimensions |
| Improvement of objective living conditions | | age of housing stock |
| level of supply with dwellings and housing space |
| size of dwellings |
| equipment of dwellings |
| security |
| housing costs |
| quality of environs |
| Enhancement of Subjective well-being | | subjective perception and evaluation of: |
| 1. housing conditions |
| 2. quality of environs |
| Reduction of disparities/inequalities | | Regional disparities of housing conditions |
| Equal opportunities/inequalities regarding housing of: |
| 1. disabled people |
| 2. social strata |
| Social exclusions: (homelessness, poor housing conditions) |
| Preservation of natural capital | | Area used for settlement |
| Life domain: transport | | |
| Goal dimensions | | Measurement dimensions |
| Improvement of objective living conditions | | Access to transport |
| Travel speed |
| Costs of transports |
| Enhancement of subjective well-being (SWB) | | Subjective perception an evaluation of: |
| 1. transport conditions |
| 2. noise pollution |
| Reduction of disparities/inequalities | | Regional disparities of access to and quality of transport |
| Equal opportunities/inequalities regarding transport of disabled people |
| Social exclusion: no access to private and public transport |
| Strengthening social connections and ties – social capital | | European-specific concerns: |
| 1. Quality of transport connections between European countries |
| 2. frequency of journeys in European countries |
| Preservation of human capital | | traffic accidents |
| Preservation of natural capital | | pollution due to transport |
| consumption of natural resources due to transport (energy, area) |
| Life domain: Leisure, media and culture | | |
| Goal dimensions | | Measurement dimensions |
| Improvement of objective living conditions | | amount of leisure time |
| availability of facilities and goods in the area of leisure, media and culture |
| Enhancement of SWB | | subjective perception an evaluation of: |
| 1. Leisure time |
| 2. Possibilities for recreational and cultural activities |
| Reduction of disparities/inequalities | | regional disparities in the availability of facilities and goods in the area of leisure, media and culture |
| equal opportunities/inequalities of |
| 1. women and men regarding leisure time |
| 2. disabled people regarding access to media recreational and cultural facilities |
| Strengthening social connections and ties – social capital | | European-specific concerns: Exchange of cultural products between European countries |
| Preservation of human capital | | Leisure activities promoting health |
| Leisure activities promoting human knowledge |
| Preservation of natural capital | | consumption of paper |
| Social structure: values and attitudes | | Subjective importance of leisure and culture |
| Life domain: Social and political participation and integration | | |
| Goal dimensions | | Measurement dimensions |
| Reduction of disparities/inequalities | | Equal opportunities/inequalities regarding social and political participation and integration of: |
| 1. women and men |
| 2. generations |
| 3. social strata |
| 4. disabled people |
| 5. citizenship groups |
| Social exclusion: social isolation |
| Strengthening social connections and ties – social capital | | Availability of social relations (personal relations outside family, informal networks, membership in associations) |
| Social and political activities and engagement (frequency of contacts, support in information networks, volunteering, political engagement) |
| Quality of social relations (extent of trust, feelings of belonging, shared values, solidarity, conflicts, attitudes towards population groups, loneliness) |
| Trust in institutions: political institutions |
| European-specific concerns: |
| 1. European identity |
| 2. Social relation and attitudes to national from European countries |
| 3. commonalities between European countries in basic values and attitudes |
| 4. Social and political activities at the European level |
| Social structure: values and attitudes | | Political orientation |
| subjective importance of religion |
| Life domain: Education and vocational training | | |
| Goal dimensions | Measurement dimensions | |
| Improvement of objective living conditions | level of education and vocational training | |
| effectiveness of education | |
| Enhancement of SWB | subjective perception and evaluation of level of education and vocational training | |
| Reduction of disparities/inequalities | Regional disparities of | |
| 1: access to education and vocational training | |
| 2: investment in education | |
| Equal opportunities /inequalities regarding educational participation and qualification of: | |
| 1. men and women | |
| 2. social strata | |
| 3. disabled people | |
| 4. citizenship groups | |
| Social exclusion: lack of completed education and vocational training | |
| Strengthening social connections and ties – social capital | trust in institutions: educational institutions | |
| European-specific conditions:  1. exchange of pupils, students, apprentices | |
| 2. teaching and dissemination of European languages | |
| Preservation of human capital | Access to educational institutions | |
| enrolment of young people in general education and vocational training | |
| participation in continuing training | |
| teachers, university personnel | |
| GDP spent on education | |
| Social structure: values and attitudes | subjective importance of education | |
| Life domain: Labour market and working conditions | | |
| Goal dimensions | Measurement dimensions | |
| Improvement of objective living conditions | labour market: opportunities and risks | |
| employment level | |
| working conditions | |
| mobility | |
| unemployment | |
| Enhancement of SWB | subjective perception and evaluation of personal employment situation | |
| Reduction of disparities/inequalities | regional disparities of employment opportunities and risks | |
| equal opportunities/inequalities regarding employment of | |
| 1. men and women | |
| 2. social strata | |
| 3. disabled people | |
| 4. citizenship groups | |
| Social exclusion: long-term unemployment | |
| Strengthening social connections and ties – social capital | participation in the area of working life | |
| quality of social relations at the work place | |
| trust in institutions: trade unions | |
| European-specific concerns: exchange of working people between countries | |
| Preservation of human capital | working accidents and occupational diseases | |
| participation in continuing training | |
| Preservation of natural capital | consumption of natural resources by economy | |
| environmental pollution by economy | |
| Social structure: Socio-economic structure | employment status | |
| occupational structure | |
| sector structure | |
| Social structure: Values and attitudes | subjective importance of work and job characteristics | |
| Life domain: Income, standard of living, and consumption patterns | | |
| Goal dimensions | Measurement dimensions | |
| Improvement of objective living conditions | income level and growth | |
| assets | |
| level of supply with private goods and services | |
| discretionary of income expenditure | |
| Enhancement of SWB | subjective perception and evaluation of financial situation and level of living | |
| Reduction of disparities/inequalities | inequity of income and standard of living | |
| subjective evaluations of inequality of income and standard of living | |
| regional disparities of income and standard of living | |
| equal opportunities/inequalities regarding income and standard of living of | |
| 1. men and women | |
| 2. generations | |
| 3. social strata | |
| 4. Disabled people | |
| Social exclusion: poverty | |
| Preservation of human capital | healthy consumption patterns | |
| Preservation of natural capital | consumption of natural resources by private households (for example energy, water, materials) | |
| environmental pollution by private households (for example non-recyclable waste, ozone depleting substances) | |
| non-polluting consumption patterns (for example ecologically produced food, products made of recycled material) | |
| attitudes towards consumption habits | |
| Social structure: Values and attitudes | subjective importance of income and wealth | |
| Life domain: Health | | |
| Goal dimensions | Measurement dimensions | |
| Improvement of objective living conditions | state of health | |
| Enhancement of SWB | subjective perception and evaluation of the state of health | |
| Reduction of disparities/inequalities | regional disparities of availability of health care facilities | |
| equal opportunities/inequalities between social strata in the area of health | |
| Social exclusion: heavy health impairments | |
| Strengthening social connections and ties – social capital | trust in institutions: system of health care | |
| Preservation of human capital | availability of health care facilities | |
| health expenditures | |
| health prevention measures | |
| measures of rehabilitation | |
| Life domain: Environment | | |
| Goal dimensions | Measurement dimensions | |
| Improvement of objective living conditions | stock of natural resources (minerals, oil, water, flora and fauna) | |
| state of the environment (quality of air, water, forests, soil) | |
| Enhancement of SWB | subjective perception and evaluation of the environment | |
| Reduction of disparities/inequalities | regional disparities in the state of environment | |
| Preservation of human capital | health hazards (e.g. By pollution, accidents, noxious substances in food) | |
| Preservation of natural capital | eco-efficiency: resource use per unit of product or service or per unit of GDP (energy efficiency, material efficiency) | |
| share of renewable energy sources | |
| pollution per unit of energy consumption | |
| public expenditures on environmental protection and research | |
| share of protected areas | |
| Social structure: Values and attitudes | subjective importance of the environment | |
| Life domain: Social security | | |
| Goal dimensions | Measurement dimensions | |
| Improvement of objective living conditions | coverage of social security | |
| efficiency of social insurance | |
| Enhancement of SWB | equal opportunities/inequalities regarding social security of | |
| 1. men and women | |
| 2. generations | |
| Strengthening social connections and ties – social capital | trust in institutions: social security institutions | |
| Life domain: Public safety and crime | | |
| Goal dimensions | Measurement dimensions | |
| Improvement of objective living conditions | extent of criminality | |
| structure of offenders | |
| structure of victims | |
| protection and combat against crime | |
| Enhancement of SWB | subjective perception and evaluation of public safety | |
| Reduction of disparities/inequalities | regional disparities of the extent of criminality | |
| inequalities regarding public safety of | |
| 1. men and women | |
| 2. generations | |
| 3. citizens groups | |
| 4. races | |
| Strengthening social connections and ties – social capital | trust in institutions: legal system | |
| Total life situation | | |
| Goal dimensions | Measurement dimensions | |
| Improvement of objective living conditions | comprehensive welfare indices | |
| Enhancement of SWB | subjective perception and evaluation of the total living situation | |
| Reduction of disparities/inequalities | regional disparities in comprising welfare measures | |
| inequalities regarding comprehensive measures of quality of life of | |
| 1. men and women | |
| 2. generations | |
| 3. social strata | |
| 4. disabled people | |
| 5. citizenship groups | |
| equal opportunities of generations regarding quality of life: public debts per capita | |
| Social exclusion: multiple deprivation | |
| Social structure: Socio-economic structure | social stratification | |
| Social structure: Values and attitudes | materialism – post-materialism | |
| equality | |
| freedom | |
| security | |

Annex N  
  
Smart Cities Wheel

Source: Boyd Cohen, http://www.boydcohen.com/smartcities.html



There are six key components, and three key drivers for each component [7].

Table N.1 – key components and drivers of smart city wheel

| Key component | Key driver |
| --- | --- |
| **Smart economy** | Entrepreneurship and innovation |
| Productivity |
| Local and global interconnectedness |
| **Smart environment** | Green buildings |
| Green energy |
| Green urban planning |
| **Smart governance** | Enabling supply and demand side policy |
| Transparency and open data |
| ICT and e-government |

| Key component | Key driver |
| --- | --- |
| **Smart living** | Culturally vibrant and happy |
| Safe |
| Healthy |
| **Smart mobility** | Mixed-model access |
| Prioritized clean and non-motorized options |
| Integrated ICT |
| **Smart people** | 21st century education |
| Inclusive society |
| Embrace creativity |

Annex O  
  
Ericsson: Networked society city index

Source:

Ericsson, [http://www.ericsson.com/res/docs/2013/ns-city-index-report-2013.pdf](http://carbonn.org/fileadmin/user_upload/carbonn/Standards/IEAP_October2010_color.pdf)

<http://www.ericsson.com/res/docs/2013/ns-city-index-report-2013-methodology.pdf>

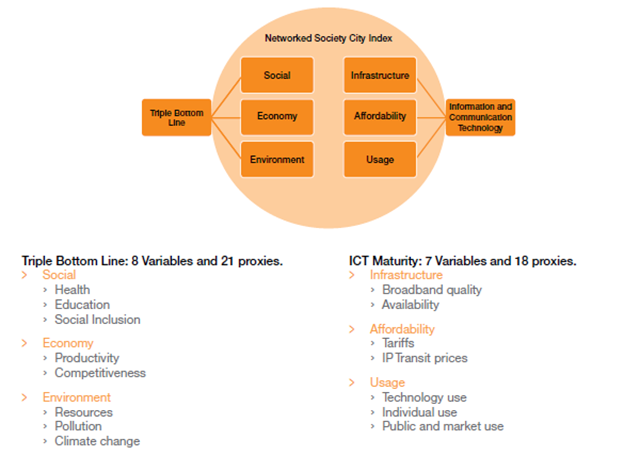


Table O.1 – networked society city index

| Dimension | Variable | Indicator | Proxy |
| --- | --- | --- | --- |
| **Social** | **Health** | Infant mortality | Death of children under the age of one |
| Life expectancy | Average life expectancy |
| **Education** | Education attainment | Upper secondary or tertiary education attainment |
| Literacy rate | Percentage of literate people |
| **Social inclusion** | Homicide rate | Murders per 100000 inhabitants |
| Unemployment rate | Unemployment as a percentage of the labour force |
| **Economy** | **Productivity** | Gross domestic product (GDP) per capita | GDP in dollars purchasing power parity (PPP) per capita |
| **Competitiveness** | Tertiary education attainment | Percent to have attained tertiary education |
| Patents | Patent cooperation treaty (PCT) patents per million inhabitants |
| Knowledge-intensive employment | Percent of Knowledge-intensive services (KIS) |
| Business start-up | New enterprises per 100,000 inhabitants |
| **Environment** | **Resources** | Waste | Recycled waste per person  Non-recycled waste per person |
| Energy | Fossil fuels consumption per capita  Non-fossil fuels consumption per capita |
| (Material) | (Not included so far) |
| **Pollution** | Air | PM10 microgram/m3  PM2.5 microgram/m3  NO2 microgram/m3  SO2 microgram/m3 |
| Water | Percentage of the wastewater treated |
| (Land) | (Not included so far) |
| **Climate change** | CO2 | CO2 emissions per person |
| **ICT infrastructure** | **Broadband quality** | Fixed broadband (BB) quality | Mean download speed |
| Mobile BB quality | Cell edge performance |
| Bandwidth capacity | International bandwidth capacity |
| **Availability** | Internet access | Percentage with Internet access at home |
| Fiber | FTTH/FTTB penetration |
| LTE/HSPA+ | Three largest operators have HSPA+ or LTE |
| WiFi hotspots | Number of WiFi hotspots |
| **ICT affordability** | **Tariffs** | Fixed BB tariffs | BB tariffs as percentage of GDP per capita |
| Mobile cellular tariffs | Mobile tariffs as percentage of GDP per capita |
| **IP transit prices** | IP transit prices | Median IP transit prices per Mbps, 10Gb Ethernet |
| **ICT usage** | **Technology use** | Mobile phones | Mobile phone subscriptions |
| Smartphones | Number of smartphones per capita |
| Computers | Percentage with a computer at home |
| Tablets | Number of tablets per capita |
| **Individual use** | Internet use | Internet usage as a percentage of the population |
| Social networking | Social networking penetration |
| **Public and market use** | Open data | Open data homepage and application programming interface (API) |
| Electronic payments | Electronic and mobile phone payments |

Annex P  
  
IBM: Smarter city assessment

Source: Dencik, J. (2010). Smarter city assessment. Presentation by IBM in Leuven, 1 June 2010.

Table P.1 – smarter city assessment

|  |
| --- |
| People |
| Investment in education |
| Investment in health |
| Expenditure on public safety |
| Investment in housing |
| Strategic planning and performance management for skills |
| Strategic planning and performance management for health |
| Strategic planning and performance management for public safety |
| Strategic planning and performance management for housing |
| ICT for education |
| ICT for health |
| Smart technologies for public safety |
| Smart technologies for housing |
| Education outcomes |
| Health outcomes |
| Public safety outcomes |
| Housing outcomes |
| Quality of life |
| Business |
| Access to finance |
| Business real estate |
| Openness to trade/access to markets |
| Strategic planning and performance management for business |
| Administrative burden |
| Efficient regulation |
| E-business |
| Business dynamics and entrepreneurship |
| Communication |
| Investment in telecommunication infrastructure |
| Presence of communication services |
| Strategic planning and performance management for communication systems |
| Deployment of broadband |
| Wi-Fi coverage |
| Quality and reliability of communication infrastructure |
| Access to communication services/digital divide |
| ICT take-up and use |
| Transport |
| Investment in transport infrastructure |
| Presence and quality of transport infrastructure |
| Public transport |
| Strategic planning and performance management |
| Congestion management |
| Energy efficiency of transport system |
| Accessibility |
| Congestion management |
| Pollution and climate change |
| Road safety |
| Energy |
| Quality of basic energy infrastructure |
| Investment in energy infrastructure |
| Strategic planning and performance management for energy system |
| Smart grid |
| Smart metre use |
| Reliability of energy supply |
| Energy losses |
| Renewable energy |
| CO2 emissions from household energy |
| Water |
| Investment in water infrastructure |
| Investment in flood defences |
| Strategic planning and performance management |
| Use of smart metering and pricing |
| Access to water and sewage |
| Water quality |
| Water usage |
| Water waste |
| Prevalence and cost of flooding |
| City services |
| Local government expenditure/budget |
| Local government staff |
| Strategic planning and performance measurement |
| Integrated information system |
| E-government |
| Efficiency and effectiveness of service delivery |

Annex Q  
  
IDC: Index system of SSC

Source: http://www.slideshare.net/cibbva/idcwp38-t-print

D1 Key components of smartness

There are five smartness dimensions: smart government, smart buildings, smart mobility, smart energy and environment, and smart services.

There are three enabling forces: people, economy, and ICT [6].

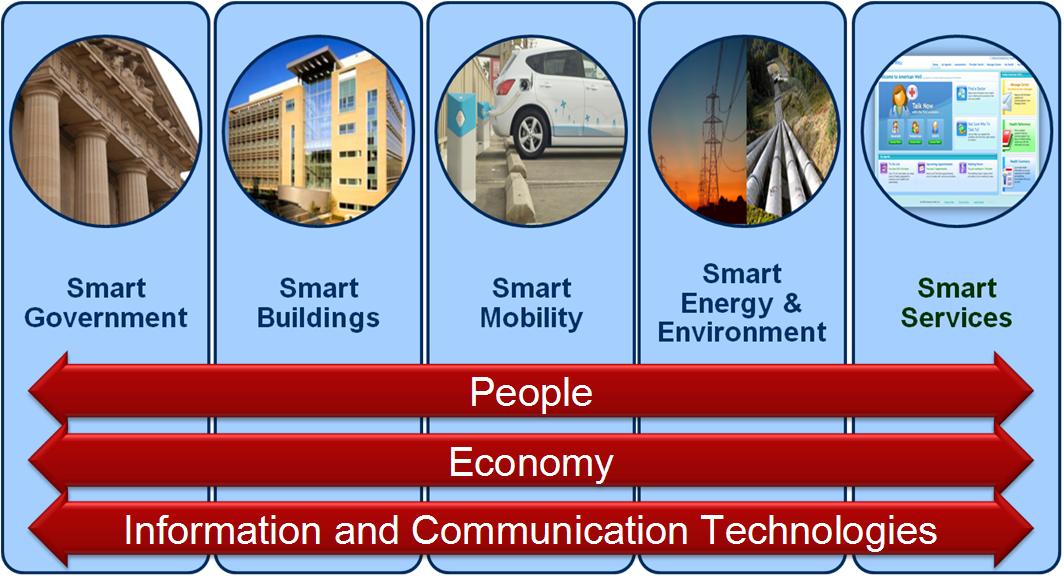


Figure Q.1 framework of IDC index system of SSC

D2 Component weighting

**Enabling forces**

Table Q.1 – component weighting of criteria - Enabling forces

|  |  |
| --- | --- |
| Criteria | weighting |
| People | 30 |
| Economy | 30 |
| ICT | 40 |
| Total | 100 |

**Smartness dimensions**

Table Q.2 – component weighting of criteria - Smartness dimensions

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

**Enabling forces**

Table Q.3 – component weighting of sub-criteria - Enabling forces

|  |  |  |
| --- | --- | --- |
| Criteria | Sub-criteria | weighting |
| People | Age | 40 |
| Education | 30 |
| Population dynamics | 30 |
| Subtotal | 100 |
| Economy | Economic wealth | 40 |
| Economic make-up | 30 |
| Economic dynamics | 30 |
| Subtotal | 100 |
| ICT | Adoption | 40 |
| Mobile | 60 |
| Subtotal | 100 |

**Smartness dimensions**

Table Q.4 – component weighting of sub-criteria - Smartness dimensions

| Criteria | Sub-criteria | weighting |
| --- | --- | --- |
| Smart government | Communication | 10 |
| Sustainable behavior | 30 |
| Environment protection policy | 20 |
| e-Services | 40 |
| Subtotal | 100 |
| Smart buildings | Efficiency in operations | 60 |
| Quality of construction | 40 |
| Subtotal | 100 |
| Smart mobility | Electromobility ( including low carbon) | 40 |
| Traffic intelligence | 40 |
| Teleworking | 20 |
| Subtotal | 100 |
| Smart energy and environment | Intelligence of distribution networks | 30 |
| Clean energy | 40 |
| Sustainable environment | 30 |
| Subtotal | 100 |
| Smart services | Security | 40 |
| Emergency | 30 |
| Services for the community | 30 |
| Subtotal | 100 |

D3 Key indicators

**Enabling forces**

Table Q.5 – Key indicators - Enabling forces

|  |  |  |  |
| --- | --- | --- | --- |
| Criteria | Sub-criteria | Indicator # | Indicator |
| People | Age | A.1 | Average citizen age |
| Education | A.2 | Level of literacy |
| A.3 | Average level of education |
| Population dynamics | A.4 | Population growth CAGR 2005-2010 |
| Economy | Economic wealth | B.1 | GDP per capita |
| B.2 | Energy/electricity consumption per capita |
| B.3 | Percentage of register unemployment, total unemployment (2009) |
| Economic make-up | B.4 | Economic activity index, industrial index, commercial index, etc |
| Economic dynamics | B.5 | GDP growth rate |
| B.6 | Variation of registered unemployment CAGR 5 years |
| ICT | Adoption | C.1 | ICT spending per capita |
| C.2 | Personal computer (PC) per capita |
| C.3 | Broadband lines per capita |
| Mobile | C.4 | Number of SIM cards per capita |
| C.5 | Internet access (percentage of population) |

**Smartness dimensions**

Table Q.6 – Key indicators - Smartness dimensions

| Criteria | Sub-criteria | Indicator # | Indicator |
| --- | --- | --- | --- |
| 1.Smart government | Communication | 1.1 | (Online) free public access to government spending |
| Sustainable behaviour | 1.2 | Existence of congestion charge |
| 1.3 | # of electric vehicles (EVs) in local government's vehicle fleet |
| 1.4 | Public light automation and control systems (level of adoption) |
| 1.5 | Emissions monitoring system (level of adoption) |
| 1.6 | Internal administrative process integration and data sharing (level) |
| 1.7 | Urbanization planning (level of adoption and level of digitalization) |
| Environment protection policy | 1.8 | City is signatory of Covenant of Mayors European Initiative |
| 1.9 | Quantified parameter goals for city's sustainability (emissions, RES, energy efficiency) |
| e-Services | 1.10 | Percentage of vital certificates/records obtainable online (e-Government) |
| 1.11 | Availability of e-Registry |
| 1.12 | Availability of e-Taxes |
| 1.13 | Availability of Digital Property Registry |
| 2. Smart buildings | Efficiency in operations | 2.1 | Energy consumption per square meter |
| 2.2 | Percentage of buildings served by district heating/cooling |
| 2.3 | Percentage of buildings with an energy management systems |
| 2.4 | Percentage of building automation systems (%) |
| 2.5 | Penetration of lighting control system (%) |
| Quality of construction | 2.6 | Minimum level of energy class standards for construction of new buildings |
| 2.7 | Percentage of buildings of class "A" energy efficiency standard |
| 3. Smart mobility | Electromobility ( including low carbon) | 3.1 | # of public electrical vehicle charging points |
| 3.2 | Percentage of public transport that is "green" (runs on low emission fuels) |
| 3.3 | City incentive program for low emission vehicles |
| Traffic intelligence | 3.4 | Car-pooling initiatives |
| 3.5 | Percentage of traffic lights that are intelligent |
| 3.6 | Web-portals for traffic information |
| 3.7 | Real-time passenger information display systems |
| 3.8 | Systems for traffic monitoring and congestion prediction |
| Teleworking | 3.9 | Percentage of remote workers |
| 4. Smart energy and environment | Intelligence of distribution networks | 4.1 | Percentage of smart meters installed to date /2011/2010 |
| 4.2 | Percentage of network automation (electricity, gas and water) |
| Clean energy | 4.3 | Weight of renewable energy sources (RES) on total consumption |
| 4.4 | Percentage of energy consumption from district heating/cooling |
| Sustainable environment | 4.5 | CO2 emissions per capita |
| 4.6 | NOX and other emissions |
| 4.7 | Electricity consumption (on GDP) |
| 4.8 | Waste generated (per capita) |
| 4.9 | Water consumption (per capita) |
| 4.10 | Average number of citizens per water purifier |
| 4.11 | Waste to energy power plant (level of adoption) |
| 4.12 | Percentage of differentiated/categorized recycling |
| 5. Smart services | Security | 5.1 | City video surveillance penetration |
| 5.2 | Police mobile devices and applications (level of adoption) |
| Emergency | 5.3 | Sensors and control system for fire prevention (availability) |
| 5.4 | Flood control/predictive systems |
| Services for the community | 5.5 | Surface of green area (on total city surface) |
| 5.6 | Digital access to urban planning documents |
| 5.7 | E-tourism penetration |
| 5.8 | Availability of education |

Annex R  
  
PwC: Cities of opportunities index

Source: PwC and Partnership for New York City (2011). Cities of opportunities.

PwC and Partnership for New York City (2012). Cities of opportunities, <http://www.pwc.com/us/en/cities-of-opportunity/2012/pdf-download.jhtml>

The indicators below were used for 2011.

Table R.1 – PwC: Cities of opportunities index

|  |  |
| --- | --- |
| ***Air pollution*** | Measurement of the quality of a city's air based on the degree of pollution from sources such as vehicles and power plants. |
| ***Aircraft movements*** | Count of air traffic movements at each of the major airports servicing a city, including civil international and domestic passenger, cargo and non-revenue flights but excluding military flights. |
| ***Airport to CBD access*** | Measure of the ease of using public transit to travel between a city's central business district and the international terminal of its busiest airport in terms of international passenger traffic. Cities are separated into categories according to whether a direct rail link exists between the city center and the airport – if so, the number of transfers required, and if not, whether there is a public express bus route to the airport. Cities with direct rail links are preferred to those with express bus services. Cities with rail links with fewer transfers are ranked higher than those with more. Cities are ranked against other cities in the same category according to the cost of a single one-way, adult weekday trip and the length of the trip, with each factor weighted equally. |
| ***Attracting FDI: capital investment*** | Total value of greenfield (new job-creating) capital investment activities in USD in a city that are funded by foreign direct investment. Data cover the period from January 2003 through May 2010. |
| ***Attracting FDI: number of greenfield***  ***projects*** | Number of greenfield (new job-creating) projects in a city that are funded by foreign direct investment. Data cover the period from January 2003 through May 2010. |
| ***Broadband quality score*** | Measurement of the quality of a broadband connection in a given country. The Broadband Quality Study is an index that is calculated based on the normalized values of three key performance parameter categories: download throughput, upload throughput and latency. A formula weights each category according to the quality requirements of a set of popular current and probable future broadband applications. |
| ***Business trip index*** | Weighted index of the cost of a business trip to a city, including measures such as taxi cab rates, lunch prices, and quality of entertainment and infrastructure. The business travel index comprises the following five categories: stability, health care, culture and environment, infrastructure and cost. |
| ***City carbon footprint*** | Annual amount of CO2 emissions in metric tons divided by the city population. Supplemental national reports on data and policies on greenhouse gas emissions were used when city-level data were not available. |
| ***Classroom size*** | Number of students enrolled in public primary education programs divided by the number of classes in these programs. Primary education programs usually begin at ages five to seven and last four to six years. Primary education is counted as the equivalent of kindergarten through grade 5 in the US education system wherever possible. |
| ***Commute time*** | Assessment of the average commute time for workers commuting into or within a city across all modes of transport, measured in minutes. |
| ***Cost of business occupancy*** | Annual gross rent divided by square feet of Class A office space. Gross rent includes lease rates, property taxes, and maintenance and management costs. |
| ***Cost of living*** | Measure of the comparative cost of more than 200 items in each city. Counted items include housing, transport, food, clothing, household goods and entertainment. |
| ***Cost of public transport*** | Cost of the longest mass transit rail trip within a city's boundaries. The cost of a bus trip is used in the cities where there are no rail systems. |
| ***Crime*** | Amount of reported crimes in a city such as petty and property crimes, violent crimes and street crimes. |
| ***Cultural vibrancy*** | Weighted combination of city rankings based on: the quality and variety of restaurants, theatrical and musical performances, and cinemas within each city; which cities recently have defined the "zeitgeist," or the spirit of the times; and the number of museums with online presence within each city. The "zeitgeist" rankings take into account cultural, social and economic considerations. |
| ***Digital economy score*** | Assessment of the quality of a country's information and communication technology (ICT) infrastructure and the ability of its consumers, businesses and governments to use ICT to their benefit. |
| ***Domestic market capitalization*** | Total number of issued shares of domestic companies listed at a city's stock exchange(s) multiplied by their respective prices at a given time. This figure reflects the comprehensive value of the market at that time in millions of USD. |
| ***Ease of entry: number of countries***  ***with visa waiver*** | Number of nationalities able to enter the country for a tourist or business visit without a visa. Excludes those nationalities for whom only those with biometric, diplomatic or official passports may enter without a visa. |
| ***Ease of firing*** | Ranking based on notification and approval requirements for termination of a redundant worker or a group of redundant workers, obligation to reassign or retrain, and priority rules for redundancy and re-employment. |
| ***Ease of hiring*** | Ranking based on restrictions and regulations that employers must follow when taking on new staff. |
| ***Ease of starting a business*** | Assessment of the bureaucratic and legal hurdles an entrepreneur must overcome to incorporate and register a new firm. Accounts for the number of procedures required to register a firm; the amount of time in days required to register a firm; the cost (as a percentage of per capita income) of official fees and fees for legally mandated legal or professional services; and the minimum amount of capital (as a percentage of per capita income) that an entrepreneur must deposit in a bank or with a notary before registration and up to three months following incorporation. |
| ***End-of-life care*** | Ranking of countries according to their provision of end-of-life care. The Quality of Death Index scores countries across four categories: Basic End-of-Life Healthcare Environment; Availability of End-of-Life Care; Cost of End of-Life Care; and Quality of End-of-Life Care. These indicator categories are composed of 27 variables, including quantitative, qualitative and "status" (whether or not something is the case) data. The indicator data are aggregated, normalized, and weighted to create the total index score. |
| ***Entrepreneurial environment*** | Measurement of the entrepreneurial attitudes, entrepreneurial activity and entrepreneurial aspirations in a country. The Global Entrepreneurship Index integrates 31 variables, including quantitative and qualitative measures and individual-level data. |
| ***Financial and business services***  ***employment*** | Proportion of employees working in businesses located within a city in the financial and business services sectors to the total employed workforce in the city. Where industry data were disaggregated, the equivalents of "finance and insurance" and "real estate and rental and leasing" were included in financial services; and the equivalents of "professional and technical services" and "management of companies and enterprises" were included in business services. |
| ***Flexibility of visa travel*** | Ranking based on the number of visa waivers available for tourist or business visits and the length of time for which the visa waiver is granted. Ranking is based on the number of those countries that can stay for at least 90 days, excluding those countries whose residents can enter only without a visa if they have a biometric, diplomatic or official passport. |
| ***Foreign embassies or consulates*** | Number of countries that are represented by a consulate or embassy in each city. |
| ***Green space as a percent of city area*** | Proportion of a city's land area designated as recreational and green spaces to the total land area. Excludes undeveloped rugged terrain or wilderness that is either not easily accessible or not conducive to use as public open space. |
| ***Health system performance*** | Measurement of a country's health system performance made by comparing healthy life expectancy with health care expenditures per capita in that country, adjusted for average years of education (years of education is strongly associated with the health of populations in both developed and developing countries). Methodology adapted from the 2001 report "Comparative efficiency of national health systems: cross-national econometric analysis". |
| ***Hospitals*** | Ratio of all hospitals within each city accessible to international visitors to every 100,000 members of the total population. |
| ***Hotel rooms*** | Count of all hotel rooms within each city. |
| ***Housing*** | Measure of availability, diversity, cost and quality of housing, household appliances and furniture, as well as household maintenance and repair. |
| ***Incoming/outgoing passenger flows*** | Total number of incoming and outgoing passengers, including originating, terminating, transfer and transit passengers in each of the major airports servicing a city. Transfer and transit passengers are counted twice. Transit passengers are defined as air travellers coming from different ports of departure who stay at the airport for brief periods, usually one hour, with the intention of proceeding to their first port of destination (includes sea, air and other transport hubs). |
| ***Inflation*** | Ranking according to how far a country deviates from a +2% inflation rate, with inflation that is closer to +2% being favoured over inflation or deflation that is further from this rate. A +2% inflation rate is used as the benchmark because it is widely regarded as a target or healthy inflation rate by large international banks. A country's inflation rate is based on a projection of how much its Consumer Price Index, which measures the rise in prices of goods and services, is expected to rise during the course of 2010. |
| ***Intellectual property protection*** | Leading business executives' responses to the question in the World Economic Forum's Executive Opinion Survey 2010 that asks, "How would you rate intellectual property protection, including anti-counterfeiting measures, in your country? (1 = very weak; 7 = very strong)." The survey covers a random sample of large and small companies in the agricultural, manufacturing, non-manufacturing, and service sectors. |
| ***International tourists*** | Annual international tourist arrivals for 100 cities collected by Euromonitor International. Euromonitor's figures include travellers who pass through a city, as well as actual visitors to the city. |
| ***Internet access in schools*** | Leading business executives' responses to the question in the World Economic Forum's Executive Opinion Survey 2010 that asks, "How would you rate the level of access to the Internet in schools in your country? (1 = very limited; 7 = extensive)." The survey covers a random sample of large and small companies in the agriculture, manufacturing, non-manufacturing, and service sectors. |
| ***Level of shareholder protection*** | Measurement of the strength of minority shareholder protection against misuse of corporate assets by directors for their personal gain. The Strength of the Investor Protection Index is the average of indices that measure "transparency of transactions," "liability for self-dealing" and "shareholders' ability to sue officers and directors for misconduct." |
| ***Libraries with public access*** | Number of libraries within each city that are open to the public divided by the total population and then multiplied by 100,000. |
| ***Licensed taxis*** | Number of officially licensed taxis in each city divided by the total population and then multiplied by 1,000. |
| ***Life satisfaction*** | Average score in robust international surveys of country populations in response to the question, "All things considered, how satisfied are you with your life as a whole these days?" The (Un) Happy Planet Index 2.0 predominantly drew its data from the 2006 Gallup World Poll, with the 2000 and 2005 World Values Surveys being used to fill in values for countries excluded from the Gallup survey. Responses are scored on a numeric scale from 0 to 10, where 0 is dissatisfied and 10 is satisfied. |
| ***Literacy and enrollment*** | Measurement of a country's ability to generate, adopt and diffuse knowledge. The World Bank's Knowledge Index is derived by averaging a country's normalized performance scores on variables in three categories – education and human resources, the innovation system, and information and communications technology. The variables that compose education and human resources are adult literacy rate, secondary education enrollment and tertiary education enrollment. |
| ***Mass transit coverage*** | Ratio of kilometers of mass transit track to every 100 square kilometers of the developed and developable portions of a city's land area. A city's developable land area is derived by subtracting green space and governmentally protected natural areas from total land area. |
| ***Math/science skills attainment*** | Top performers' combined mean scores on the math and science components of an Organisation for Economic Co-operation and Development (OECD) assessment of 15 year olds' academic preparedness. Top performers are defined as those students who achieved in the top two proficiency levels (Level 5 and Level 6) on the math and science portions of the test. Comparable examinations are used wherever possible to place cities not included in the OECD assessment. |
| ***Miles of mass transit track*** | Total miles of metro, tram and light rail track within a city divided by the total population and then multiplied by 100,000. Includes monorail and commuter rail that run within a city if they operate as metros in the city. |
| ***Natural disaster risk*** | Risk of natural disasters occurring in or near a city. Counted hazards include hurricanes, droughts, earthquakes, floods, landslides and volcanic eruptions. |
| ***Number of global 500 headquarters*** | Number of global 500 headquarters located in each city. |
| ***Operational risk climate*** | Quantitative assessment of the risks to business profitability in each of the countries. Assessment accounts for present conditions and expectations for the coming two years. The operational risk model considers 10 separate risk criteria: security, political stability, government effectiveness, legal and regulatory environment, macroeconomic risks, foreign trade and payment issues, labour markets, financial risks, tax policy, and standard of local infrastructure. The model uses 66 variables, of which about one-third are quantitative. |
| ***Percent of gross domestic expenditure on R&D*** | Total gross domestic expenditure on research and development in 2007 as a percentage of the gross domestic product. |
| ***Percent of population with higher education*** | Number of people who have completed at least a university-level education divided by the total population. A university-level education is set equivalent to a Bachelor's degree or higher from a US undergraduate institution. |
| ***Political environment*** | Measure of a nation's relationship with foreign countries, internal stability, law enforcement, limitations on personal freedom and media censorship. |
| ***Purchasing power*** | Measure of the comparative relationship between prices and earnings calculated by dividing net hourly income by the cost of a basket of 122 goods and services, including rent. |
| ***Quality of living*** | Score based on more than 30 factors across five categories: socio-political stability, health care, culture and natural environment, education and infrastructure. Each city receives a rating of either acceptable, tolerable, uncomfortable, undesirable or intolerable for each variable. For qualitative indicators, ratings are awarded based on the Economic Intelligence Unit analysts' and in city contributors' judgments. For quantitative indicators, ratings are calculated based on cities' relative performances on a number of external data points. |
| ***Recycled waste*** | Percentage of municipal solid waste diverted from the waste stream to be recycled. |
| ***Renewable energy consumption*** | Percentage of total energy consumption in a nation that comes from renewable sources. Renewable energy sources include geothermal, solar thermal, solar voltaics, hydro, wind, and combustible renewable sources and waste (composed of solid biomass, liquid biomass, biogas, industrial waste and municipal waste). Non-renewable sources include coal and peat, crude oil, petroleum products, gas and nuclear. |
| ***Research performance of top universities*** | Sum of the scaled scores of a city's universities that are included in the rankings of top performing research universities in the world. Scaled scores are based on the number of articles published, number of citations to published work and the quantity of highly cited papers. The scoring accounts for social sciences papers but not humanities papers. The rankings favor large universities, universities with medical schools, and universities that focus predominantly on the "hard sciences" rather than social sciences and humanities. |
| ***Rigidity of hours*** | Ranking is based on the flexibility in scheduling of non-standard work hours and annual paid leave for a business. |
| ***Skyline impact*** | Measure of the visual impact of completed high-rise buildings on their skylines, accounting for the height and the breadth of a skyline. Cities are given scores based on the number of buildings located within them that are above 90 meters tall, with taller buildings receiving more points than smaller ones. |
| ***Skyscraper construction activity*** | Count of skyscraper construction projects in each city under way as of September 26, 2010. A skyscraper is defined as any building 12 stories or greater in height. |
| ***Software and multimedia development and design*** | Combined score for each city in fDi magazine's Best Cities for Software Development and Best Cities for Multi-Media Design Centres indices. Both indices weight a city's performance 70% based on the quality of the location and 30% based on the cost of the location. The software design index is based on an assessment of 120 quality competitiveness indicators. These indicators include availability and track record in ICT, availability of specialized-skills professionals such as scientists and engineers, access to venture capital, R&D capabilities, software exports, quality of ICT infrastructure and specialization in software development. The multimedia design centre rankings are based on an assessment of 120 quality competitiveness indicators, including the size of the location's leisure and entertainment sector, its specialization and track record, information technology infrastructure, quality of life and skills availability. |
| ***Sport and leisure activities*** | The quality and variety of sport and leisure activities within each city. |
| ***Strength of currency (SDRs per currency unit)*** | Currency value of the special drawing rights (SDRs) per currency unit. The currency value is determined by summing the values of a basket of major currencies (USD, euro, Japanese yen and pound sterling) in USD based on market exchange rates and the amount that can be bought by a given currency unit. |
| ***Thermal comfort*** | Measure of the average deviation from optimal room temperature (72 degrees Fahrenheit) in a city. January and July heat indices were calculated for each city using an online tool that integrates average temperature and average morning relative humidity during each month. A final thermal comfort score was derived by first taking the difference between a city's heat index for each month and optimal room temperature and then averaging the absolute values of these differences. |
| ***Total tax rate*** | Total amount of taxes and any mandatory contributions required by local, state and national law payable by a business as a percent of its profit. This does not include employer contributions to health care coverage. |
| ***Traffic congestion*** | Measure of traffic congestion and congestion policies for each city scored on the level of congestion as well as the modernity, reliability and efficiency of public transport. |
| ***Workforce management risk*** | Ranking based on staffing risk in each city associated with recruitment, employment, restructuring, retirement and retrenchment. Risk was assessed based on 25 factors grouped into five indicator areas: demographic risks associated with labor supply, the economy and the society; risks related to governmental policies that help or hinder the management of people; education risk factors associated with finding qualified professionals in a given city; talent development risk factors related to the quality and availability of recruiting and training resources; and risks associated with employment practices. A lower score indicates a lower degree of overall staffing risk. |
| ***Working age population*** | Proportion of a city's population aged 15-64 to the total population of the city. |

Annex S  
  
Siemens: Green city index

Source: Siemens. http://www.siemens.com/entry/cc/en/greencityindex.htm

The green city index was developed by Siemens. Green city index reports are developed for Europe, Asia, South America, North America, and Africa. The green city index focuses on environmental performance and the categories and indicators vary between the different geographical indices.

Eight categories are used in the European version index: CO2 emissions, energy, buildings, transport, water, waste and land use, air quality and environmental governance; 16/30 indicators are derived from quantitative data (how the city is performing) and 14/30 of the indicators are qualitative assessments of the cities ambition and aspirations.

Reference: European Green City index – assessing the environmental performance of Europe's major cities – A research project conducted by the Economist Intelligence Unit, sponsored by Siemens. Siemens report.

Table S.1 – European green city index

|  |  |  |  |
| --- | --- | --- | --- |
| **European green city index** | | | |
| **Category indicator** | | **Type** | **Description** |
| CO2 | CO2 emissions | Quantitative | Total CO2 emissions in tons per head |
| CO2 intensity | Quantitative | Total CO2 emissions in grams per unit of real GDP (2000 base year) |
| CO2 reduction strategy | Qualitative | An assessment of the ambitiousness of CO2 emissions reduction strategy |
| Energy | Energy consumption | Quantitative | Total final energy consumption, in gigajoules per head |
| Energy intensity | Quantitative | Total final energy consumption, in mega joules per unit of real GDP (in euros, 2000 base year) |
| Renewable energy consumption | Quantitative | The percentage of total energy derived from renewable sources, as a share of the city's total energy consumption, in tera joules |
| Clean and efficient energy policies | Qualitative | An assessment of the extensiveness of policies promoting the use of clean and efficient energy |
| Buildings | Energy consumption of residential buildings | Quantitative | Total final energy consumption in the residential sector, per square meter of residential floor space |
| Energy-efficient buildings standards | Qualitative | An assessment of the extensiveness of cities' energy efficiency standards for buildings |
| Energy-efficient buildings initiatives | Qualitative | An assessment of the extensiveness of efforts to promote energy efficiency of buildings |
| Transport | Use of non-car transport | Quantitative | The total percentage of the working population travelling to work on public transport, by bicycle and by foot |
| Size of non-car transport network | Quantitative | Length of cycling lanes and the public transport network, in km per square meter of city area |
| Green transport promotion | Qualitative | An assessment of the extensiveness of efforts to increase the use of cleaner transport |
| Congestion reduction policies | Qualitative | An assessment of the efforts to reduce vehicle traffic within the city |
| Water | Water consumption | Quantitative | Total annual water consumption, in cubic meters per head |
| Water system leakage | Quantitative | Percentage of water lost in the water distribution system |
| Wastewater treatment | Quantitative | Percentage of dwellings connected to the sewage system |
| Water efficiency and treatment policies | Qualitative | An assessment of the comprehensiveness of measures to improve the efficiency of water usage and the treatment of wastewater |
| Waste and land use | Municipal waste production | Quantitative | Total annual municipal waste collected, in kg per head |
| Waste recycling | Quantitative | Percentage of municipal waste recycled |
| Waste reduction and policies | Qualitative | An assessment of the extensiveness of measures to reduce the overall production of waste, and to recycle and reuse waste |
| Green land use policies | Qualitative | An assessment of the comprehensiveness of policies to contain the urban sprawl and promote the availability of green spaces. |
| Air quality | Nitrogen dioxide | Quantitative | Annual daily mean of NO2 emissions |
| Ozone | Quantitative | Annual daily mean of O3 emissions |
| Particulate matter | Quantitative | Annual daily mean of PM10 emissions |
| Sulphur dioxide | Quantitative | Annual daily mean of SO2 emissions |
| Clean air policies | Qualitative | An assessment of the extensiveness of policies to improve air quality |
| Environ-mental gover-nance | Green action plan | Qualitative | An assessment of the ambitiousness and comprehensiveness of strategies to improve and monitor environmental performance |
| Green management | Qualitative | An assessment of the management of environmental issues and commitment to achieving international environmental standards |
| Public participation in green policy | Qualitative | An assessment of the extent to which citizens may participate in environmental decision-making |

Siemens web sites include links to the Green city index reports. [http://www.siemens.com/entry/cc/en/greencityindex.htm](http://www.iadb.org/en/topics/emerging-and-sustainable-cities/implementing-the-emerging-and-sustainable-cities-initiative-approach,7641.html)

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