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

**ITU-T Y.4050-Y.4099 – Smart sustainable cities –
an analysis of definitions**

ITU-T Y-series Recommendations – Supplement 38

ITU-T



ITU-T Y-SERIES RECOMMENDATIONS

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Supplement 38 to ITU-T Y-series Recommendations

Smart sustainable cities – An analysis of definitions

Summary

Supplement 38 to the ITU-T Y-series Recommendations analyses the major aspects of smart sustainable cities and eco-cities from: (i) the perspective of academics, (ii) the business initiative approach, and (iii) the international organization collaborations with the final aim of establishing a concrete definition for smart sustainable cities which can be used worldwide. This would also provide a basis for understanding the most common features of smart sustainable cities.

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

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

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

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Supplement 38 to ITU-T Y-series Recommendations

Smart sustainable cities – An analysis of definitions

1 Introduction

In 2007, the number of people living in cities surpassed the number of those living in rural areas. It is estimated that the proportion of people living in an urban environment will exceed 70% by 2050. From 1950-2010, small cities have witnessed a net increase of 1.3 billion people, double the number of people inhabiting medium cities (632 million) or large cities (570 million).

People move to urban areas with the hope of finding better job opportunities as well as a better standard of living. However, the increasing number of people migrating to urban areas leads to complex issues such as congestion, increased demand for a limited pool of natural as well as other resources including energy, water, sanitation, education and healthcare services¹, among others.

Information and communication technologies (ICTs) are able to provide more environmentally friendly and more economically viable solutions to some of the aforementioned problems faced in cities. As of today, ICTs' role in tackling environmental issues has not been completely identified. Potential areas where ICTs can assist include management of water sources, energy efficiency, and solid waste management, public transport infrastructure reducing traffic congestion, growth of ICT infrastructure and managing its environmental impact with reference to concerns related to electromagnetic field (EMF), visual aspects and air quality monitoring².

A Focus Group on Smart Sustainable Cities³ (FG-SSC) was established in February 2013 by ITU-T Study Group 5 (SG5) which has been working on environmental and climate change issues including the development of a methodology to assess the environmental impact related to ICT in cities.

FG-SSC has been assigned the task to analyse ICT solutions and projects that promote environmental sustainability in cities. This would help identify the best practices using ICTs in cities which can be standardized by ITU-T SG5. FG-SSC has held a series of open meetings with the participation of a variety of stakeholders including ITU-T members, telecommunications companies, ICT companies, governments, academia and others. These open meetings provide a broad-based source of information gathered from all stakeholders. The FG-SSC will leverage the role of the ICT sector to foster the growth of smart sustainable cities worldwide, while developing a standardization roadmap that ensures activities currently undertaken by various standards development organizations (SDOs) and forums are taken into consideration.

FG-SSC has four (4) main working groups (WGs):

- WG1 – ICT role and roadmap for smart sustainable cities.
- WG2 – ICT infrastructure.
- WG3 – Standardization gaps, KPIs and metrics.
- WG4 – Policy and positioning (communications, liaisons and members).

One of the key deliverables for WG1 in the Focus Group on SSC is to develop a standardized definition for smart sustainable cities: "What definitions and attributes describe a Smart Sustainable City" especially in terms of ICT infrastructure. In order to help address the above questions, FG-SSC has developed this detailed Supplement on Smart Sustainable Cities – An Analysis of Definitions.

¹ <http://www.itu.int/en/ITU-T/focusgroups/ssc/Pages/default.aspx>

² Organization for Economic Cooperation and Development (OECD): Addressing Environmental Challenges: The role of Information and Communication Technologies (ICTs) and the Internet. 2012

³ <http://www.itu.int/en/ITU-T/focusgroups/ssc/Pages/default.aspx>

Using this Supplement as a basis, the Focus Group will be able to fulfil its mandate to develop a set of Draft Technical Specifications for ITU-T Study Group 5 for a standardized definition of a "Smart Sustainable City".

2 Scope

This Supplement analyses the major aspects of smart sustainable cities and eco-cities from: (i) the perspective of academics, (ii) the business initiative approach, and (iii) the international organization collaborations with the final aim of establishing a concrete definition for smart sustainable cities which can be used worldwide. This would also provide a basis for understanding the most common features of smart sustainable cities.

3 Definitions

This Supplement does not define any new terms.

4 Abbreviations and acronyms

This Supplement uses the following abbreviations and acronyms:

ANSI	American National Standards Institute
BSI	British Standards Institution
EMF	Electro-Magnetic Field
FG-SSC	Focus Group on Smart Sustainable Cities
IEEE	Institute of Electrical and Electronics Engineers
IEC	International Electrotechnical Commission
ICT	Information and Communication Technology
ISO	International Organization for Standardization
IT	Information Technology
IUN	International Union for Conservation of Nature
KPI	Key Performance Indicator
MRT	Mass Rapid Transit
NGO	Non-Governmental Organization
QoL	Quality of Life
RFID	Radio Frequency Identification Device
SCC	Smart Sustainable City
SDO	Standards Development Organization
SG	Study Group
UNEP	United Nations Environment Programme
WG	Working Group
WHO	World Health Organization
WWF	World Wide Fund for Nature

5 Conventions

None.

6 Goals and motivation for a comprehensive definition

6.1 Goals

With rapid urbanization and the obvious need to develop a sustainable model to support anticipated growth, a number of cities in the world has jumped on the 'Smart Sustainable City' bandwagon labelling itself as 'smart' in one way or the other.

The primary goal of this Supplement is to help understand the multiple definitions of 'Smart Sustainable Cities', based on open literature, perform analysis and then propose a formal and comprehensive definition for the ITU term Smart Sustainable City (which specifically highlights the sustainability aspect in such cities). Such a standardized set of terminologies for a "Smart Sustainable City" will be useful not only for the definition of the term but also in relation to ICT infrastructure, KPIs, metrics and policies for smart sustainable cities as viewed by ITU.

6.2 Lack of standardized terminologies

Though there is abundant literature available on smart cities, there is no standardized, commonly accepted set of terminologies which would help to aptly describe a "Smart Sustainable City". Depending upon the lens with which it is viewed, there are different descriptors, definitions, attributes, indicators and indices.

To ensure that the sustainability aspect in smart cities is not overlooked, ITU-T Focus Group on Smart Sustainable Cities has conceptualized a new term: "Smart Sustainable Cities", which may be considered a variant of smart cities (inclusive of some of the basic features of eco-cities/sustainable cities).

Various definitions and features of smart cities and sustainable cities have to be analysed before setting a standardized definition which is expected to provide a good basis for the development of the concept of smart sustainable cities (SSCs) for the Focus Group on SSC and its various stakeholders.

What could be the main features which make a city a "Smart Sustainable City"? Is it governance, technology, communication, transport, infrastructure, people, economy, environment, natural resources, innovation, quality of living or something more? What are the necessary factors for a city to be called as smart and sustainable?

6.3 Need for a comprehensive definition

As discussed in the previous subclause, there is a clear need for a standardized definition for a "Smart Sustainable City". The process for developing a new definition will clearly pave the way for a more defined structure not only for the definition of the term but also in relation to ICT infrastructure, KPIs, metrics and policies for smart sustainable cities as viewed by ITU. Another aspect which is also critical is that within ITU-T, there are multiple study groups involved with topics which overlap or intersect with smart sustainable cities. Data security (SG17) as well as other SDOs such as ISO, BSI, ANSI, IEC, and IEEE are working on smart sustainable cities as well, albeit through a different lens and based on a different framework.

7 Observations from literature

The following preliminary observations are made from the literature describing smart and sustainable cities. The definition of a smart sustainable city depends on the lens or the viewpoint taken (refer to Appendix I for list of definitions and features analysed). This is important to note, since this approach will provide an insight into why and what certain attributes are important. There are many subjective

viewpoints of what a smart sustainable city is and these can be segmented into the following categories:

- Attributes
- Themes
- Infrastructure

A combination of smartness/intelligence in an urban environment with sustainability as a key backdrop is the basis for this Supplement. Note that this Supplement is not a recommendation document for best practices but a description of what is prevalent in the open literature.

7.1 Attributes

The following attributes appear consistently across the literature in terms of describing a smart sustainable city:

- **Sustainability** – This is related to city infrastructure and governance, energy and climate change, pollution and waste, and social, economics and health.
- **Quality of life** – Quality of life (QoL) is a recurrent theme. One of the aims of SSC would be to improve QoL in terms of emotional as well as financial well-being.
- **Urban aspects** – This includes multiple aspects and indicators including: technology and infrastructure, sustainability, governance and economics.
- **Intelligence or smartness** – A "smart" city exhibits implicit or explicit ambition to improve economic, social and environmental standards. Commonly quoted aspects of smartness include smart economy, smart people, smart governance, smart mobility, smart living and smart environment.

7.2 Core themes

There are four core themes for a smart sustainable city:

- **Society** – The city is for its inhabitants (i.e. the citizens).
- **Economy** – The city must be able to thrive – jobs, economic growth and finance, etc.
- **Environment** – The city must be sustainable in its functioning for the present as well as future generations.
- **Governance** – The city must be robust in its ability for administrating policies and pulling together the different elements.

7.3 Infrastructure – Physical, service and digital

Infrastructure in an urban environment can be best described in a threefold manner: physical, service and ICT or digital. Physical infrastructure is what is truly "physical" – for example, buildings, train tracks, roads, electric lines, gas pipelines, water, factories and the like. Service infrastructure is the service overlay on the physical aspects – for example, a transportation service such as Mass Rapid Transit ((MRT), bus), utilities (water, gas, and electricity), education and health care. The ICT infrastructure is essential for a successful smart sustainable city – it acts as the "glue" which integrates all the other elements of the smart sustainable city acting as a foundational platform. ICT infrastructure is at the core and acts as the nerve centre, orchestrating all the different interactions between the various core elements and the physical infrastructure.

8 Definitions and analysis

8.1 Sources of information

This clause presents a study of definitions and associated attributes in terms of indicators, indices and rankings of smart sustainable cities. For the purpose of this Supplement, various articles were collected from the Internet as well as from other databases. These articles were reviewed and analysed to help consolidate a wide range of perspectives which ensures that the definition of smart sustainable cities proposed by the Focus Group includes all major aspects. These definitions were obtained from a variety of sources including:

- Academia and research communities.
- Government initiatives including EU.
- International organizations (United Nations, ITU, etc.).
- Corporate/company profiles.
- User centric definitions (from leading market research firms).
- Trade associations.
- Standards development organizations.

A complete list of over all the definitions found in the open literature is stated in Appendix I.

8.2 Methodology

Given the large amount of data, the various indicators, metrics and the 100+ definitions for a smart city, there was a need to perform some in-depth analysis to determine what would be a comprehensive and inclusive definition of a smart sustainable city from the perspective of the work being undertaken by the Focus Group on Smart Sustainable Cities (FG-SSC). All the definitions in Appendix I were analysed to identify what makes a smart sustainable city. The results from this analysis which identified the top keywords and characteristics of a smart sustainable city are discussed in more detail in clause 9.

For each definition, a set of key words was extracted and tabulated. These keywords were then grouped under some common themes. Some words such as "smart" and "city" are implicit and were mentioned in almost every description, so they are not captured explicitly as a separate keyword.

8.3 Approach

A systematic approach was followed throughout the study including:

- Top down approach – Indicators, indices, and rankings.
- Bottom up approach – Definitions, attributes, and descriptors.

As part of the research, multiple words and combinations thereof were used during the search from primary sources. Primary search words included (but not limited to): smart, sustainable, environment, city (ies), definition, attributes, index, indicator, characteristics, ICT, intelligent, urban, methodology, solution, example, success, and ranking. A detailed analysis of different key words and attributes and perspectives from these diverse sources was performed. Such an approach has provided a truly diverse set of definitions and supplied a sense of "completeness" or comprehensiveness to the study.

Based on the definitions, a series of keywords was identified and documented as illustrated in the sample below:

Source	Definitions	Keywords
<p>Giffinger, Rudolf, <i>et al.</i>. "Smart Cities Ranking of European Medium-sized Cities." Centre of Regional Science, Vienna UT, Oct. 2007. Page 10. Web. Last Accessed 8 Feb. 2014. http://www.smart-cities.eu/download/smart_cities_final_report.pdf</p>	<p>"A city well performing in a forward-looking way in [economy, people, governance, mobility, environment, and living] built on the smart combination of endowments and activities of self-decisive, independent and aware citizens."</p>	<p>Economy, people, governance, mobility, environment, quality of living, forward looking, aware citizens, self-decisive citizens, independent citizens.</p>
<p>Cohen, Boyd. "The Top 10 Smart Cities On The Planet." Fast Company, 11 Jan. 2011. Web. Last accessed 12 Feb. 2014. http://www.fastcoexist.com/1679127/the-top-10-smart-cities-on-the-planet .</p>	<p>Smart sustainable cities use information and communication technologies (ICT) to be more intelligent and efficient in the use of resources, resulting in cost and energy savings, improved service delivery and quality of life, and reduced environmental footprint – all supporting innovation and the low-carbon economy.</p>	<p>ICT, cost efficiency, energy efficiency, energy savings, quality of life, environment, improved service delivery, innovation, low carbon economy.</p>
<p>Hitachi. "Smart Sustainable City Overview." <i>Smart Cities: Hitachi</i>. Hitachi, Web. http://www.constructionweekonline.com/article-21349-smart-infrastructure/.</p>	<p>Hitachi's vision for the smart sustainable city seeks to achieve concern for the global environment and lifestyle safety and convenience through the coordination of infrastructure. Smart Sustainable Cities realized through the coordination of infrastructures consist of two infrastructure layers that support consumers' lifestyles together with the urban management infrastructure that links these together using information technology (IT).</p>	<p>Coordinated infrastructure, lifestyle safety, lifestyle convenience, urban infrastructure, IT.</p>
<p>Meijer, Albert, and Manuel Pedro Rodríguez Bolívar. "Governing the Smart Sustainable City: Scaling-Up the Search for Socio-Techno Synergy." T EGPA 2013 (Edinburgh, September) Permanent Study Group on E-Government, 2013, Web. Last accessed 8 Feb. 2014. https://www.scss.tcd.ie/disciplines/information_systems/egpa/docs/2013/BolivarMeijer.pdf</p>	<p>"We believe a city to be smart when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance."</p>	<p>ICT, high quality of life, natural resource management, participatory governance, transport infrastructure, communication infrastructure, economic growth, sustainability.</p>

Source	Definitions	Keywords
IBM. "India Needs Sustainable Cities." IBM SMARTER PLANET, Web. Last accessed 6 Feb. 2014. http://www.ibm.com/smarterplanet/in/en/sustainable_cities/idea_s/ .	Replacing the actual city infrastructures is often unrealistic in terms of cost and time. However, with recent advances in technology, we can infuse our existing infrastructures with new intelligence. By this, we mean digitizing and connecting our systems, so they can sense, analyse and integrate data, and respond intelligently to the needs of their jurisdictions. In short, we can revitalize them so they can become smarter and more efficient. In the process, cities can grow and sustain quality of life for their inhabitants.	Technology, connecting systems, analyse data, integrate data, responsive, efficient, growth, quality of life, sustainability.

9 Results

9.1 Keyword analysis from definitions

All the definitions (listed on Appendix I) were analysed to identify the top keywords and characteristics that make a smart sustainable city. Some words such as "smart" and "city" are implicit and mentioned in almost every description, and hence these words have not been captured explicitly as a separate keyword.

A total of 50 keywords were identified which appeared to have multiple references across all the studied definitions. There were a total number of 726 instances of these 50 keywords. These are captured and presented below in a table to reflect the relative contribution/number of times that these keywords were repeated across all the 100+ definitions. Based on the literature review, a graphical representation of the relative importance of the different keywords was developed. The larger the font is, the more important the word is.



Table 9-1 reflects a quantitative analysis of different keywords and the number of occurrences that these keywords had from the documents studied (as detailed in Appendix I).

Table 9-1 – List of keywords, occurrences and relative percentage

	Keyword	Total Occurrences	% Occurrence
1	Quality of Life	44	6.1%
2	Development	16	2.2%
3	Services	10	1.4%
4	Buildings	17	2.3%
5	Health, Safety and Security	26	3.6%
6	Utilities	3	0.4%
7	Education	16	2.2%
8	Energy	17	2.3%
9	Water	16	2.2%
10	Electricity	3	0.4%
11	Modern	2	0.3%
12	ICT	27	3.7%
13	Technology	42	5.8%
14	Interconnected	1	0.1%
15	Information	24	3.3%
16	Communication	15	2.1%
17	Intelligent	16	2.2%
18	Integrate	22	3.0%
19	Systems	34	4.7%
20	Advanced	1	0.1%
21	Design	4	0.6%
22	Community	5	0.7%
23	Accessible	2	0.3%
24	People	36	5.0%
25	Urban	16	2.2%
26	Society	6	0.8%
27	Actively	4	0.6%
28	Innovation	15	2.1%
29	Aware	2	0.3%
30	Participatory	3	0.4%
31	Efficient	24	3.3%
32	sustainable	28	3.9%
33	Adaptable	3	0.4%
34	Optimal	2	0.3%
35	Environment	22	3.0%
36	Resources	27	3.7%
37	Natural	11	1.5%

Table 9-1 – List of keywords, occurrences and relative percentage

	Keyword	Total Occurrences	% Occurrence
38	Governance and Administration	35	4.8%
39	Management	20	2.8%
40	Capital	4	0.6%
41	Operational	1	0.1%
42	Public	6	0.8%
43	Solutions	4	0.6%
44	Vision	1	0.1%
45	Economy	34	4.7%
46	Investments	9	1.2%
47	Business	13	1.8%
48	Competitive	5	0.7%
49	Mobility	14	1.9%
50	Transport	18	2.5%
	Total	726	100%

9.2 Keyword grouping

Some logical groupings were made as illustrated by Table 5-2 and the different keywords mapped into these groupings (appropriately colour coded) in order to better understand the relative importance of the different keywords and categories.

Table 9-2 – Logical groupings

Category	% Occurrence
Quality of life and lifestyle	6%
Infrastructure and services	17%
ICT, communication, intelligence, information	26%
People, citizens, society	12%
Environment and sustainability	17%
Governance, management and administration	10%
Economy and Finance	8%
Mobility	4%
Total	100%

In order to minimize any subjectivity in defining the above keyword grouping, a literature search was conducted to best describe each of them. This is important to maintain a baseline of what is meant by each of those keywords.

ICT/Communication/Intelligence/Information

Information and communication technology (ICT) provides services such as security, health care, and transport for citizens, improved and cost effective power supply for industries, remote working and e-commerce for businesses, as well as entertainment and communications for individuals.⁴

Infrastructure

Infrastructure includes the basic physical and organizational structures necessary for the operations of society/enterprises and the services/facilities that keep the economy functional.^{5, 6}

Environment/Sustainability

As defined by the IUCN, UNEP and WWF: "sustainability is improving the quality of human life while living within the carrying capacity of supporting eco-systems"⁷. The World Commission on Environment and Development⁸ (also known as the Brundtland Commission) defines sustainable development as a form of development which "meets the needs of the present without compromising the ability of future generations to meet their own needs".⁹

People/Citizens/Society

The differentiating element between a digital city and a smart city is smart people. Key elements include skills, education level, life-long learning, and social integration in terms of human capital.¹⁰

Quality of life/Lifestyle

The World Health Organization (WHO) defines quality of life as "individuals perception of their position in life in the context of the culture and value systems". These include their location in relation to goals, expectations, and concerns¹¹.

Governance/Management/Administration¹²

Smart governance includes political and active participation, citizenship services and the smart use of e-government.

Economy/Resources

Successful elements of the enterprise economy and the innovation/ideas economy are combined to form the smart economy. It also provides for a high-quality environment that focuses on the bettering of energy security and social cohesion.¹³

⁴ ICT behind cities of the future. Nokia. Retrieved 29th June 2014 from <http://nsn.com/news-events/publications/unite-magazine-february-2010/the-ict-behind-cities-of-the-future>

⁵ Oxford Dictionaries. Retrieved 1st June 2014 from http://www.askoxford.com/concise_oed/infrastructure

⁶ Sullivan, Arthur, Steven M. Sheffrin (2003), Economics: Principles in action. Upper Saddle River, New Jersey 07458: Pearson Prentice Hall. p. 474.

⁸ UN Documents Gathering a body of global agreements. NGO Committee on Education. Retrieved 2nd June from < <http://www.un-documents.net/wced-ocf.htm> >

⁷ IUCN/UNEP/WWF. Caring for the Earth: A Strategy for Sustainable Living. (Gland, Switzerland: 1991). (IUCN – The International Union for Conservation of Nature, UNEP – United Nations Environment Programme, WWF – World Wide Fund for Nature).

⁹ Toolkit on Environmental Sustainability for the ICT Sector. International Telecommunication Union. Retrieved from http://www.itu.int/dms_pub/itu-t/oth/4B/01/T4B010000060001PDFE.pdf. 2012

¹⁰ SMART CITIES STUDY: International study on the Situation of ICT, Innovation and Knowledge in cities. Iñaki Azkuna, Mayor of the City of Bilbao. Retrieved from http://www.cities-localgovernments.org/committees/cdc/Upload/formations/smartcitiesstudy_en.pdf

¹¹ Programme on Mental Health: Measuring Quality of Life. Division of Mental Health and Prevention of Substance Abuse. World Health Organization. 1997. Retrieved from http://www.who.int/mental_health/media/68.pdf.

¹² <http://www.cities-localgovernments.org/committees/cdc/index.asp?IdPage=62>

Mobility

Smart mobility moves people and freight while enhancing economic, environmental, and human resources by emphasizing convenient and accessible multimodal travel (ensuring safety and operating at suitable speeds).¹⁴

9.3 Important terms to be included in a standardized definition

Based on all the analysis performed above, using the key categories and principle key word indicators, the following are 30 key terms which should be included in a standardized definition for a smart sustainable city.

ICT	Standard of living	Water
Adaptable	Employment	Utilities and energy
Reliable	Citizens	Telecommunications
Scalable	Well-being	Manufacturing
Accessible	Medical	Natural and man-made disasters
Security	Welfare	Regulatory and compliance
Safe	Physical safety	Governance
Resilient	Education	Policies and processes
Economic	Environmental	Standardization
Growth	Physical and service infrastructure	
	Transportation and mobility	

10 Recommended definition

10.1 Criteria for definition

Based on a detailed analysis of the keywords in over 100 definitions of a smart sustainable city, it was found that the following criteria best define a smart sustainable city:

Key categories or groups

- ICT/Communication/Intelligence/Information
- Infrastructure and services
- Environment/Sustainable
- People/Citizens/Society
- Quality of life/Lifestyle
- Governance/Management/Administration
- Economy/Resources
- Mobility

Categories based on key indicators

- Smart living
- Smart people
- Smart environment and sustainability
- Smart governance
- Smart mobility

¹³ Building Ireland's Smart Economy – Government of Ireland 2008 Report Retrieved from http://www.taoiseach.gov.ie/BuildingIrelandsSmartEconomy_1_.pdf

- Smart economy

Key terms to be included

A set of 30 key terms were identified as essential to be included in the standardized definition for a *Smart Sustainable City*. This list is provided in clause 9.3.

10.2 Specification

Based on the analysis discussed in this Supplement, the following can form the basis for a specification for a "smart sustainable city".

A smart sustainable city is a city that leverages the ICT infrastructure in an adaptable, reliable, scalable, accessible, secure, safe and resilient manner in order to:

- Improve the quality of life of its citizens.
- Ensure tangible economic growth such as higher standards of living and employment opportunities for its citizens.
- Improve the well-being of its citizens including medical care, welfare, physical safety and education.
- Establish an environmentally responsible and sustainable approach which "meets the needs of today without sacrificing the needs of future generations".
- Streamline the physical infrastructure based services such as transportation (mobility), water, utilities (energy), telecommunications, and manufacturing sectors.
- Reinforce prevention and handling functionality for natural and man-made disasters including the ability to address the impacts of climate change.
- Provide an effective and well-balanced regulatory, compliance and governance mechanisms with appropriate and equitable policies and processes in a standardized manner.

10.3 Agreed definition by FG-SSC

In the meetings held by FG-SSC from 5-6 March 2014 in Geneva, the following definition encompassing the major attributes of smart sustainable cities was agreed upon:

"A smart sustainable city (SSC) 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".

11 Conclusions

This Supplement provides an insight into what is meant by a "smart sustainable city (SSC)" and the underlying factors that make a city smart:

- This Supplement analysed approximately 120 existing definitions of smart sustainable cities from various sources to determine a common theme identifying a smart sustainable city.
- In addition, this Supplement considered the key indicators and categories which should be taken into account for a smart sustainable city.
- A list of 30 key terms to be included in a standardized definition were also identified.

- Although this Supplement is based on secondary data sources, it can be extremely useful to understand the concept of a smart sustainable city.
- Similarly, this Supplement can form the basis of developing a standard definition of a global smart sustainable city and subsequently can be used to develop a framework to measure the performance of a smart sustainable city.
- Finally, a proposed comprehensive definition of a smart sustainable city has been presented.

Appendix I

Definitions of a smart sustainable city

*Details of references are provided in Appendix II.

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
1	Academic	A smart sustainable city is a city well performing in six (6) characteristics, built on the 'smart' combination of endowments and activities of self-decisive, independent and aware citizens. 1) Economy, 2) Mobility, 3) Environment, 4) People, 5) Living, 6) Governance.	Economic growth, transport, mobility, environment, standard of living, governance.	Giffinger <i>et al.</i> (2007)
2	Academic	"We believe a city to be smart when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance."	ICT, high quality of life, natural resource management, participatory governance, transport infrastructure, communication infrastructure, economic growth, sustainability.	Meijer <i>et al.</i> (2013)
3	Academic	The rudiments of what constitutes a smart sustainable city which we define as a city in which ICT is merged with traditional infrastructures, coordinated and integrated using new digital technologies.	Traditional infrastructure, ICT, integrated infrastructure, coordinated infrastructure, digital technology.	Batty <i>et al.</i> (2012)
4	Academic	Instead of striving for physical growth, a city's success today should be measured by how wisely it uses energy, water, and other resources, how well it maintains a high quality of life for its people, and how smart it is in building prosperity on a sustainable foundation. In short, cities have to become much smarter about how they use the existing capacities and resources.	Wise use of resources, quality of life, sustainability.	Dixon (2012)

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
5	Academic	The Cellular City Compact, diverse, walk able and attractive cities are a luxury, but they should not be. The City Science Initiative at the MIT Media Lab is exploring technologies to help develop cities that facilitate the creation of desirable urban features, such as shared electric vehicles, adaptable living environments, and flexible work spaces. Our goal is to design urban cells that are compact enough to be walk able and foster casual interactions, without sacrificing connectivity to their larger urban surroundings. These cells must be sufficiently autonomous and provide resiliency, consistent functionality, and elegant urban design. Most importantly, the cellular city must be highly adaptable so it can respond dynamically to changes in the structure of its economic and social activities.	Urban, technology, desirable features, shared electric vehicles, adaptable living environments, flexible work places, compact urban cells, elegant design, connected, autonomous adaptable dynamic.	Massachusetts Institute of Technology (2014)
6	Academic	Tracing the genealogy of the word smart in the label Smart Sustainable City can contribute to an understanding of how the term smart is being loaded. In marketing language, smartness is cantered on a user perspective. Because of the need for appeal to a broader base of community members, smart serves better than the more elitist term intelligent. Smart is more user-friendly than intelligent, which is limited to having a quick mind and being responsive to feedback. Smart Sustainable City is required to adapt itself to the user needs and to provide customized interfaces.	User perspective, user friendly, responsive, adaptability.	Nam <i>et al.</i> (2011)
7	Government	"A city that monitors and integrates conditions of all of its critical infrastructures including roads, bridges, tunnels, rails, subways, airports, sea-ports, communications, water, power, even major buildings, can better optimize its resources, plan its preventive maintenance activities, and monitor security aspects while maximizing services to its citizens."	Integrated infrastructure, resource optimization, preventive maintenance, monitors security, and maximizes services.	Hall <i>et al.</i> (2009)

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
8	Academic	The term "smart city" is not used in a holistic way but with reference to various aspects which range from ICT districts to smart inhabitants in terms of their educational level. In addition, the term often refers to the relation between city government and citizens (e.g. good governance or smart governance). There is often a strong reference to the use of modern technology in everyday urban life, which includes innovative transport systems, infrastructures and logistics as well as green and efficient energy systems. Additional 'soft factors' connected to urban life for a Smart City include: participation, security/safety, cultural heritage. In conclusion, the literature review reveals the following main dimensions (or clusters of aspects): smart governance (related to participation); smart human capital (related to people); smart environment (related to natural resources); smart living (related to the quality of life) and smart economy (related to competitiveness).	Living, governance, economy, infrastructure, ICT, citizens, transport, energy, urban life.	Lombardi (2011)
9	Academic	The 'eco-cities' theme does not stand alone but is situated in a complex array of relevant variations of sustainable development, sustainable urban development, sustainable communities, bioregionalism, community economic development, appropriate technology, social ecology, green movement.	Ecology, technology, communities.	Roseland (1997)
10	Academic	A sustainable city is one in which its people and businesses continuously endeavour to improve their natural, built and cultural environments at neighbourhood and regional levels, whilst working in ways which always support the goal of global sustainable development.	Business, natural environment, built environment, cultural environment.	Haughton <i>et al.</i> (1994)

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
11	Academic	We say that a sustainable city is one in which the community has agreed on a set of sustainability principles and has further agreed to pursue their attainment. These principles should provide the citizenry with a good quality of life, in a liveable city, with affordable education, health care, housing, and transportation.	Quality of life, lovable city, education, health care, housing	Munier (2007)
12	Academic	A sustainable city can broadly be defined as "one that has put in place action plans and policies that aim to ensure adequate resource availability and (re)utilization, social comfort and equity and economic development, and prosperity for future generations".	Policies, resource availability, social comfort, economic development, future generations.	Jingzhu (2011a)
13	Academic	A sustainable city is one that relates its use of resources and its generation and disposal of wastes to the limits imposed on such activities by the planet and its organisms.	Resources, waste, planet and organisms.	Jingzhu (2011b)
14	Academic	The basic feature of a sustainable city can be characterized as: facilitating economical uses of resources by technological and environmental improvements, targeting economic development, wealth building, social progress, and ecological security, maintaining a balance among resources, environment, information, interflow of material of the inner-outer urban system, meeting a city's future needs based on a correct assessment, and satisfying the present needs of urban development.	Technology, economic development, wealth, social progress, resources, information, urban development.	Jingzhu (2011c)
15	Academic	"Improving the quality of life in a city, including ecological, cultural, political, institutional, social, and economic components without leaving a burden on future generations".	Ecological, cultural, political, institutional, social and economic.	Jingzhu (2011d)

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
16	Academic	World Watch Institute considered that a city moving toward sustainability should improve public health and well-being, lower its environmental impacts, increase recycling its materials, and use energy with growing efficiency.	Public health, materials, recycle, energy efficiency.	Jingzhu (2011e)
17	Academic	A sustainable city is one that can provide and ensure sustainable welfare for its residents with the capacity of maintaining and improving its ecosystem services.	Residents, ecosystem services, welfare.	Jingzhu (2011f)
18	Academic	The urban ecosystem service can be generally defined as processes and conditions offered for people's survival and development by cities as social-economic-natural complex ecosystems.	People, survival, development, social, economic, natural.	Jingzhu (2011g)
19	Academic	A smart city is referred to as the safe, secure, environmentally green, and efficient urban centre of the future with advanced infrastructures such as sensors, electronics, and networks to stimulate sustainable economic growth and a high quality of life.	Safe, secure, environment, green, efficient, urban, future, infrastructure, sensor, electronics, networks, sustainability, economy, quality of life.	Schaffers <i>et al.</i> (2012a)
20	Academic	Major aspects highlighted in this paper balance different economic and social demands as well as the needs implied in urban development, while also encompassing peripheral and less developed cities.	Economic, social, urban development.	Schaffers <i>et al.</i> (2012b)
21	Academic	A smart city as a high-tech intensive and advanced city that connects people, information and city elements using new technologies in order to create a sustainable greener city, a competitive and innovative commerce and an increase in the quality of life with a straightforward administration and maintenance system of the city.	Advanced, high-tech, information, sustainability, green, competitive, innovation, commerce, quality of life, administration, maintenance.	Schaffers <i>et al.</i> (2012c)

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
22	Academic	A "smart city" is a city well performing in a forward-looking way in the six characteristics (smart economy, smart people, smart governance, smart mobility, smart environment, smart living) built on the 'smart' combination of endowments and activities of self-decisive, independent and aware citizens.	Citizens, economy, people, governance, mobility, environment, living.	Chourabi <i>et al.</i> (2012a)
23	Academic	A city "connecting the physical infrastructure, the IT infrastructure, the social infrastructure, and the business infrastructure to leverage the collective intelligence of the city".	Interconnected IT, social, business infrastructure.	Chourabi <i>et al.</i> (2012b)
24	Academic	A city striving to make itself "smarter" (more efficient, sustainable, equitable, and liveable)	Efficient, sustainable, equitable, liveable, standard of living.	Chourabi <i>et al.</i> (2012c)
25	Academic	Based on the exploration of a wide and extensive array of literature from various disciplinary areas, we identify eight critical factors of smart city initiatives: management and organization, technology, governance, policy context, people and communities, economy, built infrastructure, and natural environment.	Technology, governance, policy context, people and communities, economy, built infrastructure, and natural environment.	Chourabi <i>et al.</i> (2012d)

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
26	Academic	<p>In general terms, we can define a "smart city" as a public administrative service or authority that delivers (or aims to deliver) a set of new generation services and infrastructure, based on information and communication technologies. Defining a new generation service is nevertheless a bit more complex and broader as the systems and services provided by smart cities should be easy to use, efficient, responsive, open and sustainable for the environment. The "smart city" concept brings together all the characteristics associated with organizational change, technological, economic and social development of a modern city. Moreover, smart city services and infrastructures entail the characteristics of engaging and interacting with the citizen that makes use of them. Another central element is the adaptive nature of services, ICT systems, infrastructures, buildings that comprehend the smart city concept. They acknowledge their initial status via a set of indicators and adapt their response according to the external changes that affect them. In doing so, they intelligently adapt to the external variables and demands that they are subject to, thus offering an always customized, more efficient and adaptive response.</p>	Technology, economic, social development, ICT, infrastructure, buildings.	González <i>et al.</i> (2011)
27	Corporate	<p>Hitachi's vision for the "smart sustainable city" seeks to achieve concern for the global environment and lifestyle safety and convenience through the coordination of infrastructure. Smart sustainable cities realized through the coordination of infrastructures consist of two infrastructure layers that support consumers' lifestyles together with the urban management infrastructure that links these together using IT.</p>	Coordinated infrastructure, lifestyle safety, lifestyle convenience, urban infrastructure, IT.	Hitachi (2014)

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
28	Corporate	A smarter city uses technology to transform its core systems and optimize finite resources. At the highest levels of maturity, a smarter city is a knowledge-based system that provides real-time insights to stakeholders, as well as enabling decision-makers to proactively manage the city's subsystems. Effective information management is at the heart of this capability, and integration and analytics are the key enablers.	Technology, transform, optimize finite resources, real-time information, decision-making information, information management, integration, analytics.	IBM (2013)
29	Corporate	Five (5) steps to make a city smart: 1. Vision: setting the goal and the roadmap to get there; 2. Solutions: bringing in the technology to improve the efficiency of the urban systems; 3. Integration: combining information and operations for overall city efficiency; 4. Innovation: building each city's specific business model; 5. Collaboration: driving collaboration between global players and local stakeholders.	Urban systems, efficiency, technology, integration, innovation, efficiency.	Schneider Electric (2014)
30	Corporate	A "smart sustainable city" is one in which the seams and structures of the various urban systems are made clear, simple, responsive and even malleable via contemporary technology and design. Citizens are not only engaged and informed in the relationship between their activities, their neighbourhoods, and the wider urban ecosystems, but are actively encouraged to see the city itself as something they can collectively tune in, such that it is efficient, interactive, engaging, adaptive and flexible, as opposed to the inflexible, mono-functional and monolithic structures of many 20th century cities.	Urban system optimization, technology and design, informed citizens, citizen contribution, efficiency, interactive, adaptive, flexible.	ARUP (2011)

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
31	Corporate	Infrastructure, operations and people. What makes a city? The answer, of course, is all three. A city is an interconnected system of systems. A dynamic work in progress, with progress as its watchword. A tripod that relies on strong support for and among each of its pillars, to become a smarter city for all.	Interconnected systems, progress, infrastructure, operations, and people.	IBM (2014)
32	Corporate	<p>A city's attractiveness is directly related to its ability to offer the basic services that support growth opportunities, build economic value and create competitive differentiation. Potential inhabitants, of both the commercial and residential variety, are a discriminating lot, and they are looking for cities that operate efficiently and purposefully. They are looking for smarter cities. In particular, we are seeing the most advanced cities focus on three areas of expertise:</p> <ul style="list-style-type: none"> • Leveraging information to make better decisions. • Anticipating and resolving problems proactively. • Coordinating resources to operate more efficiently. Forward-thinking cities are not waiting for better economic times to take action. <p>They are focused on staying competitive, maximizing the resources at their disposal and laying the groundwork for transformation. They are redefining what it means to be a smarter city.</p>	Growth, economy, competitive differentiation, efficiency, purpose.	IBM (2012)

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
33	Corporate	Replacing the actual city infrastructures is often unrealistic in terms of cost and time. However, with recent advances in technology, we can infuse our existing infrastructures with new intelligence. By this, we mean digitizing and connecting our systems, so they can sense, analyse and integrate data, and respond intelligently to the needs of their jurisdictions. In short, we can revitalize them so they can become smarter and more efficient. In the process, cities can grow and sustain quality of life for their inhabitants.	Technology, connecting systems, analyse data, integrate data, responsive, efficient, growth, quality of life, sustainability.	IBM-India Needs Smart Cities (2014)
34	Corporate	The "smart sustainable city" concept is really a framework for a specific vision of modern urban development. It recognizes the growing importance of information and communication technologies (ICTs) as drivers of economic competitiveness, environmental sustainability, and general liveability. By leveraging ICT as a core element of their development, the smart sustainable cities of the future will foster economic growth, improve the lifestyle of citizens, create opportunities for urban development and renewal, support eco-sustainability initiatives, improve the political and representative process, and provide access to advanced financial services. The right ICT infrastructure will affect the way each city will be created and evolved. It will enable smart sustainable cities to include vastly enhanced sustainable areas, such as smart buildings, smart infrastructures (water, energy, heat, and transportation) and smart services (e-substitutes and e-services for travel, health, education, and entertainment), which drastically change the urban experience for city dwellers and travellers.	ICT, economy, environment, sustainability, quality of life, development, renewal, citizen representation, financial services, smart buildings, smart infrastructure, water, energy, heat, transportation, e-services.	Alcatel Lucent (2011)

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
35	Corporate	<p>The most effective definition of a smart sustainable city is a community that is efficient, liveable, and sustainable, and these three elements go hand-in-hand. Traditionally, water, gas, electricity, transportation, emergency response, buildings, hospitals, and public services systems of a city are separate and operate in silos independent of each other. A truly efficient city requires not only that the performance of each system is optimized but also that these systems are managed in an integrated way to better prioritize investment and maximize value. An efficient city also starts a community on the path to become competitive for talent, investment, and jobs by becoming more liveable. A city must work to become a pleasant place to live, work, and play. It must appeal to residents, commuters, and visitors alike. It must be socially inclusive, creating opportunities for all of its residents. It must provide innovative, meaningful services to its constituents. Liveability plays a critical role in building the talent pool, the housing market, and in providing cultural events which can bring memorable experiences, international attention, and investment to the community. A sustainable community is one which reduces the environmental consequences of urban life and is often an output of efforts to make the city more efficient and liveable. Cities are the largest contributors of carbon emissions; the highways, public spaces, and buildings we rely on to live, work, and play emit the bulk of each city's emissions. Implementing efficient, cleaner, and sustainable operations in all of these areas is critical to minimizing a city's environmental footprint.</p>	<p>Efficient, quality of life, sustainability, integrated, services, natural resources, resource optimization, talent, investment, jobs, socially inclusive, innovative, low carbon, efficiency, regeneration.</p>	<p>Aoun-Schneider Electric (2014)</p>

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
		<p>Cities must also look at other methods of achieving sustainability, including resource efficiency, regenerating aging districts, ensuring robustness of systems, and incorporating design and planning in harmony with their natural ecosystem, as opposed to simply living in them.</p>		
36	Corporate	<p>A smart sustainable city is typically defined as "an environmentally conscious city that uses information technology (IT) to utilize energy and other resources efficiently." In Hitachi's vision, a smart sustainable city is one that seeks to satisfy the desires and values of its residents, with the use of advanced IT to improve energy efficiency and concern for the global environment as prerequisites, and in so doing maintains a "well-balanced relationship between people and the Earth."</p>	<p>Environment, ICT, energy, resource management, efficiency, environment, values of citizens, desires of citizens.</p>	<p>Smart Cities: Hitachi (2014)</p>
37	Corporate	<p>A city has common capabilities and delivers a set of common services, as well – office and residential buildings, natural resource management, transportation, health and safety, waste management, education and culture, public administration and services. One important characteristic that distinguishes an intelligent city is the manner in which it delivers services using advanced technologies: an integration of a number of innovations including machine-to-machine communication enabled by telematics, sensors and RFID technologies, smart grid technologies to enable better energy production and delivery, intelligent software and services, and high-speed communications technologies that serve as a core network for all related city, citizen and business services.</p>	<p>Services, natural resource management, transportation, health, safety, waste management, education, culture, public administration, services, ICT, RFID, integrated, smart grid, energy, high speed communication.</p>	<p>Berton <i>et al.</i>Accenture (2014)</p>

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
38	Corporate	The 'Smart Community' is a next-generation community in which the management and optimized control of various infrastructures such as electricity, water, transportation, logistics, medicine, and information are integrated. The 'Smart Community' will provide comprehensive solutions encompassing energy, water, and medical systems in order to realize a synergetic balance between environmental considerations and comfortable living.	Electricity, water, transportation, logistics, medicine, information, integrated, optimization, energy, comfortable living.	Takenaka- Toshiba (2012)
39	Corporate	We define a "smart sustainable city" as the city that uses information technology and communications to make both its critical infrastructure, its components and utilities offered more interactively, efficiently and where citizens are made more aware of them. It is a city committed to the environment, both environmentally and in terms of cultural and historical elements	ICT, infrastructure, utilities, interactive, efficient, aware, environment, culture, history	Telefónica (2014)
40	Corporate	A city that uses data, information and communication technologies strategically to: <ul style="list-style-type: none"> • provide more efficient, new or enhanced services to citizens, • monitor and track government's progress toward policy outcomes, including meeting climate change mitigation and adaptation goals, • manage and optimize the existing infrastructure, and plan for a new one more effectively, • reduce organizational silos and employ new levels of cross-sector collaboration, enable innovative business models for public and private sector service provision. 	Quality of life, authority, development, citizens, infrastructure.	Arup, Accenture, Horizon, University of Nottingham (2014)

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
41	Corporate	The "smart city" concept includes digital city and wireless city. In a nutshell, a smart city describes the integrated management of information that creates value by applying advanced technologies to search, access, transfer, and process information. A smart city encompasses e-home, e-office, e-government, e-health, e-education and e-traffic.	ICTs, quality of life, health, employment.	Huawei (2014)
42	Corporate	A sustainable city is made up of three (3) main parameters to make sure that there is an overall development of energy, health care, buildings, transport, and water management in a city: <ul style="list-style-type: none"> • Environmental care – With right technologies, cities will become more environmentally friendly. • Competitiveness – With the right technologies, cities will help their local authorities and businesses to cut costs. • Quality of life – With the right technologies, cities will increase the quality of life for their residents. 	Quality of life, technologies, authorities, buildings, transport, water.	Siemens (2014)
43	Corporate	As nations look to rebuild their aging infrastructures and at the same time take on the challenge of global climate change, Patel argues that resource usage needs to be at the heart of their thinking. We must also take a fundamental perspective in examining "available energy" in building and operating the infrastructure. Only if we use fewer resources to both build and run our infrastructures, he says, we will create cities that can thrive for generations to come. We can only build in that way, he suggests, if we seamlessly integrate IT into the physical infrastructure to provision the resources – power, water, waste, etc. – at a city scale based on the need.	Infrastructure, energy, IT, power, water, waste.	Patel,-Hewlett Packard (2014)

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
44	Corporate	One manifestation of the Oracle iGovernment vision is Oracle's Solutions for Smart Cities, which will address the ever increasing need to provide businesses and citizens with transparent, efficient and intelligent engagement with their local authority/administration – through any channel – for any purpose, from information requests and government programme enrolment, to incident reporting or scheduling inspections, to complete online start-up of a local business. Development, implementation and refinement of such a multichannel, single point-of-contact platform to all government organizations lays the foundation for a range of additional capabilities from business recruitment and retention to self-selecting, interest- and knowledge-based communities amongst citizens to improved management of civil contingencies and emergency disaster planning.	Authority, information, business, development, citizens, disaster.	Oracle (2014)
45	Corporate	A future where clean, efficient and decentralized energy will power a smart electricity grid to deliver power efficiently to millions of homes; a world not suffering from water scarcity where waste is seen as a resource; where citizens' mobility and health care needs are all taken care of by efficient and comprehensive systems; and where they can live in sustainable cities with green spaces, clean air and a high quality of life.	Efficient, decentralized, energy, electricity, water, waste, green spaces, clean air and quality of life.	Dunlop (2012)

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
46	Corporate	Urbanization, rapid population growth and shortages of resources are placing a new strain on city systems. So how can cities fuel economic growth whilst improving environment and social conditions? What must they do to raise service quality despite finite resources, and ever-growing demand? How can they work more effectively across the public sector, and with the private and 3rd sectors to transform outcomes? Smart technologies help city administrations tap into public information and create not just smarter, but more sustainable cities.	Fuel economy, technology, administrations, sustainable.	Capgemini (2014)
47	Corporate	"Smart Cities" are an effective response to today's needs which have become crucial. Thanks to the rapid, pressing trends seen throughout the world. In our view, the "smart city" is an urban model that minimizes efforts around "low level" needs and effectively satisfies "higher level" needs to guarantee an elevated quality of life while optimizing resources and areas for sustainability.	Quality of life, optimization, resources, sustainability.	ABB Group (2014)
48	Corporate	It takes more to build a smart city than simply using ICT to link and manage social infrastructure. Providing new values and services that residents truly need is also essential. Generating the knowledge to arrive at solutions by continuing to closely examine local issues, while putting this information into the equation when analysing the enormous amount of data from smartphones, various sensors, metres, and other devices, is a crucial task. Achieving it requires that Fujitsu put ICT to work to establish a sustainable social value cycle and create new innovations.	Knowledge, solutions, sensors, data, ICT, innovations, infrastructure.	Fujitsu (2014)

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
49	Corporate	<p>The IBM vision for a smarter city uses technology to bring cities forward so that they can accomplish these types of objectives:</p> <ul style="list-style-type: none"> – Quality of life for its citizens and visitors, – A well-managed city works to create an optimal urban environment for its citizens, visitors, and industries by focusing on urban design, energy and water management, and an efficient and easy-to-use transportation system. These cities provide better performing and reliable city services that enable simplified and integrated access to services. – A healthy and safe city addresses the health and safety of residents and visitors through innovations in local health care networks, disease management and prevention, social services, food safety, public safety, and individual information privacy. – A sustainable city implements concrete measures toward sustainability through, for example, reduced consumption of energy and water and reduced emissions of CO₂. Possible measures that can make a city sustainable include urban planning principles for mixed land use, architecture and construction principles for buildings, and methods to use rainwater instead of treated water. – A city with good governance strives to improve the quality and efficiency of city services. It mandates transparency and accountability at all levels of the government. It provides the means to listen, understand, and respond to the needs of its citizens and businesses. 	Quality of life, water and energy consumption, networks, information.	Kehoe-IBM (2011a)

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
		<ul style="list-style-type: none"> – A city that incorporates culture and events attracts visitors and keeps citizens interested in the city through investments in arts, culture, and tourism. These investments are a great way to draw attention to the city and a way to establish the city as a world-class location to live in. – A city focused on its citizens looks to address their needs by providing information and access to city services in a convenient and easy-to-use manner. When done rightly, both the citizens and the city government can benefit. This mechanism gives the citizens access to the information and services when needed and gives the city a means to share important information and obtain input from its citizens in a timely manner. 		
50	Corporate	<p>Business growth and development, building the city's economy:</p> <ul style="list-style-type: none"> – A city of digital innovation focuses on using strategic investments in connectivity and communications (for example, wireless broadband either broadcast or through hotspots). It attracts cutting edge businesses in the industrial and high-tech fields and builds human and intellectual capital. – A city of commerce establishes itself as a local, regional, or national centre of commerce and economic development. It builds local expertise in a specific industry and the infrastructure and services to support continued growth and to remain competitive. – A city attracting and keeping skilled workers promotes itself as being a desirable place to locate to or to grow up and stay in. 	Digital, commerce, building the city's economy, cost effective.	Kehoe-IBM (2011b)

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
		<p>This ability to maintain skilled workers is accomplished by anticipating and accommodating shifts in business needs, skills, local population, and demographics to offer economic opportunities.</p> <ul style="list-style-type: none"> – A city with free flowing traffic identifies and manages congestion actively. This demand is accomplished by making various forms of transport (such as road, air, rail, and bus) cost effective and efficient. 		
51	Corporate	<p>IBM defines a smarter city as one that makes optimal use of all the interconnected information available today to better understand and control its operations and optimize the use of limited resources.</p>	Information, operations, resources, optimize.	IBM Smarter City Assessment Tool (2009)
52	Corporate	<p>Smart cities: Innovative urban developments that leverage ICT for the management of natural energy consumption at the community level and other technologies to balance environmental stewardship with comfortable living.</p>	Innovation, urban, ICT, energy, community, technology, environment, living.	Fujitsu (2014)
53	Corporate – Derived from video	<p>Cities are a complex and dynamic system. According to SAP, there are eight (8) fundamental factors that determine what defines a sustainable city:</p> <ul style="list-style-type: none"> • Smart economy – Long-term prosperity, innovation, entrepreneurs, and social business models. • Good government – High performance. • Open society. • Resilience and sustainability – being clean and green. • Global attractiveness. • Human and social capital. • World-class financial expertise. • Excellent infrastructure – physical and soft infrastructure (technology, research and knowledge). 	Smart economy, good government, open society, global attractiveness, human and social capital, infrastructure, knowledge, technology.	SAP (2014)

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
54	Corporate definition derived	Smart is a combination of collaborative leadership, policy and legal, customer insight, budget and performance management, service orientation and technology.	Leadership, policy, customer, service orientation, technology.	Colclough-Capgemini (2011)
55	Corporate CSR	In a broader definition, a city can be considered as "smart" when its investment in human and social capital and in communications infrastructure actively promotes sustainable economic development and a high quality of life, including the wise management of natural resources through participatory government.	Human capital, social capital, communication, economic growth, economic development, sustainability, quality of life, natural resource management, participatory government.	Hirst-European Investment Bank (2012)
56	Corporation	A smart city is a city that meets its challenges through the strategic application of ICT goods network and services to provide services to citizens or to manage its infrastructure. A sustainable city is a city that meets the needs of the present without compromising the ability of future generations to meet their own needs.	ICTs, citizens, environment, social, economic growth.	Lovehagen-Ericsson (2013)
57	Government / International organization	Traditionally, a "smart sustainable city" has been defined as a city that uses information and communication technology to make both its critical infrastructure, its components and utilities more interactive, efficient, making citizens more aware of them.	ICT, interactive critical infrastructure, interconnectivity, efficiency, awareness.	Azkuna (2012a)

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
58	Government / International organization	In preparing this report, we used the smart sustainable city model, which identifies the presence and convergence of six areas: economy, mobility, environment, citizenship, quality of life, and, finally, management. A city can be defined as smart when it displays a positive performance in these six areas, and when it has been built based on a "smart" combination of elements (communication, infrastructure, economic development) and on purposeful and independent citizen activities (participation, education) that make sound management of natural resources through participatory governance.	Convergence, integration, economy, mobility, environment, citizenship, quality of life, communication, infrastructure, economic development, citizen participation, education, natural resource management, participatory governance.	Azkuna (2012b)
59	Government / International organization	A type of city that uses new technologies to make them more liveable, functional, competitive and modern, the promotion of innovation and knowledge management, bringing together six (6) key fields of performance: economy, mobility, environment, citizenship, quality of life and, finally, management.	Liveable, technology, citizens, quality of life, management, economy.	Azkuna (2012c)
60	Government / International organization	Smart sustainable cities combine diverse technologies to reduce their environmental impact and offer citizens better lives. This is not, however, simply a technical challenge. Organizational change in governments – and indeed society at large – is just as essential. Making a city smart is therefore a very multidisciplinary challenge, bringing together city officials, innovative suppliers, national and EU policymakers, academics and civil society.	Diverse technology, environment, quality of life, city officials, suppliers, policy makers, academics, civil society.	European Commission (2014)
61	Government / International organization	A real smart city develops the city to reach the aim of improving the quality of life. It needs sound and innovative economic development as a means to reach this aim. Uses ICT as a tool with a great potential for ameliorating daily life, public services and the economy.	Quality of life, innovative, economic, ICT, public services.	Schweiker - Council of European Municipalities (2010)

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
62	Academic	Amsterdam Smart City uses innovative technology and the willingness to change behaviour related to energy consumption in order to tackle climate goals. Amsterdam Smart City is a universal approach for design and development of a sustainable, economically viable programme that will reduce the city's carbon footprint.	Smart city, innovative, technology, energy, economically, carbon footprint.	Lee <i>et al.</i> (2012)
63	Government / International organization	There are three major functions that "ICT Smart Town" is expected to contain. ICT to be used both in ordinary times and in times of disaster. ICT is used in order to contribute to self-sustaining town development in ordinary times, while it functions for disaster prevention and mitigation in times of disaster. Users, mainly local citizens, can participate in the Smart Town community using the ICT system through user-friendly and accessible interfaces such as mobile phones and TVs. New services resulting from the use of "Big Data", including the government-held (public) data, private sector data and real-time data, collected through sensors.	Disaster, citizens, smart town, community, interfaces, government, real-time data.	Japan Ministry of Internal Affairs and Communications (2013)
64	Government / International organization	Smart cities should be regarded as systems of people interacting with and using flows of energy, materials, services and finance to catalyse sustainable economic development, resilience, and high quality of life; these flows and interactions become smart through making strategic use of information and communication infrastructure and services in a process of transparent urban planning and management that is responsive to the social and economic needs of society.	People, quality of life, energy, materials, sustainable, economic, urban planning, society.	European Commission (2013)

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
65	Government / International organization	A "city" can be defined smart when systematic information and communication technologies and resource-saving technologies are used to work towards a post fossil society, to reduce resource consumption, enhance permanently citizens' quality of life and the competitiveness of local economy – thus improving the city's sustainability. The following areas are at least taken into account: energy, mobility, urban planning and governance. An elementary characteristic of a smart city is the integration and cross-linking of these areas in order to implement the targeted ecological and social aspects of urban society and a participatory approach.	Energy, mobility, urban planning, governance, integration, ecological, ICT.	Homeier-City of Vienna (2013)
66	Government / International organization	Create a real shift in the balance of power between the use of information technology by business, government, communities and ordinary people who live in cities.	Power, information technology, business communications, government, people.	Deakin-European Commission (2014)
67	Corporate	A smart city offers its inhabitants a maximum of life quality by a minimum use of resources thanks to intelligent combination of different infrastructure systems (transport, energy communication, etc.) on different levels like buildings, areas, quarters and cities. «Intelligent» in this context does not automatically mean "IT". By similar performance, passive or self-regulating mechanisms is preferable to active regulated systems.	Quality of life, infrastructure systems, intelligence.	Horbaty-Energie Schweiz (2013)
68	Academic	"...are territories with a high capacity for learning and innovation, which is built into the creativity of their population, their institutions of knowledge creation and their digital infrastructure for communication". [and are concerned] with people and the human capital side of the equation, rather than blindly believing that IT itself can automatically transform and improve cities.	Learning, innovation, creative people, knowledge institutions, communication infrastructure.	Hollands (2008)

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
69	Industry association	The Council defines a Smart Sustainable City as one that has digital technology embedded across all city functions.	ICT, integrated, city functions.	Smart Cities Council (2014)
70	Government / International organization	"At its core a smart city is a welcoming, inclusive city, an open city. By being forthright with citizens, with clear accountability, integrity, and fair and honest measures of progress, cities get smarter".	Integrity, citizens.	Comstock-World Bank Blogs (2012)
71	Internet	A developed urban area that creates sustainable economic development and high quality of life by excelling in multiple key areas: economy, mobility, environment, people, living, and government. Excelling in these key areas can be done through strong human capital, social capital, and/or ICT infrastructure.	Economic growth, standard of living, quality of life, transport, mobility, environment, governance, human capital, social capital, ICT, urban area.	Business Dictionary (2014)
72	Corporate	Framing the "triple bottom line" of economy, environment, and social equity in one big picture. We are working to get our arms around a more sustainable future – a better way to connect people, homes, jobs and places – as a metro area and region, with more transportation choices. Frankly, it is a very tough challenge.	Metro, economy, environment and social equity, transportation, interconnecting people, home, jobs and places.	Ott-HBR Blog Network (2011)
73	ITU	A "smart sustainable city" is mainly based on the information and communication technologies. Through the transparent and full access to information, the extensive and secure transmission of information, the efficient and scientific utilization of information, SSC increases the urban operational and administrative efficiency, improves the urban public service level, forms the low-carbon urban ecological circle, and constructs a new formation of urban development.	ICT, information access, information utilization, operational efficiency, administrative efficiency, services, low carbon, urban development.	FG-SSC-0005 (2014)

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
74	ITU	<p>Smart sustainable cities are well managed, integrated physical and digital infrastructures that provide optimal services in a reliable, cost effective, and sustainable manner while maintaining and improving the quality of life for its citizens.</p> <p>Key attributes of a smart sustainable city are mobility, sustainability, security, reliability, flexibility, technology, interoperability and scalability.</p> <p>Foundational aspects include economy, governance, society and environment with vertical infrastructures such as mobility, real estate and buildings, industrial and manufacturing, utilities - electricity and gas, waste, water and air management, safety and security, health care and education. All of these are woven into a single fabric with ICT infrastructure as a core.</p>	<p>Well managed, integrated, digital infrastructure, optimize services, sustainability, quality of life, mobility, security, reliability, flexibility, technology, interoperability, scalability, economy, governance, society, environment, real estate and buildings, industrial and manufacturing, utilities - electricity and gas, waste, water and air management, safety and security, health care and education, integrated, ICT.</p>	FG-SSC-0013 (2014)
75	ITU/ Government	<p>It is a city with a large, efficient and widespread technological network that fosters dialogue between citizens and everyday objects. It integrates the huge amount of information available to generate intelligence and improve daily life in a lifestyle that is increasingly "smart". It combines innovation with the environment, mobility and quality of life. It is a new phenomenon, complex and rapidly changing. Technological innovation moves in several directions (green buildings, smart mobility, e-health, e-government, etc.).</p>	<p>ICT, integrated, quality of life, innovation, environment, mobility, green buildings, health, environment governance.</p>	FG-SSC-0014 (2013)
76	ITU	<p>ICT spans across a number of application sectors that characterize the framework of smart sustainable cities. Among others, energy, buildings, transport and mobility, water and waste management.</p>	<p>ICT, sustainability, energy, buildings, transport, mobility, water management, waste management.</p>	FG-SSC-0020 (2013)

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
77	ITU	<p>"A Smart Sustainable City has been defined as a 'knowledge', 'digital', and 'cyber' or 'eco' city; representing a concept open to a variety of interpretations, depending on the goals set out by a Smart Sustainable City's planners. We might refer to a Smart Sustainable City as an improvement on today's city both functionally and structurally, using information and communication technology (ICT) as an infrastructure.</p> <p>Looking at its functions as well as its purposes, a Smart Sustainable City can perhaps be defined as "a city that strategically utilizes many smart factors such as Information and Communication Technology to increase the city's sustainable growth and strengthen city functions, while guaranteeing citizens' happiness and wellness."</p>	ICT, strategic resource utilization, sustainability, growth, services, citizen happiness, citizen wellness.	Hwang <i>et al.</i> (2013)
78	Magazine	Smart sustainable cities use information and communication technologies (ICT) to be more intelligent and efficient in the use of resources, resulting in cost and energy savings, improved service delivery and quality of life, and reduced environmental footprint – all supporting innovation and the low-carbon economy.	ICT, cost efficiency, energy efficiency, energy savings, quality of life, environment, improved service delivery, innovation, low carbon economy.	Cohen (2011)
79	Magazine	An eco-city is defined as a city in which citizens, business and government sustainably work, live and interact through delivery of integrated, low carbon products and services. The objective of this project is to build a new industrial community to maximize the welfare of the people and minimize carbon emission. The above vision can be achieved by integrating technology across water, waste, energy, transportation and safety infrastructure while taking measures like maximum utilization of renewable resources for electricity supply, minimum loss of natural resources and others.	Sustainably, integrated, low carbon products and services, maximize welfare, industrial community, integrated technology.	Manesar (2011)

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
80	User centric	"The use of Smart Computing technologies to make the critical infrastructure components and services of a city-which include city administration, education, healthcare, public safety, real estate, transportation, and utilities-more intelligent, interconnected, and efficient" (58).	Computing technologies, interconnected components, city administration, education, healthcare, public safety, real estate, transportation, utilities, efficiency.	Washburn <i>et al.</i> (2010)
81	User centric	A smart sustainable city is characterized by the integration of technology into a strategic approach to sustainability, citizen well-being, and economic development.	ICT, integrated, sustainability, citizen well-being, economic development.	Woods <i>et al.</i> (2013)
82	User centric	The terms "smart" and "intelligent" have become part of the language of urbanization policy, referring to the clever use of IT to improve the productivity of a city's essential infrastructure and services and to reduce energy inputs and CO ₂ outputs in response to global climate change.	ICT, infrastructure productivity, services, low carbon, environment.	Hodkinson, S. (2011)
83	User centric	A smart sustainable city is one that "uses information and communications technologies to make the critical infrastructure components and services of a city – administration, education, healthcare, public safety, real estate, transportation and utilities – more aware, interactive and efficient."	ICT, administration, education, health care, public safety, real estate, transportation, utilities, integrated, efficient, interactive.	Belissent (2010)
84	User centric	An urbanized area where multiple public and private sectors cooperate to achieve sustainable outcomes through the analysis of contextual information exchanged between them. The sectors could include hospitals or emergency services or finance and so on. The interaction between sector-specific and intra-sector information flows results in more resource-efficient cities that enable more sustainable citizen services and more knowledge transfer between sectors.	Information exchange, integrated, resource efficiency, services, sustainability.	Maio (2012)

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
85	User centric	Cities need to differentiate themselves to attract investment and productive residents, and this is coupled with constrained financial resources, fast-growing populations, and aging infrastructures, is driving investment in smart sustainable city solutions. Smart sustainable city solutions leverage ICT not only to deliver higher-quality citizen services more efficiently but also to effect behavioural change in government workers, city businesses, and citizens so that cities can develop more sustainably.	ICT, services, efficient, development and behavioural change in government workers, city businesses, and citizens.	IDC (2014)
86	User centric	It is precisely because of the importance of cities and the need to deepen knowledge of urban issues that we undertake the study. The effort to question and understand where cities are and where they are headed benefits all of us in a world urbanizing like never before. This includes the officials and policymakers setting the course, businesses invested in city well-being, and the citizens who build their lives in thousands of city neighbourhoods worldwide, rich or poor, picturesque or prosaic.	Policymakers, business, well-being, urbanizing.	Ernst & Young (2014)

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
87	User centric	<p>Many cities are exploring the "Smart City" or "Intelligent Community" concept to improve efficiencies, optimize how they use largely finite resources and become better places to live and make business. They are deploying new information and communications technology to strengthen social and business services across different sectors and to build an intelligent digital nervous system supporting urban operations. By incorporating information and communications technology and strategically exploiting the vast amounts of data they generate, smart cities can make buildings more efficient, reduce energy consumption and waste, and make better use of renewable energy. They can manage traffic intelligently, monitor how infrastructure performs, provide better communications infrastructures, deliver services much more efficiently, and enhance citizens' access to government.</p>	<p>Social, business, efficient, renewable, monitor, infrastructure, citizens, government, ICT, energy consumption.</p>	<p>Craren <i>et al.</i> (2012a)</p>
88	User centric	<p>What makes a city tick? "Justice remains the appropriate name for certain social utilities which are vastly more important, and therefore more absolute and imperative, than any others," John Stuart Mill wrote in Utilitarianism in 1861. He added, "education and opinion, which have so vast a power over human character, should so use that power to establish in the mind of every individual an indissoluble association between his own happiness and the good of the whole." Many of those we spoke with this year in developing Cities of Opportunity agree. The foundations of healthy cities remain rule of law and safety and security today, as well as strong education to foster those qualities for future generations.</p>	<p>Justice, education, happiness, healthy, security, safety.</p>	<p>Craren <i>et al.</i> (2012b)</p>

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
89	User centric	Smart city is characterized by the integration of technology into a strategic approach to sustainability, citizen well-being, and economic development. Smart city projects span several industry and operational silos: energy, water, transportation, buildings management, and government services. Most importantly, the smart city concept promotes new integrated approaches to city operations, leading to innovation in cross-functional technologies and solutions.	Technology, well-being, economic development, energy, water, transportation, buildings, government, innovation, technology.	Woods <i>et al.</i> (2013)
90	User centric	According to Deloitte the three market drivers of smart cities are smart water, smart energy and smart agriculture. Smart water is increasingly seen as a component of ambitious smart city programmes that address the myriad of problems created by mass urbanization. Smart energy – the race for more and more energy sources is driving an increase in unconventional oil and gas exploration – in turn driving significant water and wastewater issues. Smart agriculture – the challenge to feed a growing global population is stressing food systems in both the developed and developing world and requires novel agricultural solutions.	Solutions, water, agriculture, energy, population,	Haji (2013)

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
91	User centric	The definition of sustainable development comprises five categories. Basic needs. Access to safe water, sufficient living space, adequate health care, and education are fundamental priorities for urban populations. Resource efficiency. A city's efficiency in such areas as the use of water and energy and the effective recycling of waste directly correlates to the quality of life of its citizens. Environmental cleanliness. Limiting exposure to harmful pollutants is fundamental to a city's liveability. Built environment. Equitable access to green space, public transportation, and dense, efficient buildings makes communities more liveable and efficient. Commitment to future sustainability. An increase in the number of employees and the level of financial resources devoted to sustainability suggests how committed city governments are to implementing national and local policies and standards.	Water, living space, health care, urban populations, energy, recycling, quality of life, pollutants, cleanliness, efficient, policies and standards.	Bouton <i>et al.</i> (2012)
92	Non-profit	A city "combining ICT and Web 2.0 technology with other organizational, design and planning efforts to de-materialize and speed up bureaucratic processes and help to identify new, innovative solutions to city management complexity, in order to improve sustainability and liveability."	ICT, web 2.0, bureaucratic efficiency, city management, innovative solutions, sustainability, liveability, standard of living.	Toppeta (2010)

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
93	Conference	<p>What makes a city smart? A non-vendor driven definition of a 'Smart Sustainable City'</p> <p>The closer a city behaves to the ethos of the Internet, the smarter it is. That means the city is a platform – an enabler for the people. So, empowering people is at the centre of the perfect storm.</p> <p>So, what does a Smart Sustainable City look like? A city can be defined as smart when investments in human and social capital and traditional (ex-transport) and modern (ex-ICT) communications infrastructure fuel sustainable economic development and a high quality of life with a wise management of natural resources through participatory governance.</p>	<p>People enabler, human capital, social capital, traditional communication, modern communication, ICT, economic development, quality of life, natural resource management, participatory governance.</p>	Jaokar (2012)
94	Others	<p>Seven (7) important elements in most cases of a smart sustainable city (Source: Xi She): 1) sensible – sensor sensing the environment ,2) connectable – networking devices bringing the sensing information to the web, 3) accessible – the broader information of our environment is published on the web, and is accessible to the user on the web, (web), 4) ubiquitous – the user can access information through the web, but more importantly through the use of the mobile (mobile), 5) social – the user acquires the information, and publishes it through his social network (social network), 6) Sharing – sharing is not limited to data but also to the physical object, when some objects are in free status, people can get the notification and use it. (web, mobile), 7) visibility/augmented – to retrofit the physical environment, make the hidden information seen not only through the mobile device by individuals but also with the naked eyes in a more border range like street signs.</p>	<p>Sensor monitoring, Internet connectivity, information availability, mobile, visible.</p>	World Smart Capital (2012)

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
95	Industry	A smart city is a city that employs ICT infrastructures by sensing, transmitting and utilizing information in order to fulfil information sharing and service collaboration, further improve citizens' livelihood standards and their quality of life, increase urban operation efficiency and public service level, enhance the quality of economic development and industry competitive ability, and realize the scientific and sustainable development of the city.	Sensing, transmitting, ICT infrastructure, information, collaboration, quality of life, urban efficiency, economy, competitive, scientific, sustainable.	China Communication Standards Association (2014)
96	Government	Smart cities should be regarded as systems of people interacting with and using flows of energy, materials, services and finance to catalyse sustainable economic development, resilience, and high quality of life; these flows and interactions become smart through making strategic use of information and communication infrastructure and services in a process of transparent urban planning and management that is responsive to the social and economic needs of society.	Systems, people, energy, materials, services, finance, sustainable, economic, resilience, quality of life, ICT infrastructure, urban planning, responsive, social.	European Innovation Partnership on Smart Cities and Communities
97	Academic	Main features to be included in smart city administration: (i) Quality of life, (ii) Sustainable resource management, (iii) Cultural facilities, (iv) Health facilities, (v) Sustainable and innovative and safe transport systems, (vi) Environmental protection.	QoL, resources, sustainability, environment, health, transport, mobility.	Vienna University of Technology, University of Ljubljana, Delft University of Technology (2007)
98	Academic	Eco-cities focus on: (i) entrepreneurship, (ii) environment, (iii) sustainable urban development.	Business, environment, sustainability.	Rapoport, E. (2014)

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
99	Academic	Smart cities should focus on: (i) improvement of urban living capacity, (ii) resource efficient development, (iii) low carbon economy, (iv) use of ICT to manage complex urban system.	Urban, resources, economy, people.	Alusi, A., Eccles, R. G., Edmondson, A. C., Zuzul, T. (2011)
100	Academic	Smart city triple helix: human and social relations connecting the intellectual capital, natural wealth and governance of their regional development.	People, intelligent, development, governance and administration, natural, resources.	Njikamp, Lombardi, P., Giordano, S., Caraglui, A., Del Bo, C., Deakin, M.
101	Academic/ Corporate	Key aspect of smart cities is a plan for efficient management of utilities enabled by technologies such as those entailing smart metering of the residential consumption of electricity, water or gas.	Technology, utilities, efficient, water, electricity.	Monedero, D. R., Bartoli, A., Hernandez-Saerrano, J., Forne, J., Soriano, M. (2013)
102	Academic	Features of smart cities involve the use of discrete future Internet technologies (RFID), improving e-governance, providing and environment for innovation.	ICT, technology, governance and administration.	Balloon, Pieter, Glidden, J., Kranas, P., Menychtas, A., Ruston, S., Van der Graaf, S. (2011)

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
103	Academic	<p>Typology of smart city functions:</p> <ul style="list-style-type: none"> (i) Smart economy (competitiveness): innovative spirit, entrepreneurship, economic image, productivity. (ii) Smart mobility (transport and ICT): local accessibility, availability of ICT infrastructure, innovative and safe transport systems. (iii) Smart people (social and human capital): level of qualification, flexibility, creativity, participation in public life. (iv) Smart environment (natural resources): pollution control, environmental protection, sustainable resource management. (v) Smart governance (participation): decision-making, transparent governance, political strategies and perspectives. (vi) Smart living (quality of life): cultural activities, health conditions, housing quality, education facilities, touristic attractiveness, social cohesion. 	Economy, business, competition, mobility, transport, social, people, capital, society, environment, sustainable, resources, natural, efficient, governance and administration, QoL, education, health, buildings.	Batty, M. Axhausen, K. W., Giannotti, F., Pozdnoukhov, A., Bazzani, A., Wachowicz, M., Ouzounis, G., Portugali, Y. (2012)
104	Academic	Smart cities should be centred around ecological modernization with an emphasis on business opportunities associated with a move to low carbon economy.	Environment, business, resources, efficient, economy.	Antrobus, D. (2011)

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
105	Academic	<p>"Smarter cities" has the following four components:</p> <ul style="list-style-type: none"> (i) the application of a wide range of electronic and digital technologies to communities and cities, (ii) the use of information technologies to transform life and work within a region, (iii) the embedding of such ICTs in the city, (iv) The territorialisation of such practices in a way that brings ICTs and people together so as to enhance innovation, learning, knowledge and problem solving that the technologies offer. 	ICT, technology, QoL, community, public, innovations, society, intelligent.	Allwinkle, S., Cruickshank, P. (2011)
106	Academic	Urban dwellers should be provided with smart phones that provide advanced capabilities to connect to the Internet, determine the user's location as well as provide crowd-sourcing platforms.	Public, ICT, community, participatory, actively, accessible, mobility.	Benouret, K., Ramalingam, R. V., Charoy, F. (2013)
107	Academic	"A smart city is generally meant as a city capable of joining competitiveness and sustainability by integrating different dimensions of development and addressing infrastructural investments able to support economic as well as the quality of life of communities, a more careful management of natural resources, a greater transparency and participation to the decision making process."	Sustainable, participatory, society, quality of life, integrate, resources, competitive, investment, economy, community, transparency, active, development.	Papa, R. (2013)

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
108	Academic	<p>Findings denote that smart cities should include the following dimensions:</p> <ul style="list-style-type: none"> (i) Urban openness: making information visually available, participatory services to drive civic engagement. (ii) Service innovation: using ICTs to drive development in health, welfare, education, transportation, sectors, etc. (iii) Partnership formation: partnerships for building effective smart cities (central government, state government, private bodies, NGO involvement), direct vs indirect involvement, contracted/outsourcing development. (iv) Smart city integration: smart service access over multiple device platforms, app-based formatting of service information. (v) Smart city governance: Smart city teams involved with strategy, policy, and infrastructure and include ICT-based performance evaluation and feedback channels. 	<p>Accessible, participatory, ICT, governance and administration, investments, transport, business, health security and safety, urban, design, innovation.</p>	<p>Lee, J. H. Hancock, M. G., Hu, M. (2012)</p>

Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
109	Corporate	<p>IBM Smarter Cities Initiative: "</p> <p>(a) is a long term process aiming to transform city based technologies and, in the process, help cities achieve their strategic vision;</p> <p>(b) recognizes that the needs and aspirations of each city may be very different;</p> <p>(c) requires partnerships (across many clients and with other delivery partners) to achieve the desired large scale transformations;</p> <p>(d) is based heavily on dimensions from IBM's global Smarter Planet strategy of which there are many applications (smart education systems, cloud computing, risk assessments, ICT based platform for exchange of ideas etc.)."</p>	Vision, solutions, design, management, business, education, ICT, technology.	Paroutis. S., Bennett, Heracleous, L. (2012)
110	Academic	"The basic concept of the Smart Cities initiative can be expressed as follows: the Smart Cities initiative seeks to improve urban performance by using data, information and IT to provide more efficient services to citizens to monitor and optimize existing infrastructure, to increase collaboration between economic actors and to encourage innovative business models in both public and private sectors".	Urban, ICT, innovation, people, economy, business, public, information, management, services.	Llacuna, M. L. M. Llinas, J. C., Frigola, J. M. (2014)
111	Academic	<p>Six successful factors for a smart city:</p> <p>(i) broadband connectivity,</p> <p>(ii) knowledge workforce,</p> <p>(iii) digital inclusion,</p> <p>(iv) innovation,</p> <p>(v) marketing,</p> <p>(vi) advocacy.</p>	ICT, education, technology, innovation, business, communication.	Kramers, A., Hojer, M., Lovehagen, N., Wangel, J. (2014)

112	Academic	<p>"The concept of Smart City as a means to enhance the life quality of citizens has been gaining increasing importance in the agendas of policy makers".</p> <p>The main domains of a smart city include:</p> <ul style="list-style-type: none"> (i) Employing ICT to deliver energy, enhance entrepreneurship and enable information exchange about consumption between providers and users with the aim of reducing costs and increasing reliability and transparency of energy supply systems. (ii) Public lighting, natural resources and water management. (iii) Waste management: Using innovations to manage waste generated by people, businesses and city services. This includes waste collection, disposal, recycling and recovery. (iv) Environment: Technology used to manage environmental resources and related infrastructure. This is done with the aim of improving sustainability. (v) Transport: Using sustainable public transportation based on environmentally friendly fuels and innovative propulsion systems. (vi) Healthcare: ICT applications and remote assistance to prevent and diagnose diseases. Improved access to health care systems. (vii) Public security: Use of ICT to assist with security issues like fire. ICTs may also be of help to the police department. (viii) Education and culture: Using ICTs to create opportunities for students and teachers, promote cultural events, manage tourism and hospitality. (ix) Public administration and governance: Promoting 	<p>Energy, economy, resources, management, water, environment, participatory, governance and administration, business, health security and safety, education, intelligent, ICT, innovation, natural, public, management, transport, utilities.</p>	<p>Neirotti, P., De Marco, A., Cagliano, A. C., Mangano, G., Scorrano, F. (2014)</p>
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Ref. No.	Category	Definitions/Features	Key concept/ Keywords	Source
		digitalized public administration, e-ballots and ICT-based transparency of government activities to enhance the empowerment of the inhabitants and involvement in administration.		
113	Corporate	Smart cities are aimed at: addressing urbanization, facilitating economic growth, enhancing technological progress using ICTs, environmental sustainability.	Urban, ICT, environment, innovation, technology.	Naphade, M., Guruduth, B., Harrison, C., Jurij, P., Morris, R. (2014)
114	Academic/International organization	Smart city establishments include: (i) Energy policy management, (ii) Healthcare governance, (iii) Financial policy management, (iv) Remote monitoring, (v) Complaint management, (vi) Intelligent buildings, (vii) Security systems based on ICT, (viii) IT configuration management databases.	Energy, health, security and safety, intelligent, ICT, management, buildings.	Asimakopoulou, E., Bessis, N. (2011)
115	Academic	"A city that monitors and integrates conditions of all the its critical infrastructures, including roads, bridges, tunnels, rails subways, airports, seaports, communications, water, power, even major buildings can better optimize its resources, plan its preventive maintenance activities, and monitor security aspects while maximizing services to its citizens."	Transport, energy, resources, society, integration.	Hall, R., E. (2000)
116	Academic	"A city striving to make itself smarter (more efficient, sustainable, equitable and livable)."	Sustainable, QoL, society, ICT, technology.	Nfuka, E., N., Rusu, L. (2010)

Appendix II

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