Smart Cities - Six Dimensions

(A Scholarstical Articles Review)

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Abstract—**Right now, one of the most upcoming concepts in the field of Information Technology (IT) is 'Smart City'. Smart Cities are basically built up by Internet of Things (IoT) technologies. The vision of the smart city concept is to improve the capabilities and simplify numerous problems of the city through optimized energy consumption, carbon emission mitigation, maximum recycling, smart transportation, intelligent security and 24×7 services for inhabitants. This article is emphasizing the vital role of smart cities in the world and then smart city six axes or dimensions.**

Keywords—**smart city, smart people, smart governance, smart living, smart environment, smart mobility, smart economy**

I. Introduction

A city is comprised of a government, people, industry, infrastructure, education and social services. Cities are where people want to live, invest and work. That is why cities are focal points in the future sustainable economy (Claus Bjorn Billehoj, Sustainable City Development, Municipality of Copenhagen). There are numerous definitions of the term 'city' depending on countries, but the most common one defines 'city' as a relatively large and permanent settlement. A city has highly dense population and its inhabitants, citizens, mostly live from work connected with industry, commerce and services. Cities are very important contributors to the national economy, and have grown as centers of education, health care, entertainment, science and technology, and administration. They have to grow and change to fit their new roles and responsibilities. Where their growth in every sense lags behind the demands and expectations, lopsided development takes place, leading to sheer urban chaos. Paul R Brown, AICP, CDM Smith Executive Vice President defined that "Cities are complex ecosystems that are dependent on natural systems, challenging outthinking about the development of both natural and urban environment".

II. Smart Cities – Concepts

Science fiction author David Brin told about two cities twenty years hence from that time he had written. From a distance both the cities look very similar. Both he said, would contain "dazzling technological marvels", both would suffer known urban quantities of frustration and decay. They would be thoroughly modern; they would both be suffering from urban decay. They could be Rotterdam or Vancouver; Taipei or Isthanable. The precise location here did not matter. But what did matter would be that visitors to these future cities would notice something simply similar about both. These cities are nothing but Transparent Societies (smart cities). There is no single global level accepted definition of a 'Smart City'– but most rely on the use of technology and evidence to improve cities or city inhabitant's services. Smart City can be defined that "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" (Washburn, D et al, 2010).

Right now Smart City forerunners in the world, such as San Diego, San Francisco, Ottawa, Brisbane, Amsterdam, Kyoto and Bangalore are all now setting a trend for others to follow. Other cities now keen to follow in their wake and become smart include Southampton, Vancouver, Newcastle, Edinburgh, Edmonton and Montreal etc (Deakin, M. and Al Waer H., 2012). We are living in an urban age. More than half of the World's population now lives in urban areas [Dirks, S., Gurdgiev, C., & Keeling, M. (2010), Dirks, S., & Keeling, M. (2009), Dirks, S., Keeling, M., & Dencik, J. (2009)]. In 1950s, around 30% of the world population lived in the cities whereas in 2010 it was established that the percentage increased to 50% and is projected to be 70% by the year 2050 (World Urbanization Prospects, 2006 & 2007). According to "Smart City: Smart Strategy" report dated by 21 June 2012, by Jin-Hyeok Yang (KC Smart Service-KT Corporation) the world is now urbanized and the % of population living in cities are
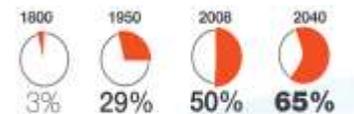
The challenges of climate change, population growth, demographic change, urbanization and resource depletion mean that the world's great cities need to adapt to survive and thrive over the coming decades. And Cities are becoming economic, political and technological power centers (A vision of smarter cities, IBM, 2009). With the increase of population and number of businesses cities now face the challenge of combining competitiveness on a global cities scale and sustainable local urban development. Also, there is a big strain on the environment and the emission of the greenhouse gases that must decrease. Cities occupy only 2% of the Earth's but emit almost 80% of global carbon dioxide and significant amounts of other greenhouse gases (R. T. Watson et al, 1998). Smart City so features arts and entertainment, attractions, recreation, festivals, restaurants, hospitals, banks, government and corporate offices and then most famous devotional places. You will instantly get access to the information about the city and provides you with all the information you need to know about the things in the city.

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III.   *Smart Cities – Dimensions*

Smart Cities can be identified along with six main dimensions (IBM Smart Cities: www.ibm.com/uk/cities), (Giffinger, R et al, 2007). These axes are

(1)Smart Economy **-** Innovation and Competitiveness
(2)Smart Mobility**-** Infrastructure and Transport
(3)Smart Environment **-** Resources and Sustainability
(4)Smart People **-** Creativity and Social Capital
(5)Smart Living **-** Culture and Quality of Life
(6)Smart Governance – Participation and Empowerment

A. *Smart Economy*

The first economist in the true meaning of the word "Economy" was the Scotsman Adam Smith (1723–1790). He defined the elements of a national economy: products are offered at a natural price generated by the use of competition - supply and demand - and the division of labour. Later an economy is defined that the total sum of product and service transactions of value between two agents in a region, be it individuals, organizations or states. An economy consists of the economic system, comprising the production, distribution or trade, and consumption of limited goods and services between two agents, the agents can be individuals, businesses, organizations, or governments. Transactions only occur when both parties agree to the value or price of the transacted good, commonly expressed in a certain currency, accessed dated on 04 September, 2013 (http://en.wikipedia.org/wiki/Economy).

In the past, economic activity was theorized to be bounded by natural resources, labor, and capital. This view ignores the value of technology (automation, accelerator of process, reduction of cost functions), and creativity (new products, services, processes, new markets, expands markets, diversification of markets, niche markets, increases revenue functions), especially that which produces intellectual property which is nothing but Smart Economy. The smart economy characteristics basically include a focus on high quality education system, publicly funded scientific research, attractive corporate fiscal incentives including tax breaks and great infrastructure including high quality domestic and international connections, pervasive broadband and excellent public services including in particular health care. Now many countries are already started their version of a smart economy i.e Denmark, Singapore, Netherlands, Ireland and Finland.

B. *Smart Mobility*

The smart mobility framework emphasizes on travel choices, healthy, lovable communities, reliable travel times for people and freight and safety for all users. The objective of smart mobility supports the goals of climate change intervention and energy security, traffic management in real time, management of passenger transport means, management of car parks, fleet management, management of the use of bicycles, payment of tolls, support in the use of electric vehicles, tracking applications and logistics, car sharing services, etc. This can be achieved through foundations for Caltrans [Caltrans is the state agency responsible for highway, bridge, and rail transportation planning, construction, and maintenance] and partner agencies to actively and successfully purse the smart mobility objectives and gain its many other travelling benefits. There are various smart mobility solutions upcoming or came in the smart cities including video surveillance and Intelligence analysis i.e. traffic detection, incident detection, license plate recognition, emergence command, customer service, passenger reservation system, multimedia.

Day by day embedded computer systems are increasingly being used within vehicles. This helps to improve their operation such as automatically controlling or providing assisted control, in which the driver still has control, of the antilock brakes, air-bag inflation, cruise speed, in vehicle climate, collision avoidance breaking etc. Location-determination computer systems (GIS) also enable vehicles and goods to be remotely tracked and interested parties to be informed of their schedule. Some transport systems can be automatically guided along tracks and controlled, with no drivers. In some cases the stations themselves are unmanned too. Buses, Trains, Flights and Water transport services can be designed about the status of arriving and departing vehicles to inform waiting passengers. Current transport information can now be distributed much more and accessed much more conveniently, e.g. by mobile device or other PDAs and transport way - points such as bus stops. In smart cities, tickets to provide authorization to travel are also becoming smarter. In some cases, electronic tickets can be requested, paid for and issued remotely. Smart tickets can also be designed to be pay-before and to support contact less verification at passenger entry and exit points like in Delhi metro systems.

Passengers, conductors, drivers, pilots and guards are getting more Internet access while they are in the moving smart vehicles such as buses, trains, boats, planes and other personal vehicles. Once connected to the Internet, not only can internet data be accessed from the vehicle, but also vehicles can be monitored and various environmental information generated within the vehicle/s by embedded RFID, computers, sensors, CCTV or cameras can be uploaded to the Internet. The Internet CAR (Internet Connected Automobile Research) project at Keio University, Japan, from 1995 onwards, has been investigating on how vehicles can be connected to the Internet in a transparent manner.

C. *Smart Environment*

As per Paddy Nixon, Simon Dobson and Gerard Lacey in their research article "Managing Smart Environments" the smart space or environment is defined that it is a region of the real world that is extensively equipped with sensors, actuators and computing components. There are many more definitions, which are listed some more as follows "Sensing, Computing, Communicating and controlling the overall structure within or among the Things, People or Cities is called smart environment" and "Several smart environment devices can adapt to human activities. Doors of buildings, lighting of

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houses, taps of water tanks and air ventilation of offices etc… can be designed to detect the presence of humans, to be activated by them and to adapt to them". The realization of the Internet of Things due to technological advances, both in software and hardware, has led to the potential for network-enabled objects with sensing and actuating capabilities in diverse environments, known as Smart Environments. From environment monitoring and military applications, to health care and event tracking applications, both the diversity and complexity of the nodes themselves and their networked applications have increased immensely (Yick et al., 2008). A combination of consumer demand for more efficient integrated systems and a steep drop in the price of hardware fuelled by manufacturing process improvements has resulted in a noticeable upward cycle of research in the field of networks that not only sense the data but also provide automated reaction to specific situations known as Wireless Sensor and Actuator Networks (Akyildiz & Kasimoglu, 2004). The Cyber-Physical System for Smart Environment (such as Smart Home, Smart Office, and Smart Building) (D. De et al, 2012) can: reason intelligently, act autonomously, and respond to the application needs in a context-aware manner (D. Cook and S. Das (2004)). Smart environments, such as smart homes or domestic systems, have the potential to support people in many of their ordinary activities, by allowing complex control strategies for managing various capabilities of a house or a building: lights, doors, temperature, power and energy, music, etc. Such environments, typically, provide these control strategies by means of computers, touch screen panels, mobile, tablets or In-house Displays (Dario Bonino, et al, 2012).

D. Smart People

The availability and quality of the ICT infrastructure is not the only definition of a smart or intelligent city. Other definitions stress the role of human capital and education in urban development. Berry and Glaeser (2005) and Glaeser and Berry (2006) show, for example, that the most rapid urban growth rates have been achieved in cities where a high share of educated labour force is available. In particular Berry and Glaeser (2005) model the relation between human capital and urban development by assuming that innovation is driven by entrepreneurs who innovate in industries and products which require an increasingly more skilled labour force. In order for the technological and political ambitions of Smart Cities to be implemented a very successfully, citizen acceptance and inclusion is vital. Citizens are the primary reason for the existence of the city and its policies. A key element in the development of smarter cities, therefore, is the inclusion of especially smart people in the Smart City creation. Smart people create and pursue S.M.A.R.T. goals; they are Specific, Measurable, Attainable, Relevant and Timely.

But with respect to Smart Cities, the smart people concept comprises various factors like affinity to lifelong learning, social and ethnic plurality, flexibility, creativity, cosmopolitanism or open-mindedness, and participation in public life. Problems associated with urban agglomerations can be solved by means of creativity, human capital, cooperation among relevant stakeholders, and their bright

scientific ideas: in a nutshell, "smart solutions" (Caragliu, A. et al, 2009). For smart city, Malek, J. A. (2009) emphasizes that the importance of human ware, which represents cognitive or creative capability and human skills. Smart city bolsters a creative environment (Yigitcanlar, T. & Velibeyoglu, K. (2008). The category of human factors also includes social inclusion of various urban residents in public services, soft infrastructure (knowledge networks, voluntary organizations, and crime-free environments), urban diversity and cultural mix, social / human / relational capital, and knowledge.

E. Smart Living

(1) Smart Homes: Cook and Youngblood (2008) stated that Smart Homes be "able to acquire and apply knowledge about its inhabitants and their surroundings in order to adopt to the inhabitants and meet the goals of comfort and efficiency". Initially, Smart Homes were houses with the sole ability to monitor and adjust environmental systems like heating and lighting, but Ricquebourg et al. (2006) asserted that since technologies have developed further, "any electrical component within the house can be included in the system". A smart house has all home appliances and these appliances are connected to HAN (Home Area Networks) or Personal Area Networks (PAN) and then to Internet to communicate in pervasively with one another and with the homeowner or people who are living in it. As Electrical Reading meters are smart devices- these in the homes and utilize electricity, it can be connected to the home's network and respond at your management. And these could be monitored or controlled by computer or remote management or by voice, the home network responds once you command it. With this kind of automation, it would be like having a personal assistant who is usually at your back and call. Smart houses increase convenience and security in smart cities. Deleawe et al. (2010) noted the importance of monitoring air quality indoors so as to mitigate health problems. Though changing our home into this kind of smart home, automation could give a fortune; the benefits will be well worth the investment.

(2) Smart Things: Smart Things make it easy to connect the things in your physical world to the Internet. Smart Things places the world of connected things at your fingertips. Smart Things are more convenient, secure, safe and efficient. Smart Things can make things more intelligent, automate, monitor and control. We call smart any physical object connected to the web with some sensing capabilities (Giulia Biamino, 2012). They are (1) Detect users and the social connections between them (2) Access user's data (3) Infer social context according to user's network topology, preferences & features (4) Infer social goals according to the social context and the user model (5) Coordinate their behaviour (6) Provide a context driven output. Based on practical experimentation and prototyping, smart objects are classified into three kinds (G.Kortuem et al, 2010)

(1) Activity-aware objects: Amount of work performed to convert I/P into O/P

(2) Policy–aware objects: The basic protocols by which government / System Admin

(3) Process-aware objects: A series of actions, motions

F. *Smart Governance*

"Governance" is the exercise of political, economic and administrative authority to manage a nation's affairs. It is the complex mechanisms, processes and institutions through which citizens and groups articulate their interests, exercise their legal rights and obligations, and mediate their differences" (UNDP-The United Nations Development Programme). In the same way smart governance is about the future of the public services in the cities. The main objective of smart governance is about greater efficiency, community leadership, mobile working, good infrastructure, and continuous improvement through innovation. Smart Governance is basically about using technology to facilitate and support better planning and decision making in the metropolitan or smart cities. It is about improving democratic processes and transforming the ways that public services are delivered effectively and efficiently. It is defined that "The employment of the Internet and the world-wide-web for delivering government information and services to the citizens" (United Nations, 2006, AOEMA, 2005) (or) "The utilization of IT (Information Technology), ICTs (Information and Communication Technology) and other web-based telecommunication technologies to improve and / or enhance on the efficiency and effectiveness of service delivery in the public sector" (Jeong, 2007).

According to Johnston, E. W., & Hansen, D. L. (forthcoming), smart governance depends on the implementation of a smart governance infrastructure that should be accountable, responsive and transparent (Mooij, J., 2003). Smart City Governance includes the use of electronic devices in government offices on a large-scale as the use of telephones and fax machines, printers, computers, laptops, servers and PDAs, video conference systems as well as networking components including surveillance systems (IP Cameras, CC TV), tracking systems such as RFID tags, smart cards, sensors, actuators and even the use of television and radios to provide government-related information and services to the citizens in the cities. Smart governance provides interaction between (1) G2G (Government to Governments) (2) G2E (Government to Employees) (3) G2B (Government to Businesses) (4) G2C (Government to Citizens) (5) C2G (Citizens to Governments).

IV. *Conclusion*

Cities are frequently confronted with a large number of key problems, like unexpected development, informal real estate markets, construction of slums, inevitable population growth, high urban densities, lack of infrastructure, inadequate transport facilities, traffic jamming, poor power supply, in competent health services, deficient in of basic services, poor natural hazards management in overpopulated areas, crime, water, soil and air pollution leading to environmental degradation and climate change are leading the urban citizen life in unhappy. For the development of sustainable cities, national economical development and city inhabitant's better life, we need to construct more … ……smarter cities in future.

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