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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



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For further details, please refer to the list of ITU-T Recommendations.

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.

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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
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	"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."	Economy, people, governance, mobility, environment, quality of living, forward looking, aware citizens, self-decisive citizens, independent citizens.
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 .	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.
Hitachi. "Smart Sustainable City Overview." <i>Smart Cities: Hitachi</i> . Hitachi, Web. http://www.constructionweekonline.com/article-21349-smart-infrastructure/ .	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).	Coordinated infrastructure, lifestyle safety, lifestyle convenience, urban infrastructure, IT.
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	"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.

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%

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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.

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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)