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Supplement 3 to ITU-T L.1600 series - Key performance indicators definitions for smart sustainable cities

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Supplement 19 to ITU-T L-series Recommendations

Supplement 3 to ITU-T L.1600 series - Key performance indicators definitions for smart sustainable cities

Summary

This Supplement 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 Supplement 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 Recommendations and Supplements. The resources presented in this Supplement were analysed with respect to common elements, and a set of indicators focusing on ICT and its contribution to smart sustainable cites was developed.

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Key performance indicators definitions for smart sustainable cities

0 Introduction

This Supplement defines key performance indicators (KPIs) for smart sustainable cities (SSC). It should be noted that the following documents have been developed with regards to KPIs for SSC:

- Recommendation on overview of key performance indicators (KPIs) in smart sustainable cities [ITU-T L.KPIs-SSC-overview].
- Recommendation on key performance indicators (KPIs) related to the use of information and communication technology (ICT) in smart sustainable cities [ITU-T L.KPIs-SSC-ICT]. This Recommendation lists the KPIs focusing on ICT use in SSCs.
- Recommendation on key performance indicators (KPIs) related to the sustainability impacts of information and communication technology (ICT) in smart sustainable cities [ITU-T L.KPIs-SSC-impact]. This Recommendation lists the KPIs proposed for ICT impact on sustainability.

This Supplement 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 series of KPIs Recommendations and Supplements.

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.

1 Scope

This Supplement 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 Supplement 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 Recommendations and Supplements. The resources presented in this Supplement 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.] ITU-T FG-SSC deliverable (2014), *Technical report on smart sustainable cities: an analysis of definitions*

[UN Resolution 288] UN General Assembly 66 Resolution 288, *The future we want*

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

[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 Definition

3.1 Terms defined elsewhere

This Supplement 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 Error! Reference source not found.: 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 Term defined in this Supplement

This Supplement 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 Supplement 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.

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 Recommendations and Supplements that are part of the KPI series.

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

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
		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.)																			

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
		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

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
		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		

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
		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	

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
		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	

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
		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	

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
		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	

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
	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												

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
	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		

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
		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 5-2 – 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

Table 5-2 – Proximity statistics of KPIs for SSC

Source	Number of similar indicators	Percentage of similar indicators (%)	Distribution of indicators
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,

Table 5-2 – Proximity statistics of KPIs for SSC

Source	Number of similar indicators	Percentage of similar indicators (%)	Distribution of indicators
			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

Table 5-2 – Proximity statistics of KPIs for SSC

Source	Number of similar indicators	Percentage of similar indicators (%)	Distribution of indicators
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 Supplement 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 Supplement 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.

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/

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

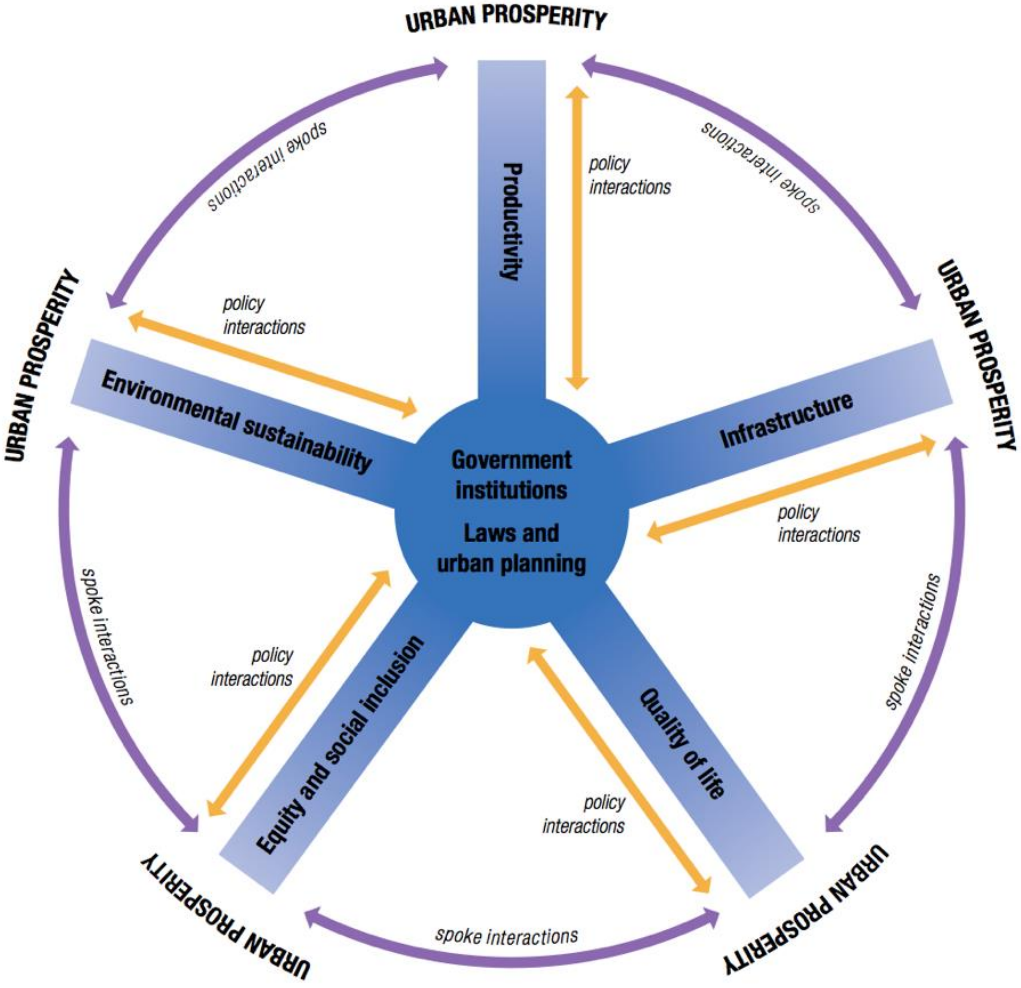
UN-Habitat: City prosperity index

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

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), CO_2 emissions, energy and indoor pollution.
Equity and social inclusion	The equity and social inclusion index combines statistical measures of inequity of income/consumption (Gini coefficient) and social and gender inequity of access to services and infrastructure.

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

Table D.1 – Evaluation index system of SSC

No.	First-level index	Second-level index	Third-level index
			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

First-level index	Second-level index	Third-level index
		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)

First-level index	Second-level index	Third-level index
		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

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

Towards a Local Sustainability Profile European Common Indicators		Principle n°					
n°	Issue/Indicator	1	2	3	4	5	6
1	Citizens' Satisfaction with the Local Community	✓	✓		✓	✓	✓
2	Local Contribution to Global Climate Change (and/or local Ecological Footprint)	✓		✓	✓	✓	
3	Local Mobility and Passenger Transportation	✓		✓	✓	✓	✓
4	Availability of Local Public Open Areas and Services	✓		✓		✓	✓
5	Quality of Local Air	✓				✓	✓
6	Children's Journeys to and from School	✓		✓	✓	✓	
7	Sustainable Management of the Local Authority and Local Businesses			✓	✓	✓	
8	Noise Pollution	✓				✓	✓
9	Sustainable Land Use	✓		✓		✓	✓
10	Products Promoting Sustainability	✓		✓	✓	✓	

Table F.2 – List of European Common Indicators

Cell Contents (EF values)	Modifier 1 (Front page)	Modifier 2 (Assumptions page)
ENERGY LAND		
Nourishment	Food consumption	Energy coefficient
Food embodied energy	kg/cap	GJ/ton
		Carbon intensity
		ton C/GJ
Shelter	Energy consumption	Carbon intensity
Domestic electricity	kWh/cap	kg C/kWh
Domestic natural gas & LPG	kWh/cap	kg C/kWh
Domestic oil	kWh/cap	kg C/kWh
District heating	kWh/cap	kg C/kWh
Domestic Coal	kWh/cap	kg C/kWh
Renewable (wood excluded)	kWh/cap	kg C/kWh
Other domestic	kWh/cap	kg C/kWh
Mobility	Distance covered	CO_2 emissions
Car	passenger-km/cap	kg CO_2/ passenger-km
Bus & coach	passenger-km/cap	kg CO_2/ passenger-km
Rail, tram, metro	passenger-km/cap	kg CO_2/ passenger-km
Waterborne	passenger-km/cap	kg CO_2/ passenger-km
Air	passenger-km/cap (intra EU only*)	kg CO_2/ passenger-km
Motorbike/scooters	passenger-km/cap	kg CO_2/ passenger-km
Goods & Services	Domestic waste	
Net traded goods	kg/cap (landfill and incinerated)	
Local goods	kg/cap (landfill and incinerated)	
	Services spending	
Hotels & restaurants	Euro/cap	
Community, social, personal	Euro/cap	
Offices & admin	Euro/cap	
Commerce	Euro/cap	
Other services	Euro/cap	
Education & health	None	

Cell Contents (EF values)	Modifier 1 (Front page)	Modifier 2 (Assumptions page)
CROP		
Nourishment Animal-based	Food consumption kg/cap	Kind of diet Proportion of animal products in diet (difference from national average)
Plant-based	kg/cap	Proportion of plant-based products in diet (difference from national average)
Goods & services	Domestic waste kg/cap (landfill and incinerated)	
PASTURE		
Nourishment Animal-based	Food consumption kg/cap	Kind of diet Proportion of animal products in diet (difference from national average)
Goods & services	Domestic waste kg/cap (landfill and incinerated)	
FOREST		
Shelter	Fuelwood consumption m^3/cap	
Goods & services	Wood products consumption m^3/cap	
BUILT LAND		
Shelter	Housing land Actual area (ha)	
Mobility Road Rail Air Ports	Land for infrastructures Road land – actual area (ha) Rail land – actual area (ha) Airport land – actual area (ha) Sea ports land – actual area (ha)	
Goods & Services	Land used Goods & services land (including Hydro) – actual area (ha)	
FISHING		
Nourishment	Food consumption kg/cap	Kind of diet Proportion of animal products in diet (difference from national average)
Goods & Services	Domestic waste kg/cap (landfill and incinerated)	

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).

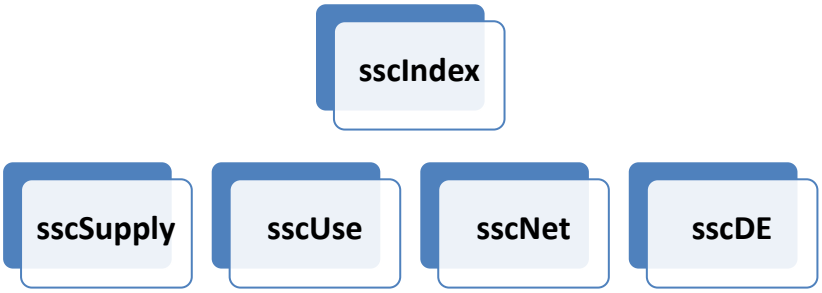


Figure G.1 – Cities' KPI

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)

Table G.2 – Indicators for "Supply" and "Use" KPIs

Dimension	KPI	Indicator
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 CO_2 emission per capita (CO_2 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.)

Table G.2 – Indicators for "Supply" and "Use" KPIs

Dimension	KPI	Indicator
	6.2 peoUse	6.2.1 Ratio of people using the e-learning system (per 1,000 citizens)* 6.2.2 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

KPI layers					Notes
First layer [unit: monetary value] *	Second layer [unit: monetary value]*		Third layer [unit: monetary value] *	Fourth layer (example) [unit: monetary value, %, time, weight, etc.]	
Environment	Environment	Less environmental impact	Environment/natural resource	Amount of CO2 emission, waste, resource depletion (water, underground resources, etc.), toxic substance, biodiversity	・Perspective of the policy implementing-side (operator-side) and subject-side(citizens-side)
			Energy	Resource depletion, the amount of consumption, sustainability of electricity supply, utilization rate of renewable energy	
Economy	Economy	High cost performance	Cost performance	Cost: deployment/ operation/maintenance Benefit: financial effect/ profit/ employment rate/ enterprising rate/ online billing rate	・Perspective of the policy implementing-side (operator-side)
Society	Safety	Less damage on people and their properties	Accident	Accident rate (victim, damaged object), damage cost	・Perspective of the subject-side(citizens-side) ・Select or define according to the goal of SCC (advanced country/ developing country, urban area/ rural area, etc.)
			Natural disaster	Damage rate (victim, damaged object), damage cost	
			Crime	Damage rate (victim, damaged object), damage cost	
			Information security	Information accessibility, information leakage rate, information importance, damage cost	
	Health	People staying healthy	Health management	Sporting ability level, nursing care cost, social security cost	
			Prevention of illness	Morbidity (incidence rate, prevalence, fatality rate), medical expense	
			Medical treatment	Mortality, morbidity, medical expense	
			Stress	Morbidity, medical expense	
	Comfort	Comfortable living	Diverse opportunities	Labor force participation rate, number of tourists, frequency of visit, purchase rate, leisure time, means of transportation	
			Barrier free	Usage ratio (number of people, frequency), composition of users	
			simplicity	Usage ratio (number of people, frequency) willingness to use, satisfaction level with equipment	
			Ubiquitous	Service area, service duration, device penetration ratio	
Satisfaction	Satisfaction	Satisfaction with the life	Citizens' degree of satisfaction	Willingness to pay	

* 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"

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)

Profile indicators list	
	Indicators
	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	

Performance indicators list		
City services	**Core indicator**	**Supporting indicator**
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)

Performance indicators list		
City services	**Core indicator**	**Supporting indicator**
	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

Quality of life	Core indicator	Supporting indicator
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). The IEAP consists of principles that should be adhered to when inventorying GHG emissions from a community.

Table J.2 – Protocol of GPC

UNFCCC Sector		Scope 1 Emissions	Scope 2 Emissions	Scope 3 Emissions
Energy	Stationary Energy	Utility-delivered fuel consumption Decentralized fuel consumption Utility-consumed fuel for electricity / heat generation	Utility-delivered electricity / heat /steam cooling consumption Decentralized electricity / heat /steam consumption	Upstream/downstream emissions (e.g., mining/transport of coal)
	Transport	Tailpipe emissions from on-road vehicles Tailpipe emissions from rail, sea, airborne and non-road vehicles operating within the community	Electricity consumption associated with vehicle movement within the community (e.g., light rail)	Tailpipe emissions from vehicles used by community residents Upstream/downstream emissions (e.g., mining/transport of oil) Tailpipe emissions from rail, sea, and airborne vehicles departing from or arriving into the community
	Fugitive Emissions	Fugitive emissions not already accounted for	n/a	Upstream/downstream emissions
Industrial Processes		Decentralized process emissions	n/a	Upstream/downstream emissions
Agriculture		Emissions from livestock and managed soils	n/a	Upstream/downstream emissions from fertilizer/pesticide manufacture
Land Use, Land Use Change and Forestry		Net biogenic carbon flux	n/a	n/a
Waste	Solid Waste Disposal	Direct emissions from landfill, incineration and compost facilities located inside the community	n/a	Landfill, incineration and compost emissions in present-year from waste produced to date inside the community Future emissions from waste disposed
	Wastewater Treatment and Discharge	Direct emissions from wastewater facilities located inside the community	n/a	Present-year emissions from wastewater produced to date inside the community Future emissions from treated wastewater

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

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

I. Environmental sustainability and climate change			
#Topics	**#Subtopic**	**#Indicator**	**#Unit of measurement**
		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 μ g/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 CO_2e 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	Yes/No

I. Environmental sustainability and climate change			
#Topics	**#Subtopic**	**#Indicator**	**#Unit of measurement**
		planning instruments that have been completed	
		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/km^2
	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	%

II. Urban sustainability			
#Topics	**#Subtopic**	**#Indicator**	**#Unit of measurement**
	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

II. Urban sustainability			
#Topics	**#Subtopic**	**#Indicator**	**#Unit of measurement**
		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

II. Urban sustainability			
#Topics	**#Subtopic**	**#Indicator**	**#Unit of measurement**
		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	101. Transparency index	#
		102. Municipal government accounts audited	%

	government's public management	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

Characteristics	Factors	Indicators
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

Characteristics	Factors	Indicators
		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

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

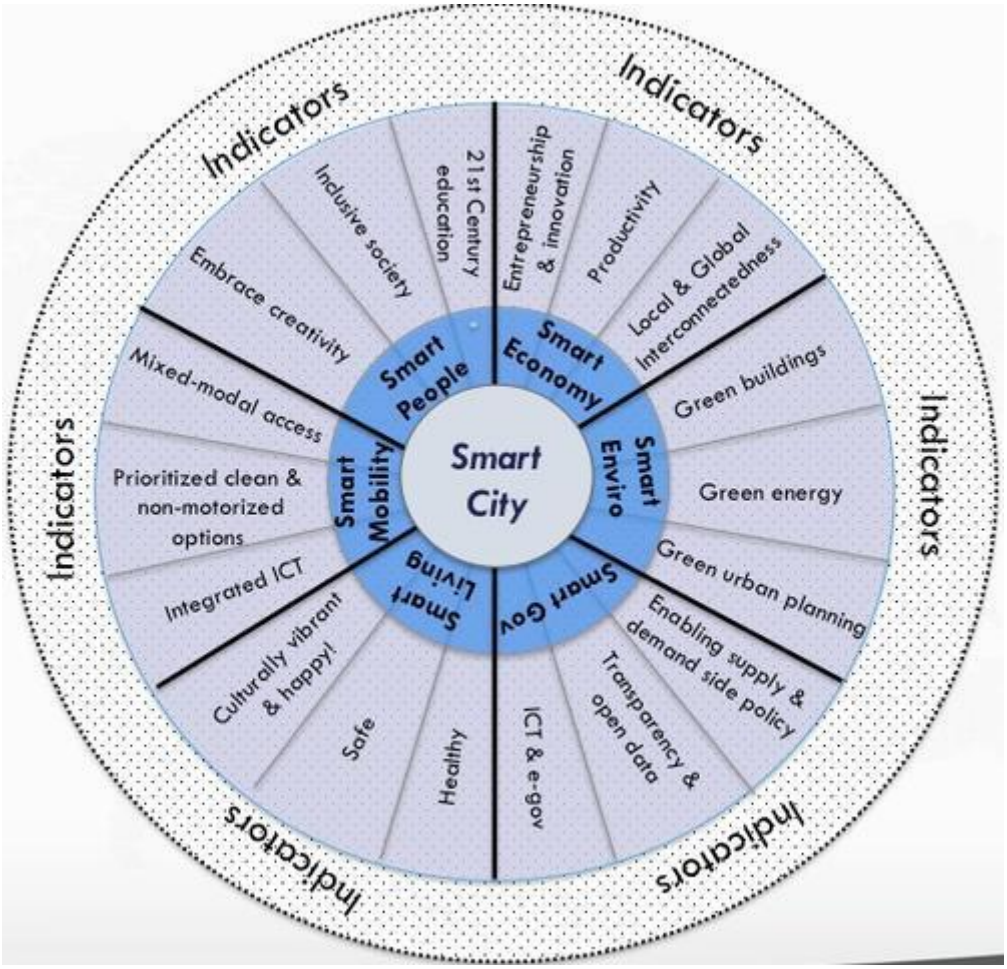
	measures of rehabilitation
Life domain: Environment	
Goal dimensions	**Measurement dimensions**
Improvement of objective living conditions	stock of natural resources (minerals, oil, water, flora and fauna)
	state of the environment (quality of air, water, forests, soil)
Enhancement of SWB	subjective 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](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://www.ericsson.com/res/docs/2013/ns-city-index-report-2013-methodology.pdf

Triple Bottom Line: 8 Variables and 21 proxies.

- Social
  - Health
  - Education
  - Social Inclusion
- Economy
  - Productivity
  - Competitiveness
- Environment
  - Resources
  - Pollution
  - Climate change

ICT Maturity: 7 Variables and 18 proxies.

- Infrastructure
  - Broadband quality
  - Availability
- Affordability
  - Tariffs
  - IP Transit prices
- Usage
  - Technology use
  - Individual use
  - Public and market use

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

Dimension	Variable	Indicator	Proxy
	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	CO_2	CO_2 emissions per person
ICT infrastructure	**Broadband quality**	Fixed broadband (BB) quality	Mean download speed

Dimension	Variable	Indicator	Proxy
		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
CO_2 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].

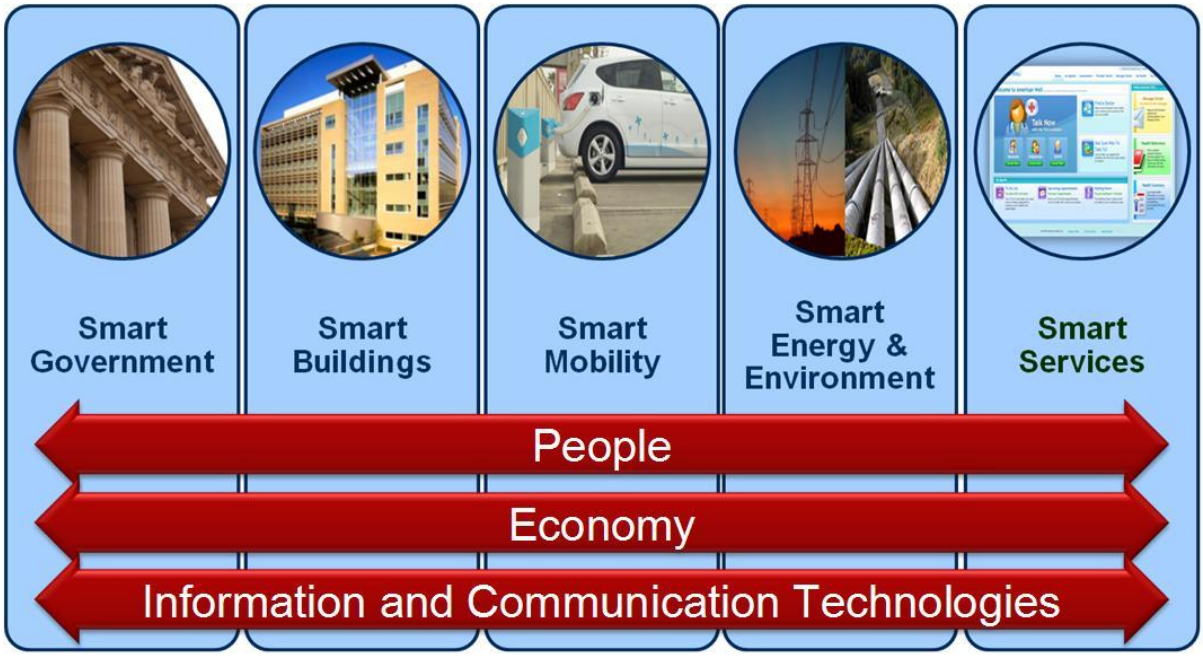


Figure Q.1 framework of IDC index system of SSC

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

Criteria	Sub-criteria	weighting
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

Criteria	Sub-criteria	Indicator #	Indicator
		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	CO_2 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)

Criteria	Sub-criteria	Indicator #	Indicator
		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 CO_2 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: CO_2 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**
CO_2	CO_2 emissions	Quantitative	Total CO_2 emissions in tons per head
	CO_2 intensity	Quantitative	Total CO_2 emissions in grams per unit of real GDP (2000 base year)
	CO_2 reduction strategy	Qualitative	An assessment of the ambitiousness of CO_2 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

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